

# **HUNTINGTON MIDDLE SCHOOL BID SET**

**Volume 3 of 3  
Divisions 21-33**

## **KELSO SCHOOL DISTRICT**

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**PREPARED FOR:**

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END OF SECTION



**DIVISION 21**  
**FIRE SUPPRESSION**



## PART 1 GENERAL

### 1.1 SUMMARY

- A. The purpose of this section is to describe the commissioning process specific for those sections found in Division 21.

### 1.2 ADMINISTRATIVE REQUIREMENTS

- A. General Responsibilities: The Contractor's commissioning responsibilities applicable to the fire suppression contractor are as follows:
  - 1. In each purchase order or subcontract written, include requirements for submittal data, commissioning documentation, O&M data and training.
  - 2. Attend a commissioning kick-off meeting and/or other meetings necessary to facilitate the Commissioning process.
  - 3. Contractors shall assist in clarifying the installation, operation, maintenance, and control of commissioned equipment if requested by the Commissioning Authority.
- B. Coordination
  - 1. Refer to Section 01 91 00 for a listing of all sections where commissioning requirements are found, for systems to be commissioned and for testing requirements.
  - 2. Fire suppression Contractor must coordinate work with the Fire Alarm System Contractor. Systems should be tested together.

### 1.3 SUBMITTALS

- A. General Submittals:
  - 1. Contractor shall provide to the Commissioning Authority, through established channels, normal cut sheets and shop drawing submittals for all commissioned equipment.

## PART 2 PRODUCTS

Not Used

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. The Contractor shall install the system to meet code requirements.

### 3.2 CLOSEOUT ACTIVITIES

- A. Testing: The Contractor shall complete any tests necessary to demonstrate code compliance with the consultant/AHJ present.
- B. Operation and Maintenance Manuals: The approved complete manuals must be on site prior to training.
- C. Training: The Owner personnel shall be trained on procedures related to the Fire Suppression System.

### 3.3 DOCUMENTS REQUIRED

- A. The General Contractor will provide the following documentation before Final Acceptance:
  - 1. Completed Inspection Forms with approval signatures of all Authority Having Jurisdiction.
  - 2. Approval Signature of Architect

END OF SECTION

## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Sprinkler System Design.
- B. Piping.
- C. Sprinkler Heads.
- D. Valves.
- E. Fire Department Connections.
- F. Accessories.
- G. Owner Instruction.

### 1.3 QUALITY ASSURANCE

- A. General: Comply with 220500 requirements.
- B. Listing: All materials and equipment shall be UL listed and FM approved for the application.
- C. Latest Design: Products shall be of the manufacturer's latest design.
- D. Code and AHJ Compliance: Products and installation shall comply with code and Authority Having Jurisdiction (AHJ) requirements. Contractor is responsible to review and be familiar with code and local AHJ requirements. Products submitted are represented by the Contractor as complying with code and AHJ requirements.
- E. Exceed Code: The Contract Documents indicate items in excess of code requirements; in all such cases the work shall be done so that code requirements are exceeded as indicated. Such work may include coverage of areas not strictly required by code, painting, concealing of piping, access provisions for system inspections, oversized mains to accommodate future expansion, etc.

### 1.4 SUBMITTALS

- A. General: Comply with Section 220500.
- B. Shop Drawings:

1. Submit shop drawings of entire sprinkler system to Architect/Engineer for review; label these as "Preliminary – Not for AHJ Review". After incorporating or satisfactorily resolving Architect/Engineer review comments, submit shop drawings to AHJ for approval; label these as "AHJ Review Set"; at same time submit informational copy to the Architect/Engineer.
  2. Shop drawings shall include: riser detail, pipe support details, heights of piping above finished floor, room names and numbers, building grid lines, and building sections to give an overall representation of pipe routing.
  3. Shop drawings shall show head locations on reflected ceiling plans; use shop drawings from ceiling installer for ceiling layout; where these drawings are not available use information in the Contract Documents to develop a reflected ceiling plans.
  4. Shop Drawings shall show ductwork along with piping. Use shop drawings from ductwork installer for ductwork layout; where these drawings are not available use information in the Contract Documents.
- C. Product Data: Submit information on all products to be used; include evidence of product UL listing and FM approval. Submit proposed labeling and signage.
- D. Calculations: Submit all system calculations showing compliance with NFPA and AHJ requirements.
- E. Review Impacts: Architect/Engineer's review may involve changes to Contractor's design in order to comply with the Contract Documents including aesthetic issues. These changes may be substantial enough to affect drawings and calculations submitted to the AHJ and requiring a resubmittal. Contractor shall assume at least one re-submittal to the AHJ will be required and shall pay all required AHJ re-submittal and AHJ re-review fees.

## 1.5 GENERAL REQUIREMENTS

- A. Experience: All fire sprinkler design shall be performed by a Contractor thoroughly familiar with and knowledgeable of NFPA 13, NFPA 24, local AHJ requirements, and fire sprinkler system design and installation. By virtue of submitting a bid, the Contractor is acknowledging that he does in fact have such knowledge; and all work provided will fully comply with all the requirements of these specifications. The fire sprinkler Contractor shall be qualified, as required by the AHJ to design and install all parts of the fire sprinkler system.
- B. Professional Stamp: All fire sprinkler design drawings and calculations shall be prepared by and stamped by a licensed fire sprinkler professional as required by the AHJ.
- C. Design: System shall be Contractor designed and approval by both the Fire Marshal and Architect/Engineer. System design shall comply with Contract Documents regarding particular system configuration as may be specified or noted (i.e. routing of mains, head locations, etc.).
- D. Special Design Areas: Various portions of the building's fire sprinkler system require special design effort and coordination; including but not limited to: multiple design layouts, multiple calculations for these layouts, multiple meetings with code officials, multiple meetings with various contractors, multiple meetings with members of the design team, added coordination among trades, coordination with the AHJ, and coordination with the design team. The Contractor shall include in his bid costs for such special design and installation work.

## 1.6 REFERENCES

- A. AWWA C104: Cement Mortar Lining for Ductile Iron Pipe and Fittings for Water.
- B. AWWA C111: Rubber - Gasket Joints for Ductile Iron Pipe with Ductile Iron or Gray Iron Threaded Flanges.
- C. AWWA C151: Ductile Iron Pipe, Centrifugally Cast for Water.
- D. FM-AG: FM Global Approval Guide.
- E. NFPA 13: Standard for the Installation of Sprinkler Systems.
- F. NFPA 24: Installation of Private Fire Service Mains and their Appurtenances.
- G. UL-FPD: Underwriters Laboratories Fire Protection Equipment Directory.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. General: All products shall comply with Section 220500, Paragraph 2.1, Acceptable Manufacturers.
- B. Pipe and Fittings: Domestic manufacturer's only.
- C. Valves: Crane, Grinnell, Potter-Roemer, Viking, Gem, Victaulic, Nibco, Stockham.
- D. Sprinkler System Components: Reliable, Viking, Potter-Roemer, Gem, Star, Victaulic.
- E. Air Compressor: Jenny, General Air Products, Air Power Products.

### 2.2 PIPE AND PIPE FITTINGS

- A. Aboveground Piping and Fittings: Piping shall be steel or copper; in accordance with NFPA 13. Fittings shall be suitable for 175 psi working pressure, and shall be cast iron or malleable iron screwed, grooved, welded, or soldered; in accordance with NFPA 13. Piping and fittings ran outside and exposed to the outdoors shall be galvanized type. Flexible braided steel piping serving individual heads may be used where acceptable to the AHJ, and such piping is FM approved and UL listed for the application.
- B. Underground Piping and Fittings: Ductile iron pipe conforming to AWWA C151, thickness class 52 minimum; in accordance with NFPA 24. Fittings shall conform to AWWA C111, with pressure rating no less than the water district main the piping is connected to; and in accordance with NFPA 24. Pipe and Fittings shall have cement-mortar lining conforming to AWWA C104, standard thickness. Pipe and fittings shall be restrained against movement in accordance with NFPA 24. Thrust restraining joints/fittings shall be UL listed for fire main use. Exception: Piping serving fire department connections may be galvanized steel pipe externally coated and wrapped as required by code.

### 2.3 VALVES

- A. Isolation Valves: Bronze construction, minimum 175 psi water working pressure, UL listed and FM approved, per NFPA 13, with configuration and accessories to suit application.
- B. Check Valves: Iron or bronze body swing check valve, minimum 175 psi working pressure, UL listed and FM approved, per NFPA 13.
- C. Automatic Ball Drip Valve: Straight or angle cast brass ball drip, 1/2 inch.

#### 2.4 ALARM VALVES--WET PIPE

- A. Alarm valve shall be UL listed and FM approved for use as an alarm valve in a wet pipe fire sprinkler system, same size as riser (unless noted otherwise).
- B. Alarm valve shall be complete with pressure gauge, main drain valve, alarm switch, and all other accessories to provide a complete alarm valve assembly as required to function in accordance with NFPA standards, and as required by the AHJ.

#### 2.5 ALARM VALVES--DRY PIPE

- A. Alarm valve shall be UL listed and FM approved for use as an alarm valve in a dry pipe fire sprinkler system, size as selected by Contractor.
- B. Alarm valve shall be complete with accelerator, pressure gauges, main drain valve, pressure alarm switch, alarm test valving, priming connections, drain lines/drain cup, connections for water motor alarm, check and isolation valves for air line connection, air line relief valve and all other accessories to provide a complete alarm valve assembly as required to function in accordance with NFPA standards, and as required by the AHJ.

#### 2.6 ALARM BELLS

- A. Electric Type: Electric motor driven alarm rated for outdoor installation, with alloy steel gong shell (color as selected by Architect/Engineer and acceptable to AHJ), stainless steel plunger striking tip, and 8-inch diameter. Voltage/electrical characteristics to match power, devices, and fire alarm system connected to.
- B. Labeling: Alarm bells shall be labeled or provided with sign mounted adjacent to bell, as required by the AHJ. Sign shall be aluminum lithographed, with red letters on white background.

#### 2.7 SPRINKLER HEADS

- A. Wet Type - Finished Areas:
  - 1. Pendant: Shall be low profile, glass bulb type, with temperature rating to suit application and factory chrome plated finish. Where installed through ceiling, provide with escutcheons, two piece adjustable recessed type, with factory chrome plated finish to match sprinkler heads. Quick response type.
  - 2. Upright: Shall be glass bulb type, with temperature rating to suit application, and factory chrome plated finish. Quick response type.
  - 3. Sidewall: Shall be glass bulb or fusible solder type, with temperature rating to suit application, and factory chrome plated finish. Quick response type.
- B. Wet Type - Unfinished Areas: link/lever type or glass-bulb type, with natural bronze or



chrome plated finish, temperature rating to suit application. Quick response type.

- C. Dry Type:
  - 1. General: Provide where system may be exposed to freezing temperatures with finish, length and temperature rating to suit application. Quick response type.
  - 2. Finished Areas: Polished chrome finish type with flush type chrome plated escutcheon where installed through ceilings, soffits, and similar elements.
  - 3. Unfinished Areas: Natural bronze finish with flush or deep type brass finish escutcheon where installed through a floor, ceiling, or similar element.
- D. Sprinkler Guards: Hard-wire cage sprinkler guard, designed to protect sprinkler from mechanical damage, with chrome plated finish. Where used on exposed heads, guards shall be type that clamp to pipe; where used on recessed heads, guards shall be surface anchor type having substantial attachments to material surrounding the head (soffit plywood, etc.); provide 2x backing as needed. Provide custom fabricated guards/attachments as required.
- E. Sprinkler heads shall be upright, pendant or sidewall type as required to suit application.
- F. Extended Coverage Heads: Provide as necessary to allow complete coverage of all areas.

## 2.8 ACCESSORIES

- A. Waterflow Alarm - Flow Type Indicator: Shall be UL listed, with polyethylene paddle water flow detector, cast metal body, adjustable time delay retard mechanism to allow indicator to absorb fluctuations of water flow due to pressure surges to prevent false alarms. Electrical characteristics shall match alarm bell and available voltage.
- B. Sightflow Connections: Cast iron construction, with clear acrylic windows, steel covers, and Buna-N O-rings.
- C. Valve Switches: Switch for indicating operation of valve; type and configuration to suit valve used on. Switch shall have single pole, double throw type contacts, with cast aluminum housing and non-ferrous parts for corrosion resistance. Shall be weatherproof type where installed outdoors.
- D. Sway Bracing/Restraints: Contractor fabricated of riser clamps, Schedule 40 pipe and pipe fittings, all welded construction, size and configuration to suit application.
- E. Specialties: Access doors, gauges, and related piping specialties; see Section 220519.
- F. Hangers/Supports: See Section 220529.
- G. Sleeves Seals: See Section 220530.
- H. Air Compressor:
  - 1. Sizing: By Contractor, in compliance with NFPA and AHJ requirements.
  - 2. Type: Electric motor-driven, air cooled, single-stage, tank mounted type. Tank shall be ASME labeled with support legs for base mounting. Unit shall be complete with wiring, motor starter, pressure switch and devices for automatically controlling compressor operation. Unit shall have rubber-in-shear vibration isolators, relief valve, pressure gauge, outlet isolation valve, outlet union, and accessories for proper connections and operation.

3. Power: Unit shall be for use with 120 volt/1 phase electricity (unless noted otherwise), with a single point power connection. Provide unit with electric power disconnect; complying with NEC and code requirements.
  4. Noise: Compressor noise shall not exceed Noise Criteria (NC) 35 in any octave band. Provide acoustic enclosure, remote piped air intake with a muffler, and other accessories to reduce noise as required to meet this NC level.
- I. Air Maintenance Assembly: Shall be type for use with dedicated sprinkler system air compressor. Assembly shall include air line strainer, air pressure switch for compressor control, bypass globe valve, isolation valves, unions, and all related components to properly connect the air compressor to the dry pipe system, in compliance with NFPA and local code requirements.
- J. Labeling:
1. General: See Section 220500 for labeling of piping, valves, equipment, concealed items, and similar items.
  2. Design Basis: Provide label identifying hydraulic basis of design and other design parameters, fabricated of material as required by the AHJ, with lettering type and information as required by the AHJ.
  3. Other: Provide additional labels as required by AHJ, fabricated of material as required by the AHJ, with lettering type and information as required by the AHJ.
- K. Signage:
1. Room Doors: Metal or self-adhesive vinyl sign with white lettering on a red background; lettering minimum of 2-inches high. Where exposed to weather sign and accessories shall be UV and corrosion resistant. Label wording as directed by the AHJ (e.g. "SPRINKLER VALVE ROOM", "FIRE SPRINKLER RISER ROOM", etc.). Verify AHJ labeling requirements prior to ordering.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. General: Installation of all equipment shall be performed by a Contractor specializing in this work and subject to Owner and Fire Marshal approval. Install all items in accordance with code, manufacturers' recommendations, and best construction practices.
- B. Water Main Flushing: Flush outside fire water mains prior to connecting to inside system to prevent any contamination. Such flushing by Division 21 is in addition to any flushing performed by other trades. Failure to flush will result in system rejection. Reference NFPA 24 for requirements; coordinate with site contractor.
- C. Pipe Routing:
1. Select pipe routing that maintains full personnel access to building equipment and systems, without requiring stepping over or bending down to cross sprinkler piping. Follow specific pipe routing requirements of the Contract Documents as indicated. Piping shall run parallel to building structure in a neat, workmanlike manner.
  2. All piping shall be run concealed in ceiling space, attic space, pipe shafts, soffits, etc. where possible. Piping may only be exposed with Engineers approval and shall be painted as directed by the Architect/Engineer. Where piping must run exposed, it shall

- be ran in as unobtrusive fashion as possible, in lines parallel to major building features, as high as possible, and as directed by the Architect/Engineer.
3. Provide all necessary drilling of beams, trusses, etc; reference Section 220500 for cutting requirements; structural Engineers approval is required prior to any such cutting or drilling.
- D. Escutcheons: Provide chrome plated escutcheon plates at exposed pipe penetrations of all ceilings, floors and walls.
- E. Conflict Prevention:
1. Review all building and system plans carefully and arrange the fire sprinkler work to avoid interferences and conflicts with other trades. Discuss and coordinate proposed sprinkler routing with other trades. The fire sprinkler system has the lowest priority of all building systems and is required to accommodate the space requirements of other systems.
  2. If piping routes are not properly coordinated with other trades and structures, rerouting and possible re-sizing will be required as directed by the Architect/Engineer. Offset, crossover and otherwise route piping to install system in available space.
- F. System Drainage: Special care shall be taken to ensure that entire sprinkler system is drainable in accordance with code. Provide drain valves as required (with labels) to allow for drainage; valves shall be concealed (with access doors) where possible; provide valves with provisions (male pipe nipple) for attaching temporary drain lines (where needed). Extend main drain(s) and 1 inch inspector's test connections to outside for drainage.
- G. Alarm Devices: Provide alarm indicators as required by the AHJ. Connection of devices to the fire alarm system is by Division 26 (unless indicated otherwise). Adjust water flow indicator time delay as necessary to prevent false alarms due to pressure fluctuations.
- H. Labeling: Provide labeling of items per Section 220500. Provide additional labeling of items per AHJ requirements. All drain valves, alarm bells, and risers shall be labeled to clearly indicate purpose and area served. Label riser with hydraulic basis of design information. All piping shall be labeled per Section 220500.
- I. Posted Plans: Provide reduced size as-built (or a building key plan) with all system drains and valves clearly indicated. Laminate plan(s) and post adjacent to each riser (or as directed by the Architect/Engineer and AHJ). Provide copy of plan(s) with the O&M Manual.
- J. Tamper Switches: Provide valve tamper switches at all isolation valves and as required by the AHJ to indicate valves not fully open. Connection to central fire alarm system shall be by Division 26.
- K. Sprinkler Heads: Heads shall be centered in ceiling panels. Where "scored" ceiling panels are used, heads shall be located to be centered in the flat portion of the tile between "scores".
- L. Head Protection: Provide wire cage protectors for heads susceptible to damage (this includes all heads in mechanical loft areas with sprinkler heads 7 feet or less above walking surface, all gym heads, outside soffit heads below 9 feet, and similar areas).
- M. Hangers and Supports: Shall comply with NFPA 13 and Section 220529. See also structural drawings for added limitations/requirements of supports and attachments to structure.

- N. Room Signage: Rooms containing fire suppression risers, system control valves, and other major fire suppression components shall have signage on the outside of the door to the room. Verify AHJ requirements and locations prior to ordering.

### 3.2 SYSTEM DESIGN

- A. General: System shall be Contractor designed in accordance with NFPA 13, AHJ requirements, and additional requirements as cited in the Contract Documents.
- B. Hydraulically Designed: System design shall be based on hydraulic calculations using approved water flow test data on the water supply main serving the fire protection system. Such test data must meet the approval of the AHJ and the Engineer. Any water flow data indicated on the drawings is preliminary only. It shall be the Contractor's responsibility to obtain updated water flow data (including new water tests) and pay all associated test fees or charges. Design and calculations shall include complete system, including water main to building, and extending as far back into the local utility systems (i.e. to reservoirs) as deemed necessary by the AHJ.

### 3.3 TESTING

- A. Testing: The systems shall be hydrostatically and operationally tested in accordance with the requirements of NFPA 13 and the AHJ. Any changes required to meet time or flow test requirements shall be made without additional cost to the Owner. Certificates of acceptance shall be submitted to the Architect/Engineer.

### 3.4 OPERATING AND OWNER INSTRUCTIONS

- A. Typed Instructions: Typewritten, plastic covered, framed operational and maintenance instructions shall be mounted in the building(s) near each fire sprinkler riser. Information shall clearly indicate portion of the building covered by the system, type of system, location of sub-risers, locations of system drains, when system was placed into service, installed, installers name (company) and contact information for service, how to close and open system main valve, and other pertinent operational instructions. Provide reference to O&M manuals provided to the Owner for additional operation and maintenance instructions.
- B. O&M Manual: See Division 01 and Division 22.
- C. Owner Instructions: The Owner or his representative shall be instructed by the Sprinkler Contractor in the operation of the system. The instruction shall be given by Contractor's personnel who are considered qualified in the opinion of the Architect/Engineer and shall be for a minimum of two hours. Instruction shall include location of all valves, drains, and pipe routing, as well as proper maintenance and testing procedures.

END OF SECTION

# **DIVISION 22**

## **PLUMBING**



## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Operation and Maintenance Manual.

### 1.3 SUBMITTALS

- A. General: Comply with Section 220500 and Division 01.
- B. Preliminary O&M: Submit preliminary review O&M manual for review.
- C. Final O&M: Submit Final O&M manuals per Division 01.

## PART 2 PRODUCTS

### 2.1 GENERAL

- A. General Contents: A maintenance manual shall be compiled containing maintenance and operating information and maintenance schedules for all project mechanical systems. See Division 01 for quantities, organization, format, and other requirements; meet additional requirements as specified herein.
- B. CD Electronic Copy: Shall contain pdf open format copies of the entire O&M manual, pdf open format copies of record drawings, and ACAD files for record drawings where ACAD shop drawings or ACAD record drawings are required (see individual specifications Sections for requirements). Files shall be bookmarked by section and by product. Drawings shall be bookmarked and labeled by sheet number and name.

### 2.2 SUBMITTAL DATA AND TECHNICAL O&M DATA

- A. Submittal Data: Provide manufacturer's technical product data, with manufacturer's model number, description of the equipment, equipment capacities, equipment options, electrical power voltage/phase, special features, and accessories. Label equipment and fixtures data with same designation as used on contract documents. This information may consist of the same information as the submittal data (clearly identified and marked to suit each item). This information shall be provided for all items requiring maintenance and for items that may require replacement over a 30 year period or be revised due to an Owner building improvement.
- B. Technical O&M Data: Provide for each equipment or item requiring maintenance. Label O&M data to clearly indicate which equipment on the project it applies to (use same

designation as used in the Contract Documents). Data to include:

1. Manufacturer's operating and maintenance manuals and instructions.
  2. Itemized list of maintenance activities and their scheduled frequency.
  3. Maintenance instructions for each maintenance activity.
  4. Manufacturer's parts list.
  5. Manufacturer's recommended lubricants.
  6. Size, quantity and type of filters required (as applicable).
  7. Size, quantity and type each belts unit requires (as applicable).
  8. Size, quantity and type of fuses (as applicable).
  9. Control devices calibration information.
  10. System wiring diagrams and schematics.
  11. Control sequence descriptions with setpoints and range of adjustments.
  12. Programming logic.
  13. Description of unique devices/controls/programs specific to this system.
  14. Programmers manuals.
- C. Sources: Provide names, addresses, and phone numbers for local manufacturer's representative, service companies, and parts sources for mechanical system components. List shall include all mech including: system riser components, valves, sprinkler heads, and equipment plumbing fixtures, valves, and equipment HVAC system valves, filters, belts, and equipment control valves, actuators, dampers controllers, relays, and sensors.
- D. Start-Up Reports: Include copies of all equipment and system start-up reports.
- E. Balancing Report: Include a full copy of the balancing report under a dividing tab for the specification section (or building system) where this work is specified. Where balancing is provided by others, obtain from the balancer a copy of the report to insert in the O&M's.

## 2.3 MAINTENANCE SCHEDULES

- A. General: Provide Maintenance schedules with an itemized list of maintenance activities and their scheduled frequency (i.e., weekly, monthly, semi-annually, etc.) for item requiring maintenance.
- B. Special Maintenance: List any critical maintenance items or areas requiring special attention.
- C. Start-Up/Shut-Down: Provide normal start-up, operating, and shut-down procedures; emergency shut-down procedures; and (where applicable) seasonal shut-down procedures.

## PART 3 EXECUTION

NOT USED

END OF SECTION



## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Division 21 - Fire Suppression.
- C. Division 22 - Plumbing Systems.
- D. Division 23 - Heating, Ventilation, and Air Conditioning (HVAC) Systems.
- E. Division 25 - Integrated Automation.

### 1.2 WORK INCLUDED

- A. General Mechanical System Requirements.
- B. Mechanical System Motors.
- C. Identification and Labeling.

### 1.3 DEFINITIONS

- A. Abbreviations and Terms: Where not defined elsewhere in the Contract Documents, shall be as defined in RS Means Illustrated Construction Dictionary, Fourth Addition and in the ASHRAE Handbook of Fundamentals, latest edition.
- B. "As required" means "as necessary to form a safe, neat, and complete working installation (or product), fulfilling all the requirements of the specifications and drawings and in compliance with all codes."
- C. "Concealed" means "hidden from view" as determined when areas are in their final finished condition, from the point of view of a person located in the finished area. Items located in areas above suspended ceilings, in plumbing chases, and in similar areas are considered "concealed." Items located in cabinet spaces (e.g. below sinks) are not considered concealed.
- D. "Coordinate" means "to accomplish the work with all others that are involved in the work by: directly discussing the work with them, arranging and participating in special meetings with them to discuss and plan the work being done by each, obtaining and completing any necessary forms and documentation required for the work to proceed, reaching agreement on how parts of the work performed by each trade will be installed relative to each other both in physical location and in time sequence, exchanging all necessary information so as to allow the work to be accomplished with a united effort in accordance with the project requirements".
- E. "Finished Areas" means "areas receiving a finish coat of paint on one or more wall surface."

- F. "Mechanical", where applied to the scope of work, includes all project fire suppression systems, plumbing systems, HVAC systems, and controls for these systems and all work covered by specification Divisions 21, 22, 23, and 25. Such work is shown on multiple drawings and is not limited to a particular set of sheets, or sheets prefaced with a particular letter.
- G. The term "related documents" (as used at the beginning of each specification section), and the Specification Divisions and Sections listed with it, is only an indication of some of the specification sections which the work of that section may be strongly related to. Since all items of work relate to one another and require full coordination, all specification sections, as listed in the Table of Contents, shall be considered as being "related documents", and shall be considered (by this reference) in the same manner as if they had all been listed under the term "related documents" in each specification section.
- H. "Work included" (as used at the beginning of each specification section), and the items listed with it, is only an indication of some of the items specified in that Section and is in no way limiting the work of that Section. See complete drawings and specifications for all required work.
- I. "Verify" means "Contractor shall obtain, by methods independent of the project Architect/Engineer and Owner, the information noted and the information needed to properly perform the work".
- J. "Substitution": As applied to equipment means "equipment that is different than the 'Basis of Design' equipment scheduled on the drawings (or otherwise indicated in the contract documents)".

#### 1.4 GENERAL REQUIREMENTS

- A. Scope: Furnish all labor, materials, tools, equipment, and services for all mechanical work. This section applies to all Division 21, 22, 23, and 25 specifications and to all project mechanical work. All mechanical equipment and devices furnished or installed under other Divisions of this specification (or by the Owner) which require connection to any mechanical system shall be connected under this division of the Specifications.
- B. General: All work shall comply with Division 00, General Conditions, Supplementary Conditions, Division 01, and all other provisions of the Contract Documents. The products and Work specified in Division 22 applies to Division 21, Division 22, Division 23, and Division 25.
- C. Code:
  - 1. Compliance: All work shall be done in accordance with all applicable codes and ordinances. Throughout the Project Documents, items are shown or specified in excess of code requirements; in all such cases, the work shall be done so that code requirements are exceeded as indicated.
  - 2. Documentation: Maintain documentation of all permits and code inspections for the mechanical work; submit documentation showing systems have satisfactorily passed all AHJ inspections and requirements.
  - 3. Code Knowledge: Contractor and workers assigned to this project shall be familiar and knowledgeable of all applicable codes and ordinances. Code requirements are typically not repeated in the Contract Documents. By submitting a bid, the Contractor is

- acknowledging that the Contractor and workers to be utilized on this project have such knowledge.
4. **Proof of Code Compliance:** Prior to final completion, satisfactory evidence shall be furnished to show that all work has been installed in accordance with all codes and that all inspections required have been successfully passed. Satisfactory evidence includes signed inspections by the local code authority, test lab results, qualified and witnessed field tests, and related acceptance certificates by local code authorities, and field notes by the Contractor as to when all inspections and tests occurred.
- D. **Complete Systems:** Furnish and install all materials, appurtenances, devices, and miscellaneous items not specifically mentioned herein or noted on the drawings, but which are necessary to make a complete working installation of all mechanical systems. Not all accessories or devices are shown or specified that are necessary to form complete and functional systems.
- E. **Review and Coordination:**
1. **General:** To eliminate all possible errors and interferences, thoroughly examine all the Drawings and Specifications before work is started, and consult and coordinate with each of the various trades regarding the work. Such coordination shall begin prior to any work starting, and continue throughout the project.
  2. **Suppliers:** Suppliers of products shall review the documents to confirm that their products are suitable for the application and that all manufacturers requirements and recommendations have been satisfactorily addressed in the Contract Documents. Where not addressed the supplier shall notify the Engineer prior to bidding to resolve any issue or include in their bid an adequate amount to resolve the issue.
- F. **Conflicts and Discrepancies:** Notify the Architect/Engineer of any discrepancies or conflicts before proceeding with any work or the purchasing of any materials for the area(s) of conflict until requesting and obtaining written instructions from the Architect/Engineer on how to proceed. Where conflicts occur, the most expensive and stringent requirement (as judged by the Architect/Engineer) shall prevail. Any work done after discovery of such discrepancies or conflicts and prior to obtaining the Architect/Engineer's instructions on how to proceed shall be done at the Contractor's expense.
- G. **Drawings and Specifications:** Drawings and specifications are complementary and what is called for in either is binding as if called for in both. The drawings are diagrammatic and show the general arrangement of the construction and therefore do not show all offsets, fittings and accessories which are required to form a complete and operating installation. Mechanical work is shown on multiple drawings and is not limited to a particular set of sheets, or sheets prefaced with a particular letter.
- H. **Offsets/Fittings:**
1. **Piping Systems:** Include in bid all necessary fittings and offset to completely connect up all systems, maintain clear access paths to equipment, and comply with all project requirements. Offsets are required to route piping around building structural elements, roof slopes, mechanical systems, electrical systems, and numerous other items. Due to the schematic nature of the plans such offsets are typically not shown. Contractor is responsible to determine the quantity of offsets and fittings required, and the labor involved. No added payment or "extras" will be granted for the Contractor's failure to correctly estimate the number of offsets and fittings and labor required. Contractor is

- advised that equipment and fixture connections may require more than 20 elbows per plumbing fixture and coil per pipe line.
2. Duct Systems: Include in bid all necessary fittings, offsets, and transitions to completely connect all systems, maintain clear access paths, and comply with all project requirements. Offsets are required to route piping around building structural elements, roof slopes, mechanical systems, electrical systems, and numerous other items. Due to the schematic nature of the plans such offsets are typically not shown. Contractor is responsible to determine the quantity of offsets and fittings required, and the labor involved. No added payments or "extras" will be granted for the Contractor's failure to correctly estimate number of offsets, fittings, transitions and labor required. Contractor is advised that transitions are required at connections to all equipment, to all air inlets/outlets, crossing of beam lines, at crossing with piping, and similar locations.
- I. Design: The level of design presented in the documents represents the extent of the design being furnished to the Contractor; any additional design needed shall be provided by the Contractor. All design by the Contractor shall be performed by individuals skilled and experienced in such work, and where required by local code (or elsewhere in the documents) shall be performed by engineers licensed in the State where the project is located. Include in bid the costs of all such project design; including engineering, drafting, coordination, and all related activities and work. Such designs services are required for many building systems; including but not limited to ductwork at equipment, piping at fixtures and equipment, hanger/support systems, temporary duct/piping systems, mechanical offsets/adjustments to suit other system, and for methods/means of accomplishing the work.
  - J. Special Tools: Furnish to the Owner one complete set of any and all special tools such as odd size wrenches, keys, etc. (allen wrenches are considered odd), which are necessary to gain access to, service, or adjust any piece of equipment installed under this contract. Each tool shall be marked or tagged to identify its use. Submit a written record listing the special tools provided, date, and signed by the Owner's representative receiving the tools.
  - K. Standards and References: Shall be latest edition unless a specific edition, year, or version is cited, or is enforced by the AHJ.
  - L. Warranties:
    1. General: Products and workmanship shall be warranted to be free from all defects, capable of providing satisfactory system operation, and conforming to the requirements of the Contract Documents. Include in the project bid all costs associated with project warranties to ensure that the warranty extends for the required period; possible project delays and failure by others to complete their work may cause the start of the warranty period to be delayed. The Contractor shall be responsible for increasing the warranty dates by corresponding amounts to provide the required warranty periods.
    2. Basic Project Warranty: As described in Division 00 and 01. See individual specification sections for specific warranty requirements. Start date and duration are as indicated in Division 00 and 01. Where not indicated otherwise in Division 00 or 01, the basic project warranty shall start at project substantial completion and be for one year.
    3. Special Warranties: See individual specification sections for special warranty requirements and extended warranty periods beyond the basic project warranty.
  - M. Permits and Fees:

1. Obtain and pay for all permits, licenses, fees and inspections as required by the Code and as specified herein (unless noted otherwise).
  2. Pay all charges made by any utility company or municipality for material, labor or services incident to the connection of service (unless noted otherwise).
- N. Commissioning: All mechanical systems are to be commissioned per Section 220800. The Contractor has specific responsibilities for scheduling, coordination, startup, test development, testing and documentation. At a minimum, the Contractor shall provide a documented and signed record to verify that all equipment and systems installed under this contract have been inspected and functionally tested to verify full compliance with the contract specifications. In many cases, this shall require the Contractor to create or otherwise provide procedures and checklists for approval by the Commissioning Consultant prior to the start of functional testing. Reference Division 01 and coordinate all commissioning activities with the Commissioning Consultant.
- O. WSSP: This project is required to comply with the Washington Sustainable School Protocol (WSSP). This requires certain reports and documentation from the Contractor; and the use of specific energy efficient and environmentally friendly materials and systems. See WSSP requirements, Division 01, and individual specification sections for specific requirements.

## 1.5 SUBSTITUTIONS

- A. General: See Division 00 and 01 for information and requirements regarding substitutions. Manufacturers not scheduled on the plans or listed as "Acceptable Manufacturers" require prior approval and shall submit a substitution request form (see Division 01 for requirements and limitations). See Paragraph 2.1 this specification section regarding "Acceptable Manufacturers".
- B. Redesign:
1. The Contract Documents show design configurations based on particular manufacturers. Use of other manufacturers' products (i.e. substitutions) from what is shown (or specified) may require redesign of mechanical, plumbing, controls, fire protection, electrical, structural, and general building construction to accommodate the substitution.
  2. Review the installation requirements for substitutions and provide redesign of all affected construction. The redesign shall be equal or superior in all respects to the Architect/Engineer's design (as judged by the Architect/Engineer), including such aspects as equipment access, ease of maintenance, utility connection locations, unit electrical requirements, noise considerations, unit performance, and similar concerns.
  3. Redesign shall be done by the Contractor and shall meet the requirements and have the approval of the Architect/Engineer prior to beginning work. Apply for and obtain all permits and regulatory approvals.
- C. Construction Modifications: Provide all required construction modifications to accommodate the substituted products; this includes all mechanical, plumbing, controls, fire protection, electrical, structural, and general building construction. Construction modification shall comply with code, specifications, and be equal to designed construction.
- D. Costs: Cost of redesign, construction costs, and all additional costs incurred to accommodate substituted equipment shall be borne by the Contractor.

- E. Submittals: In addition to other required submittals, submit shop drawings showing the redesign for substituted equipment; submittal shall include installation plans and sections, connecting services (i.e. ducts, piping, electrical) locations and routing, required service clearances, and related installation details. Submit data required by other disciplines to allow review of the impact of the substitution (i.e. weights, electrical).

## 1.6 QUALITY ASSURANCE

- A. Experience: All work shall be performed by individuals experienced and knowledgeable in the work they are performing, and experienced with the same type of systems and building type as this project. By virtue of submitting a bid, the Contractor is acknowledging that workers to be utilized on this project have such experience and knowledge. Upon request of the Engineer, submit resumes showing the work history, training, and types of projects worked on, for individuals assigned to this project.
- B. Code: Utilize workers experienced and knowledgeable with codes pertaining to their work; verify code compliance through-out the project.
- C. ASME: All pressure vessels, pressure vessel safety devices, and pressure vessel appurtenances shall comply with the standards of, and bear the stamp of ASME.
- D. Quality Assurance Checks: Prior to ordering products and making submittals, confirm the following for each:
  - 1. General: Product is suitable for the intended purpose and complies with the Contract Documents.
  - 2. Manufacturer: Product's manufacturer is listed as an acceptable manufacturer in the Contract Document's or a substitution request (where allowed) has been submitted and the manufacturer has been listed as acceptable.
  - 3. Electrical (for products requiring electrical power):
    - a. Product is for use with the voltage/phase as indicated on the electrical plans (or for the electrical circuit the item will be connected to).
    - b. Product's ampacity requirements (MCA) do not exceed that indicated on the electrical plans (or for the electrical circuit the item will be connected to).
  - 4. Weight: Product's weight is no greater than that indicated.
  - 5. Space Verification: Product will fit in the space available, and along the path available to install the item, will have adequate service clearances, and will not impede on any clearances required for other items in the space the item will be located.
  - 6. Installation: A suitable method for installing the product has been selected which meets the project schedule and other requirements.
  - 7. Lead Time: The product's fabrication, shipping, and delivery period meets the project schedule requirements.
  - 8. Substituted Equipment: Where equipment is not the basis of design confirm all requirements for substituted equipment have been met and shop drawings of construction revisions have been (or are being) prepared.
  - 9. Controls: Item is compatible with the controls it will be connected to and has been coordinated with the firm providing the project control work.
  - 10. Listing: Item is Listed when required to be as such. And if the item is to be installed as part of a Listed system or assembly, it is compliant with the Listing of the overall system or assembly.

- E. Check-Out: The Contractor shall be responsible to verify that proper installation and proper connections have been provided for all mechanical work. Contractor shall provide installation checkout, start-up services, and perform a thorough check of all mechanical systems to verify proper installation and operation. Contractor shall operate all items multiple times under varying conditions to confirm proper operation. Contractor shall submit a checklist listing all equipment, fixtures, and similar items furnished on this project, with a date and initials indicating when the item was checked, a list of what was checked, and by whom. Such check shall, as a minimum utilize documents provided by the equipment manufacturer. Such a check-out is in addition to any commissioning activities specified (unless noted otherwise).

#### 1.7 SUBMITTALS - GENERAL

- A. Variations: Only variations that are specifically identified as described herein will be considered. Provide with the submittal (in addition to other information required): description of the proposed variation, entity who is proposing the variation, why the variation is being proposed, any cost changes associated with the variation, and any other pertinent data to allow for review. Failure to submit information on the variation as described will result in the submittal review being conducted without considering the variation.
- B. Quality Assurance: By submitting an item for review, the Contractor is claiming that all "Quality Assurance Checks" (see paragraph 1.6 this specification Section) have been performed and satisfactorily passed and no further comment from the submittal reviewer is required for the "Quality Assurance Checks".
- C. Product Submittals - Information Required:
1. Manufacturer's catalog information, containing product description, model number, and illustrations. Mark clearly to identify pertinent information and exact model and configuration being submitted.
  2. List of accessories and options provided with product.
  3. Product dimensions and clearances required.
  4. Product weight.
  5. Submittal identified with product name and symbol (as shown on the drawings or written in the specifications) and specification Section and paragraph reference.
  6. Performance capacity and characteristics showing compliance with the Contract Documents.
  7. Manufacturer's and local manufacturer's representative names, addresses, and phone numbers.
  8. For equipment requiring piping or duct connections:
    - a. Type of connections required.
    - b. Size and locations of connections.
  9. For electrically operated equipment:
    - a. Number and locations of electrical service connections required.
    - b. Voltage required.
    - c. Fuse or circuit breaker protection requirements.
    - d. Motor starter requirements; if motor starter is furnished with the equipment, submit product information on motor starter.
  10. For equipment requiring control connections:
    - a. Type of control signals required.
    - b. Control communication protocol.
    - c. Information on control devices furnished with equipment.

- d. Location of control connections.
- 11. Manufacturer's installation instructions.
- 12. See each specification Section for additional submittal requirements.
- D. Shop Drawing Submittals: Provide for the following systems:
  - 1. Fire Suppression Systems.
  - 2. Mechanical room floor drain locations.
  - 3. Mechanical room hydronic piping.
  - 4. HVAC control systems.
  - 5. For any parts of any system which are to be installed differently than as shown on the drawings.
  - 6. Construction revisions to accommodate Substituted Equipment.
  - 7. Other areas/work as noted in the Contract Documents.
  - 8. For those systems requiring shop drawings, reference system's specification Section for additional requirements.

## 1.8 SCHEDULE OF VALUES

- A. Breakdown: Provide schedule of values for the following categories (as a minimum); provide a materials and labor breakdown for each category.
  - 1. Mobilization.
  - 2. General Project Management, General Design, General Coordination, Submittals.
  - 3. Insulation.
  - 4. Fire Suppression - Shop Drawing.
  - 5. Fire Suppression - Labor and Materials.
  - 6. Plumbing Fixtures.
  - 7. Plumbing Underground.
  - 8. Plumbing Aboveground.
  - 9. Hydronic System Equipment (Pumps, Boilers, Chillers, etc.).
  - 10. Hydronic System Piping.
  - 11. HVAC System (Air Handling Equipment, Ductwork and Accessories).
  - 12. Controls - Shop Drawings and Programming.
  - 13. Controls - Labor and Materials.
  - 14. Balancing.
  - 15. Commissioning.
  - 16. O&M Manual, Record Data.
  - 17. Punchlist, Closeout, Owner Training.
- B. Closeout: The dollar value for "Punchlist, Closeout, and Owner Training" shall in no case be less than 3% of the total dollar value of the mechanical work.
- C. Proof of Operation: In addition to payments held out for retainage and project final completion as specified above and in Division 01, the Owner reserves the right to withhold a percentage of the funds for any of the above categories until the systems (of that category) have been proven to operate as specified and have been completely tested, adjusted, commissioned, and balanced.

## 1.9 RECORD DOCUMENTS

- A. Field Record Drawings: Maintain a set of full size contract plans at the project site upon which all changes from the as-bid plans are noted. Plans shall be maintained clean, dry and



legible; with information recorded concurrent with construction progress. These plans shall also include actual locations (with dimensions) of all underground and concealed mechanical systems. Connection points to outside utilities shall be located by field measurements and so noted on these record drawings. All addenda, change order, field orders, design clarifications, request for information, and all other clarifications and revisions to the plans shall also be made a part of these record drawings. Plans shall be available for weekly review by the Architect/Engineer. Label drawing "As-Built" with date, name of Contractor, and name of individual overseeing the work.

- B. Final Field Record Drawings Submittal: Deliver to the Architect/Engineer the original Field Record drawings and one full size copy.
- C. Photographs: Photograph with minimum 10 megapixel digital camera (or better) all concealed utilities located below ground, under floors, and in building. Photographs shall be taken prior to any insulation being installed, and with multiple views so as to allow clear understanding and locations of the systems from the photographs. Furnish prints on 8-1/2 x 11 paper, with two 5 x 7 photographs per page. Label each photograph, as to location photographs are taken and system(s) indicated, and provide two sets of 3-ring notebooks with photographs. Provide divider tabs in notebook, and organize photographs in logical groupings; provide table of contents listing all photographs. Provide a labeled CD's containing all photographs, one with each notebook.

#### 1.10 PRODUCT HANDLING, PROTECTION AND MAINTENANCE

- A. Protection:
  - 1. Protect all products from contamination, becoming unclean, and from damage of any kind and whatever cause; when being handled, in storage, and while installed, until final project acceptance.
  - 2. Completely cover fixtures, motors, control panels, equipment, and similar items to protect from becoming unclean and damage of any kind.
  - 3. Protect premises and work of other trades from damage due to Mechanical work.
- B. Openings: Cap all openings in pipe, ductwork and equipment to protect against entry of foreign matter until all work that could cause unclean conditions or damage is complete (including work that has dust or fumes associated with it). Caps shall be of sufficient strength and seal integrity to prevent entry of water or fumes for the most extreme conditions they may be exposed to (i.e. high velocity water spray, high winds, concrete splash, etc.)
- C. Storage: Provide properly conditioned and sheltered storage facilities for products to prevent damage of any kind and to maintain new condition. Provide adequate venting arrangements to avoid condensation damage.
- D. Operation and Maintenance:
  - 1. General: Inspect products periodically to confirm conditions and maintenance needs. Keep records of inspections and (upon request) forward to the Architect/Engineer prior to project final acceptance. Operation and Maintenance shall be in accordance with manufacturer's written procedures and recognized best maintenance practices. Keep records of maintenance and (upon request) forward to the Architect/Engineer prior to project final acceptance.
  - 2. Stored Products: Provide maintenance (i.e. equipment rotation, lubrication, flush, cleaning, etc.) and inspection on products while stored to maintain new condition.

3. **Installed Products:** Provide maintenance and inspection of products and operate mechanical systems until substantial completion or specified Owner Instruction has been provided (whichever is later). Maintenance shall include all labor and materials and all manufacturers' recommended maintenance (i.e. strainer cleaning, filter changes, bearing lubrication, belt tensioning, etc.). In addition to scheduled maintenance, review all equipment periodically to allow detection of improper operation or any special maintenance needs; review shall be consistent with best practices for the product but in no case less than a site visit every two weeks. Document all maintenance activities.
- E. **Damaged Products:** Damaged products shall be replaced with new. Where damage is limited to paint (or similar finish), the product may remain if the finish is restored to a new condition (as judged by the Architect/Engineer).

#### 1.11 JOB CONDITIONS

- A. **Special Requirements:**
  1. Maintain emergency and service entrance usable to pedestrian and vehicle traffic at all times. Where trenches are cut, provide adequate bridging for traffic.
  2. Coordinate startup and shutdown of all mechanical systems and utilities with related trades and the Owner's representative.
  3. Coordinate all construction activities with the Owner's Representative and cooperate fully so as to minimize conflicts and to facilitate Owner usage of the premises during construction.
  4. Provide temporary services to occupied areas to accommodate Owner's use during construction. All temporary work shall comply with same specifications as for new work and be of same quality.
- B. **Downtime Restrictions:**
  1. Contractor shall notify the Owner at least 72 hours in advance of any intended shutdown of any building services or systems and obtain Owner approval prior to proceeding.
  2. Electrical power to the building shall not be interrupted at any one time for more than 15 minutes.
- C. **Schedule of Work:** Arrange work to comply with schedule of construction, and so as not to violate any downtime restrictions, and to accommodate the Owner's scheduled use of the premises during construction.

#### 1.12 ENGINEER REVIEWS AND WITNESSING

- A. **General:** Arrange construction schedule and notifications to the Engineer to accommodate Engineer's schedule and the possibility of review times occurring up to 14 days after notification, and for the possible failure to satisfactorily pass Engineer's reviews requiring revisions and re-reviews.
- B. **Notification:** Notify Engineer at least 7 days in advance of readiness for reviews; arrange mutually agreed upon times for the reviews to occur.

- C. Access: Provide ladders, any special tools and safety equipment to allow Engineer's access to areas and equipment. Remove and reinstall ceiling tiles, access panels, and similar items where requested to allow for reviews.
- D. Review of Systems with Equipment:
  - 1. Prior to Engineer's review, system's equipment shall have received specified start-up and be substantiated by a written report.
  - 2. Prior to Engineer's review, systems shall have been operating properly for at least five consecutive days prior to the scheduled review date.
  - 3. Personnel shall be present to operate the system's equipment and controls, and to vary system settings as directed by the Engineer to allow for a review of operation over a range of settings.
- E. Re-Review Fees: The project budget allows for one review by the Engineer for specified reviews and witnessing. See Division 00 and 01 for compensation to the Engineer for required re-reviews.

### 1.13 REFERENCES

- A. ASME A13.1: Scheme for the Identification of Piping Systems.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. General: Any reference in the Specifications or on the Drawings to any article, device, product, material, fixture, form or type of construction by manufacturer, name, make, model number, or catalog number shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition. The manufacturers listed as Acceptable Manufacturers may bid the project for the items indicated without submitting a substitution request; however, that does not relieve the products from having to comply with the Contract Documents.
- B. Substitutions: Products by manufacturers listed as "Acceptable Manufacturers" (other than those listed as the "Basis of Design") are considered substitutions and shall comply with the requirements for substitutions. See Paragraph titled "Substitutions" in Part 1 of this specification section.
- C. Considerations: In reviewing a manufacturer for acceptance, factors considered (as compared to the specified item) include: engineering data showing item's capacity, performance, proper local representation of manufacturer, likelihood of manufacturer's future local support of product, service availability, previous installations, previous use by Owner/Engineer/Architect, product quality, availability/quality of maintenance and operation data, electrical requirements, capacity/performance, acoustics, physical dimensions, weight, items geometry and access requirements, utility needs, and similar concerns.
- D. Limitations of the Term "Acceptable Manufacturer": The listing of a manufacturer as an Acceptable Manufacturer does not necessarily mean that the products of that manufacturer are equal to those specified. The listing is only an indication of those manufacturers which have represented themselves as being capable of manufacturing, or have in the past manufactured, items equal to those specified. The burden to review products to confirm

equivalency with the specified products is on the Contractor. The Architect/Engineer shall be the final judge as to whether an item is equal to that specified.

- E. Quality: Products provided by Acceptable Manufacturers shall be equal to or superior to the specified manufacturer's item in function, appearance, and quality, and shall fulfill all requirements of the Contract Documents. The Architect/Engineer shall be the judge as to whether an item meets these requirements or not.
- F. Manufacturer: To be considered as being made by a particular manufacturer, the product must be made directly by the manufacturer and have the manufacturer's name (or nameplate with name) affixed to the product (or on the product container where direct labeling is not possible). Example: manufacture "A" is listed as an acceptable manufacture; manufacturer "B" is not listed as an acceptable manufacturer; manufacturer "A" owns "B"; products from "B" do not qualify as being made by an acceptable manufacturer by virtue of ownership.

## 2.2 PRODUCTS - GENERAL

- A. Standard Products: Products shall be standard products of a manufacturer regularly engaged in the manufacture of such products. The standard products shall have been in satisfactory commercial or industrial use for two years prior to bid opening. The two year use shall include applications of equipment and materials under similar circumstances and of similar size. The two year's experience must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Except that equipment changes made solely to satisfy code requirements, to improve unit efficiency, or to comply with unique project requirements are not required to have two year prior operation.
- B. Latest Design: Products shall be the latest design and version available from the manufacturer, including software. Discontinued products shall not be used.
- C. Service Support: Qualified permanent service organizations for support of the equipment shall be located reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.
- D. Manufacturer's Nameplate: Equipment shall have a manufacturer's nameplate bearing the manufacturer's name, address, model number, serial number, and additional information as required by code. Nameplate shall be securely affixed in a conspicuous place. The nameplate of the distributing agent will not be acceptable. Nameplate shall be of durable construction, easily read, with lettering minimum size 12 font.
- E. Compatibility: All components and materials used shall be compatible to the conditions and materials the items will be exposed to. All items exposed to the weather shall be galvanized, or be of stainless steel or similar corrosion resistant material.
- F. Sizes: Sizes indicated for products manufactured to standardized sizes (e.g. pipe, pipe fittings, valves, material gauges, etc.) are minimums. During bidding confirm that the sizes are available and meet project requirements. Where indicated sizes are not available provide the next larger available size; confirm this larger size will suit the construction and meet Contract Document requirements prior to ordering. Such size revisions are subject to

Engineer's review; indicate size revisions on the product submittal and why the size is being revised.

- G. Non-Specified Items: Materials shown on the drawings but not specified shall be provided as shown and as required to suit the application illustrated and intended and shall be of commercial quality, consistent with the quality of similar type items provided on the project. Not all items shown on the drawings necessarily have a corresponding specification; such items shall be provided per this paragraph and so as to provide complete, finished, fully functioning mechanical systems.
- H. Weights: Do not exceed the weights shown unless added structural supports are provided. Such supports shall meet the requirements of the project Structural Engineer. The Contractor shall bear all costs for all redesign and added supports to accommodate heavier equipment. The Contractor shall reimburse the Engineer for all time associated with all review and analyses regarding the use of equipment heavier than that indicated.
- I. Temperature/Pressure Rating: All materials and components furnished shall be suitable for the temperature and pressures they will be exposed to. Contractor shall consider possible operating modes to ensure proper material ratings. Consideration shall include such factors as high temperatures caused by heat transfer from piping, coils, etc. when fans are shut down (e.g., motors, control devices, etc. installed within air handling units or mechanical rooms shall be rated for high temperatures due to such heat gain). Consideration shall include such factors as high temperatures caused by heat transfer from piping, water heaters, etc.
- J. Standardization: All products of the same type shall be by the same manufacturer and have the same characteristics and features to allow for Owner's standardization.
- K. Model Numbers: Any reference to a manufacturer's "model number" is a reference to a manufacturer's series number or type of product, and is not a complete "model number" in having all the necessary numbers/letters to convey all of the features, accessories, and options that are required. These series numbers are only meant to convey a type of product that may meet the project requirements. Where conflicts or discrepancies occur regarding a listed manufacturer's series or "model" number and specified capacities or features, the more stringent and expensive shall prevail.
- L. Special Products: Numerous products specified for this project are custom products, and require special and unique construction and features. Such special items may include: finishes, controls, field NRTL (Nationally Recognized Testing Laboratory) re-certification, field evaluations by accredited product testing laboratories for certification for the application, construction, configuration, capacities, accessories, spare parts, warranty, testing, flow rates, application, installation, delivery date, cleaning, etc. Include in bid all costs to provide items meeting all project requirements. Products may reference a manufacturer's series number, but are still special and custom, with the series number identifying only a reference point for the unit manufacturer. The series number is not to be construed as limiting the features or capabilities of the item. Contractor shall review all requirements and all vender quotes to ensure all requirements are being met and to include all costs in bid. No added cost will be paid for failure to include in bid all costs necessary to provide the special, unique, and custom items required.
- M. Lead Free: All solder, valve components, drinking fountain components, and other items in contact with potable water shall be lead free.

## 2.3 ELECTRICAL

- A. General: All electrical devices, wiring, products, and work shall comply with the Division 26 specifications and code. See drawings for building occupancy type, types of construction, and areas which may require special wiring methods or other electrical work.
- B. Equipment: All equipment requiring power shall be factory wired to an equipment mounted junction box (or an accessible compartment with power terminals or electrical device) arranged to allow for connection of electrical power.
- C. Overcurrent protection: Circuit breakers, circuit breaker disconnects, fuses, and other current limiting devices indicated to be provided, shall be rated to suit the maximum overcurrent rating of the item served, and have other ratings, as required by code. Circuit breakers for HVAC and refrigeration unit equipment shall be UL listed by HACR type.
- D. Short Circuit Current Rating (SCCR): All equipment (or components) requiring the use of electrical power shall have a SCCR value to comply with code. The minimum rating shall be 65,000 Amps RMS Symmetrical unless a lower value is indicated on the plans or allowed by code. Where the Contractor wishes to utilize equipment having a lower rating, the Contractor shall be responsible to provide calculations substantiating that a lower SCCR is acceptable (and complies with code), or make revisions to the electrical system to accommodate the proposed equipment (or components).
- E. Product Certification (Listing): Products which require connection to electrical power shall be certified (i.e. listed) by a Nationally Recognized Testing Laboratory (NRTL) and be labeled (in a conspicuous place) with such certification (or certification mark). Certification shall comply with code, OSHA Standards, and Authority Having Jurisdiction (AHJ) requirements. NRTL's shall be recognized as such by OSHA and the AHJ. Certification shall be for the complete assembly (approval of individual components is not acceptable). Field evaluations to obtain certification shall be performed by accredited product testing laboratories acceptable to the AHJ and Engineer, be performed in accordance with code, NFPA 791, recognized practices, and be labeled to identify the certification.

## 2.4 MOTORS

- A. General: Where a piece of equipment specified includes an electric motor, the motor shall be factory installed and mounted. Motor starters and motor electrical disconnect switches shall be provided by the Contractor doing the work of the Section where the item was specified, unless specifically shown to be provided by Division 26 (or another Division). Wiring from the motor to motor starters and to electrical disconnects shall be by the Contractor doing the work of the Section where the item was specified, unless specifically shown to be provided by Division 26.
- B. Acceptable Manufacturers: General Electric, TECO-Westinghouse, Reliance, Gould, Century, Baldor, U.S. Motors, Marathon, and acceptable manufacturers for the equipment (see individual specification sections).
- C. Type: Motor type shall comply with code and applicable standard requirements and be configured to suit the application. Motors located indoors shall be open frame, drip-proof type, unless indicated otherwise. Motors located outdoors exposed to weather shall have corrosion resistant finish and shall be totally enclosed fan cooled (TEFC) or totally enclosed

non-ventilated (TENV) type, unless indicated otherwise. Motors used in fans serving dishwashing hoods and kitchen hoods shall be TEFC type.

- D. Listing: All motors shall be UL listed.
- E. Efficiency: Motor efficiencies shall comply with code. Fractional horsepower motors shall be the electronically commuted (EC) type with speed control where noted and where non-EC motors are not available which comply with code efficiency requirements. Motor power factor shall comply with code, local utility requirements, and as indicated. Provide added power factor correction devices as necessary to comply.
- F. Sizing: Motors shall not be smaller than indicated and of adequate size to start and drive the respective equipment when handling the quantities specified without exceeding the nameplate full load current at the conditions indicated and for the expected operating conditions. If it becomes evident that a motor furnished is too small to meet these requirements as a result of the Contractor using substituted equipment or having revised the system arrangement, the Contractor shall replace it with a motor of adequate size at no additional cost to the Owner. Contractor shall also arrange with the Electrical Contractor to increase the size of the wiring, motor starter and other accessories as required to serve the larger motor at no additional cost to the Owner.
- G. Service Factor: Minimum 1.15.
- H. Variable Frequency Drive (VFD) Applications: Motors used with Variable Frequency Drives (VFD's) shall be rated for such use per IEEE standards and have shaft grounding protection.
- I. EC Motors (ECM):
  - 1. General: Electronically commutated type with integral inverter to convert AC power (of voltage/phase indicated) to DC power, and solid state circuitry to vary output power and speed of motor. Motor shall have permanently lubricated bearings with an L10 life of 100,000 hours at expected operating conditions. Motor shall have rotor position and rotation detection as required for operation.
  - 2. Speed Range: Motor speed shall be controllable down to 25% of full speed.
  - 3. Manual Speed Control: Provide with manual speed adjustment dial for motor speed control. Dial shall be motor mounted unless indicated otherwise, operable by a screwdriver or by hand. Motor mounted controls shall be factory wired. Remote mount dials shall be hand operable (i.e. no tools required), shall be for mounting on a standard 2x4 electrical junction box, and be able to be located up to 100 feet remote from the motor. Motor control wiring for remote mount dials shall be factory wired from the motor to an equipment mounted junction box (with field supplied wiring from this J-box to the remote dial).
  - 4. EMCS Control: Motor speed shall be adjustable via a remote 0-10V input signal (unless noted otherwise) from the building EMCS. Control wiring shall be factory wired from the motor to an equipment mounted junction box. EMCS control is not required where not indicated to be provided or where not utilized as part of the control sequence.
  - 5. Control Power: Provide with integral transformer, factory wired, as needed to power motor controls. Locate transformer at motor or equipment.

## 2.5 IDENTIFICATION AND LABELS

- A. General: All piping, valves, and mechanical equipment shall be labeled. Labels in concealed accessible spaces shall be reviewed and verified by Architect/Engineer prior to being concealed.
- B. Piping:
1. Type: Self-sticking colored identification markers, lettered to identify the pipe contents, and banded at each end with arrow tape indicating the direction of flow. Markers shall be similar and equal to Brady "System 1" and Seton "Opti-Code" markers. Spray painted stencil labeling is not acceptable. Some labels may be special order.
  2. Identification Colors: Comply with ASME A13.1, and as follows:

<u>Conveyed Material/System</u>	<u>Background</u>	<u>Letters</u>
Gas	Yellow	Black
Fire Suppression	Red	White
Hydronic Systems	Yellow	Black
Water	Green	White
Refrigeration	Black	White
  3. Lettering: Lettering shall identify the material conveyed in each pipe and shall match the designation used on the plans, but without abbreviations. Systems which have supply and return piping shall have piping labeled as such (i.e. heating water return, heating water supply, etc.). Systems that have different pressures shall be labeled to indicate such (i.e. Steam-Low Pressure, Steam- Medium Pressure, Natural Gas-Low Pressure, Natural Gas-Medium Pressure, etc.).
  4. Size: Size of letters and color field shall comply with ASME A13.1, repeated here for convenience:

<u>Outside Diameter of Pipe or Covering</u>	<u>Length of Color Field</u>	<u>Size of Letters</u>
3/4 to 1-1/4 Inches	8 Inches	1/2 Inches
1-1/2 to 2 Inches	8 Inches	3/4 Inches
2-1/2 to 6 Inches	12 Inches	1-1/4 Inches
8 to 10 Inches	24 Inches	2-1/2 Inches
Over 10 Inches	32 Inches	3-1/2 Inches
  5. Applications: Install on all exposed piping adjacent to each shut-off valve, at branches to indicate changes of direction, where pipes pass through walls and floors, on 20 foot centers or at least one in each room on each pipe. Markers shall be installed on all concealed accessible piping (i.e., piping above suspended ceilings, behind access doors, in accessible chases, etc.) near the point of access. For piping above suspended ceilings, markers shall be installed the same as if the piping was exposed (i.e., same as if the suspended ceiling was not in place). Markers shall be installed so as to be easily read by a person standing on the floor. Provide additional flow arrows at each pipe connection at valves having more than 2 ports (i.e. 3-way control valves).
  6. Other Requirements: See other specification Sections for additional requirements.
- C. Valves:
1. Labels: Laminated plastic or phenolic material, at least 1/16-inch thick, with black surface layer and white (unless other color indicated) sub-layer for letter engraving to expose sub-layer. Labels shall not be less than 3" x 1" in size. Label shall be pre-drilled at one end for attachment to valve. Attach to valve with No. 6 polished nickel-steel jack chain of sufficient length to allow label to hang free.



2. Lettering: Engrave label with valve size, name of system served (cold water, heating water supply, chilled water supply, etc.) and purpose of valve. Lettering size 3/16-inch, except where needed to be smaller to fit label size.
  3. Application: Labels shall be installed on all valves except valves at hydronic system coils and equipment where the valve purpose is readily obvious.
- D. Equipment:
1. Labels: Laminated plastic (or phenolic) material, 1/16-inch thick, with black surface layer and white (unless other color indicated) sub-layer, with engraving through to expose white sub-layer. Minimum 2-inch high (unless indicated otherwise or required due to equipment size) with length to contain required lettering. Label shall be pre-drilled and be mechanically fastened to the equipment. Prior to making labels, submit a list of all proposed labels.
  2. Lettering: All caps, engraved on label, with equipment designation (same designation as used on Contract Drawings; e.g. HVAC-101, EF-22, CP-1A). Air handling equipment (i.e. VAV terminal units, fans, etc.) labels shall include the room names and numbers or area of building served (use final installed room designations). Where systems serve portions of the building (i.e. wings or floors), include on label the area served. Lettering shall be in multiple rows, with equipment label on top row. Equipment lettering to be 5/8-inch high; area served lettering to be 3/8-inch high (except that smaller lettering may be used if necessary to fit label size).
  3. Application: All scheduled mechanical equipment shall be labeled. The label shall be located on a side of the equipment so as to be easily read, with the marking visible to a person standing at the access level near the equipment (assuming any necessary access to a concealed unit has been made).
- E. Electrical Devices:
1. Labels: Minimum 1/4-inch high (unless indicated otherwise) lettering, all caps, engraved on laminated plastic or phenolic material, at least 1/16-inch thick. Laminated plastic (or phenolic) shall have black surface layer and white (unless other color indicated) sub-layer, with engraving through to expose white sub-layer. Label shall be pre-drilled and be mechanically fastened to the item; where mechanical fastening is not possible use 3M VHB double sided specialty tape No. 4945. Prior to making labels, submit a list of all proposed labels.
  2. Lettering: Label shall identify the item served (using the same designation as indicated on the Contract Drawings), the source of power (by panel and circuit breaker), and comply with code.
  3. Application: Variable frequency drives, motor starters, disconnects, contactors, relays and similar items which control power to equipment and system components shall be labeled. The label shall be located so as to be easily read. See Division 25 for labeling of low voltage control components.
- F. Duct Access Doors:
1. Labels: Minimum 1-inch high (unless indicated otherwise) lettering, engraved on laminated plastic or phenolic material, at least 1/16th inch thick. Laminated plastic (or phenolic) shall have red surface layer and white (unless other color indicated) sub-layer, with engraving through to expose white sub-layer. Label shall be pre-drilled and be mechanically fastened to the duct access door. In lieu of laminate type, self-adhesive vinyl signs may be used.
  2. Lettering: Label shall comply with code, and indicate the item being accessed (i.e. Fire/Smoke Damper, Fire Damper, CO2 Sensor, etc.).

3. Application: All duct access doors serving fire dampers, fire/smoke dampers, smoke dampers, control dampers, items required by code, and control devices shall be labeled. Where these items are provided under Division 26, they shall be labeled by Division 26. Access door label is not required where it is readily obvious as to what is being accessed (e.g. duct coil where coil is easily seen). The label shall be located so as to be easily read, with the marking visible to a person standing at the access level near the access door (assuming any necessary access to a concealed label has been made).
- G. Concealed Items:
1. General: Equipment, valves, dampers and similar items concealed above accessible ceilings shall have the ceiling marked below the item to identify the item and its location.
  2. Marking System: The marking system shall consist of an engraved phenolic label, minimum 1/16-inch thick and 3/4-inch high with 1/2-inch high lettering. Label shall be black with white lettering. Apply labels to ceiling grid system using 3M double sided tape (3M VHB #4945).
  3. Labeling: Shall identify equipment using the same designation indicated on the plans; valves shall be identified by size and system (e.g. EF-1, VAV-101, VALVE 4" CW). Prior to making labels, submit a list of all proposed labels.

### PART 3 - EXECUTION

#### 3.1 GENERAL

- A. Workmanship: Furnish and install products to provide complete and functioning systems with a neat and finished appearance. If, in the judgment of the Architect/Engineer, any portion of the work has not been installed in accordance with the Contract Documents and in a neat workmanlike manner, or has been left in a rough, unfinished manner, the Contractor shall be required to revise the work so that it complies with the Contract Documents, at no increase in cost to the Owner.
- B. Coordination: Coordinate the work with all trades that may be affected by the work to avoid conflicts and to allow for an organized and efficient installation of all systems.
- C. Examination and Preparation: Examine installation conditions and verify they are proper and ready for the work to proceed. Verify compatibility of materials in contact with other materials, and suitability for conditions they will be exposed to. Do not proceed with the work until unsatisfactory conditions have been corrected. Prepare area to accept the work and prepare products for the installation.
- D. Field Conditions: Check field conditions and verify all measurements and relationships indicated on the drawings before proceeding with any work. In verifying existing conditions, the Contractor shall verify by direct physical inspection, complete tracing out of systems, by applying test pressures, by excavation and inspection, use of pipeline cameras, and other suitable absolute certain methods to confirm the actual physical conditions that exist.
- E. Openings and Cutting and Patching in Existing Construction:
1. Openings--General: Provide all openings and cutting as needed to accommodate all work. Provide patching to restore all damaged and disturbed areas to pre-construction conditions (or better). The Contractor or subcontractor requiring the opening shall be

- responsible for making that opening. The opening shall be made by skilled labor experienced in providing openings in the material being penetrated.
2. Areas To Be Cut and Patched: Wherever floors, walls, ceilings, plates, firestops and framing members are cut, these openings shall be substantially reinforced and sealed so as to maintain the strength and sealing ability of the element equal to that as if it had not been cut. All reinforcement/sealing shall satisfy the Architect/Engineer and comply with the governing codes. Such cut areas shall be patched and restored to a finished condition, equal to adjacent final finished areas that have not been cut.
  3. Cutting of Structural Features: Make no cuts or alterations to any structural framing members without explicit consent of the Engineer, and then only under his direction. Locate cuttings so they will not weaken structural components. Cut carefully and only the minimum amount necessary. All required cutting to install material shall be accomplished with the use of saw cutting equipment.
  4. Patching Materials: Patching shall be with materials of like kind and quality of the adjoining surface by skilled labor experienced in that particular trade.
- F. Openings and Cutting and Patching in New Construction:
1. Openings - General: The General Contractor shall provide all required spaces and provisions in structures of new construction for the installation of work of all other contractors or subcontractors.
  2. Coordination: The Contractors doing work subject to Division 22 shall furnish to the General Contractor (in a timely manner) all needed dimensions and locations of openings to allow for these openings to be provided as the construction adjacent to the opening is being done.
  3. Cutting and Patching: Cutting and patching of structures in place made necessary to admit work, repair defective work, or by neglect of contractors and subcontractors to properly anticipate their requirements, shall be done by the General Contractor at the expense of the contractors or subcontractors responsible. Work shall be done in a fashion to duplicate the results that would have been obtained had the work been properly sequenced.
  4. Patching Materials: Patching shall be with materials of like kind and quality of the adjoining surface by skilled labor experienced in that particular trade.
- G. Cleaning: Clean all products (whether exposed to view or not) of all construction debris, and other materials; grease and oil spots shall be removed with appropriate cleaning agents and surfaces carefully wiped clean. Where cleaning cannot restore items to new conditions, the item shall be replaced with new.

### 3.2 INSTALLATION

- A. General: Work shall be in accordance with manufacturer's written installation instructions, code, applicable standards, and best construction practices.
- B. Space Verification: Prior to ordering materials verify that adequate space exists to accept the products, and along the installation path. Such verification shall be by direct field measurement of the actual space available and use of manufacturer's final submittal dimensions. Where the project involves new construction and long lead items and a time schedule not allowing for such direct field measurements, confirm in writing with all trades associated with building the space that adequate room is available. Review maintenance and service access space required and confirm requirements will be met. No submittals shall be made until such space verification work has been performed, and confirmed that adequate

space is available. By virtue of making a submittal that Contractor affirms he has completed this verification.

- C. Installation Locations: Unless dimensioned locations for items are shown, select the precise location of the item in accordance with the Contract Documents, coordinated with other trades and item connection locations, and subject to the Architect/Engineer's review. No allowances will be granted for failure to obtain the Architect/Engineer's review, failure to coordinate the work, and failure to comply with Contract Document requirements.
- D. Replacement and Maintenance: Install mechanical equipment to permit easy access for normal maintenance, and so that parts requiring periodic replacement or maintenance (e.g. coils, heat exchanger bundles, sheaves, filters, bearings, etc.) can be removed. Relocate items which interfere with access or revise item installation location, orientation, or means of access.
- E. Building Access Doors: Provide access doors where indicated and where needed to provide access to valves, drains, duct access doors, and similar items requiring service or access that would otherwise be inaccessible. Consult architectural drawings and coordinate location and installation of access doors with trades which are affected by the installation. Access doors are typically not shown on the drawings. The Contractor shall review all construction details and types and locations of items requiring access to determine quantity and sizes of access doors required.
- F. Manually Operated Components: Valves, damper operators, on/off switches, keypads, controls, and other devices which are manually adjustable or operated shall be located so as to be easily accessible by a person standing on the floor. Any such items which are not in the open shall be made accessible through access doors in the building construction. See individual specification sections for additional requirements.
- G. Monitoring Components: Gauges, thermometers, instrumentation, and other components which display visual information (i.e. operating conditions, alarms, etc.), shall be located and oriented so as to be easily read by a person standing on the floor. Provide necessary brackets, hangers, remote read devices and accessories as needed. Equipment control panels and graphic displays furnished with equipment (or integral to equipment) shall be located to be easily accessible by a person standing on the floor adjacent to the equipment, and be located between 4-feet and 6-feet above the finished floor.
- H. Accessible Installation: If circumstances at a particular location make the accessible installation of an item difficult or inconvenient, the situation shall be discussed with the Architect/Engineer before installing the item in a location that will result in poor access.
- I. Rotating Parts: Belts, pulleys, couplings, projecting setscrews, keys and other rotating parts which may pose a danger to personnel shall be fully enclosed or guarded in accordance with Code, and so as not to present a safety hazard.
- J. Equipment Pads: All ground and slab mounted mechanical equipment shall be installed on a minimum 4-inch thick concrete pad, (unless indicated otherwise). Where the largest dimension for any pad exceeds 6 feet provide a 6 x 6 - 10 gauge welded wire fabric reinforcement in the pad (unless noted otherwise). Concrete shall be same as used for building footings (unless noted otherwise). Concrete shall be same as used for building footings (unless noted otherwise).

- K. Dissimilar Metals: Provide separations between all dissimilar metals. Where not specified in another way, use 10 mil plastic tape wrapped at point of contact or plastic centering inserts.
- L. Electrical Offsets: Provide offsets around all electrical panels (and similar electrical equipment) to maintain space clear above and below electrical panels to structure, and clearance of 3.5 feet directly in front of panel, except where indicated otherwise or required by code to be more. Such required offsets are typically not shown on the plans but are to be provided per this paragraph. Include in bid offsets for all systems near electrical panels.
- M. Piping Through Framing: Piping through framing shall be installed in the approximate center of the member. Where located such that nails or screws are likely to damage the pipe, a steel plate at least 1/16-inch thick shall be installed to provide protection. At metal framing, wrap piping to prevent contact of dissimilar metals. At metal and wood framing, provide plastic pipe insulators at piping penetrations through framing nearest each equipment connection and on at least 32-inch centers.
- N. Safety Protection: All ductwork, piping and related items installed by this Contractor that present a safety hazard (i.e., items installed at/near head height, items projecting into maintenance access paths, etc.) shall be covered (at hazardous area) with 3/4" thick elastomeric insulation and reflective red/white self-sticking safety tape. All sharp corners on supports and other installed items shall be ground smooth.
- O. Equipment Access: Access to equipment is of utmost importance. Contractor shall apply extra attention to the location of pipe and duct routings and in coordinating all work so that equipment access and a clear maintenance pathway to equipment is maintained. Poor maintenance access will not be accepted. Contractor shall note that in essentially all areas piping and ducts need to run with slopes parallel to the roof (or floor above), in necessitating elbows/fittings/transitions at crosses of ducts/pipes and at all connections to mains and branches; and requiring added fittings to maintain a clear walking path.
- P. Pressure Tests: Maintain documentation of all pressure (and leakage) tests performed on systems and submit with project closeout documents. Records shall contain (as a minimum): date of test, system name, description portion of system being tested, method of test, initial and final test pressures (or of measured leakage rates, as applicable), indication of test pass or fail, name and signature of individual performing (or documenting) the test, initials of independent witness of test.

### 3.3 PAINTING

- A. General: Painting shall comply with Division 09 specifications regarding painting. Colors, in all cases, shall be as selected by the Architect/Engineer. Color samples shall be submitted to the Architect/Engineer for approval prior to painting.
- B. The following painting shall be provided under Division 22:
  - 1. All exposed metallic surfaces (includes piping, ducts, hangers, conduits, etc.) provided by this Contractor (except equipment with factory finish or items specifically excluded) shall receive one coat of rust inhibiting primer and two (2) coats of selected finish paint.
  - 2. All exposed insulated surfaces provided by this Contractor (except where specifically excluded) shall receive one coat of primer and two coats of selected finish paint.

3. The inside of all ductwork (including visible dampers, roof vents, insulation pins, and any visible metal) behind grilles, registers, diffusers, and louvers shall be painted flat black.

C. Items to be painted under Division 09:

1. Exposed duct work in finished areas.
2. Exterior mechanical equipment.
3. Exposed piping in finished areas.

### 3.4 PENETRATION PROTECTION

- A. Exterior and Watertight Penetrations: Where any work pierces the building exterior (or construction intended to be watertight) the penetration shall be made watertight and weatherproof. Provide all necessary products (e.g. caulking, flashing, screens, gaskets, backing materials, siding, roofing, trim, etc.). Where not detailed or indicated how to install submit shop drawings of the proposed methods. Flashing arrangements shall be per SMACNA Architectural Sheet Metal Manual unless noted otherwise. Caulking alone is not an acceptable means of sealing penetrations.
- B. Equipment: Equipment or products located outdoors shall be watertight (except for provisions designed to intentionally accept water and having drain provisions) and shall be designed and intended by the manufacturer to be used outdoors at the project location. Where any work pierces the unit casing exposed to the outdoors the penetration shall be made watertight and weatherproof; provide all necessary products (e.g. caulking, flashing, gaskets, backing materials, etc.).

### 3.5 START-UP

- A. General: Provide inspections, start-up and operational checks of all mechanical systems and equipment. Maintain documentation of all start-up work and submit with project closeout documents. See individual specification Sections for additional requirements.
- B. Personnel: Inspection and start-up services shall be done by individuals trained in the operation, and knowledgeable with, the systems being started-up. Equipment start-up shall be by the manufacturer's authorized service representative where indicated (see individual specification Sections).
- C. Scheduling and Agenda: Submit a proposed detailed start-up schedule with proposed dates and times at least 30 days prior to the earliest proposed system start-up. Revise dates and times as mutually agreed upon with trades involved, and witnesses, before submitting a final start-up schedule.
- D. Witnessing: Start-up may be witnessed by the Engineer and Owner's representative (at their option). Notify the Engineer and Owner 7 days prior to the proposed start-up time.

### 3.6 OWNER INSTRUCTION

- A. General: Provide instruction to the Owner on the operation and maintenance of all installed mechanical systems. Prior to instruction provide final Operation and Maintenance (O&M) manuals. Have copy of O&M manual and project drawings on hand during instruction.

- B. Personnel: Instruction involving the general arrangement and overview of systems, including locations and connections of system components, shall be by individuals that were involved in the installation of these systems. Instruction on the operation and maintenance of products shall be by individuals trained and experienced in the installation, operation and maintenance of these products. Instruction shall be by the product manufacturer's authorized service representative where indicated (see individual specification Sections).
- C. Scheduling and Agenda: Submit a proposed instruction schedule (with proposed dates and times) and an instruction agenda at least 30 days prior to the earliest proposed instruction period. Coordinate Owner and Architect/Engineer review and arrange mutually agreed upon instruction schedule and the instruction agenda, and submit a final instruction schedule and agenda. Organize instruction by sub-systems corresponding to the project specifications (or similar logical grouping).
- D. Field Instruction:
  - 1. Scope: Provide on-site field instruction for each mechanical product requiring maintenance or expected to require repair in the next 10 year period. Provide individual instruction for each unique product, or where products of the same type vary appreciably from others (due to size, options, etc.). See individual specification sections for additional requirements.
  - 2. Overview: Show and explain the overall arrangement and locations of each mechanical system. Show the locations of all system major shut-off valves, location of major equipment components, routing of system mains, and related information.
  - 3. Operation: Demonstrate and explain normal start-up, normal shut-down, normal operation, normal settings, adjustments, signs of abnormal operation, emergency shut-down, safety concerns, and related information.
  - 4. Maintenance: Demonstrate and explain system maintenance requirements with references to the O&M Manual. Show how maintenance is performed, including how items are accessed, maintenance procedures, tools and parts required, and related information. Review typical repairs and explain how performed.
  - 5. Records: Submit documentation noting names of those receiving the instruction, scope of instruction, date and time of occurrence, and signed by the individuals receiving the instruction.
- E. Occupant Training: Provide training to building occupants explaining systems and devices that they have access to or control of. Coordinate with Owner and other training activities. Training to comply with WSSP requirements.

END OF SECTION





## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Thermometers.
- B. Pressure Gauges.
- C. Strainers.
- D. Unions.
- E. Flexible Connectors.
- F. Test Ports.
- G. Access Doors.

### 1.3 SUBMITTALS

- A. General: Comply with Section 220500.
- B. Product Data: Submit product information data for all items to be used.

### 1.4 REFERENCES

- A. ANSI Z21.24: Connectors for Gas Appliances.
- B. ASME B16.18: Cast Copper Alloy Solder Joint Pressure Fittings.
- C. ASME B16.39: Malleable Iron Threaded Pipe Unions: Classes 150, 250, and 300.
- D. ASME B40.3 - Bimetallic Activated Thermometers.
- E. ASME B40.100 - Pressure Gauges and Gauge Attachments.
- F. IFGC: International Fuel Gas Code.
- G. IMC: International Mechanical Code.
- H. UPC: Uniform Plumbing Code.

### 1.5 GENERAL REQUIREMENTS

- A. Domestic (Potable) Water Systems: All items in contact with potable water shall be lead free in accordance with ANSI/NSF 61. Plastic piping system components shall comply with ANSI/NSF 14.
- B. System Requirements: Products shall comply with additional requirements cited for the specific systems the products are being installed in; see specific system specification sections.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Products shall comply with Section 220500, Paragraph 2.1, Acceptable Manufacturers.
- B. Thermometers: Terice, Weiss, Winters.
- C. Pressure Gauges: Terice, Weiss, Winters.
- D. Strainers: Watts, Keckley, Mueller, Sarco, Taco, Paco, Bell & Gossett, Armstrong, Wilkins.
- E. Unions: Anvil, Nibco, Watts, Epcu, Victaulic, Ward, Jefferson Union.
- F. Dielectric Connectors: Victaulic Precision Plumbing Products, Elster Perfection.
- G. Flexible Connectors: Universal, Mason, Dormont, OPW, Unisource, Twin City Hose.
- H. Test Ports: Autoflow, Flowset, Peterson Equipment.
- I. Access Doors: J.R. Smith, Zurn, Josam, Acudor, Elmdoor, Kees, J.C. Industries.
- J. Escutcheons: Selected by Contractor.

### 2.2 THERMOMETERS - DIGITAL

- A. Type: Light powered digital LCD display industrial thermometer. Weiss DVU Series (or approved).
- B. Construction: Aluminum of high impact ABS case, LCD display, thermister temperature sensor, self-powered solar (light) panels, stem of brass or aluminum construction, with separate brass socket (i.e. thermowell). Bulb chambers tapered to match taper in thermowell to give metal to metal contact. Scale case adjustable over a minimum 180° range, with locking fastener.
- C. Stem Length: Stem insertion length approximately one-half of pipe diameter. Where installed on insulated piping systems, provide a longer stem thermometer and extended neck socket (thermowell) to extend thermometer base past the insulation.
- D. Display: LCD with minimum 1/2-inch high numbers, and 10 second update.
- E. Accuracy: Plus or minus 1% of reading or 1 deg F (whichever is greater). Recalibration by case potentiometer adjustment.

- F. Ranges: 50 to 300 deg F, in tenth degree increments.

### 2.3 PRESSURE GAUGES - DIGITAL

- A. Type: Light powered digital LCD display pressure gauge. Weiss DUGY series (or approved).
- B. Construction: 4-1/2" round case, stem mounting, black impact resistant phenolic (or fiberglass reinforced polypropylene) flangeless case, solid face, acrylic window, gold plated ceramic pressure sensor, brass socket, and 1/4" npt (or 1/2" npt) bottom connection. Materials in contact with system fluid shall be constructed of type 316 stainless steel. Shut off cock not allowed (use ball valve). Rated for use with the system pressures and temperatures to be exposed to, but rated no less than 250 psi at 250° F.
- C. Display: LCD with minimum 5/8-inch high numbers and two second update.
- D. Accuracy: 0.5% of full scale per ASME B40.7 AA.
- E. Pressure Gauge Ranges: 0 to 1.5 times systems normal operating pressure (at point of measurement). Except: systems which operate at a vacuum, provide range from 30 to 0 inches mercury vacuum; where measuring differential pressure provide range 1.5 times normal measured pressure.

### 2.4 STRAINERS

- A. Water Systems:
1. Copper Piping Systems 2-1/2" and Smaller: Bronze body, "Y" type, screwed or solder type end connections, 125 lb class (rated 125 psi steam working pressure at 350 deg F minimum) and 400 psi (WOG) rated working pressures at 210 deg F, stainless steel 20 mesh wire screen, and gasketed retainer cap. Reinforce wire mesh with perforated stainless steel sheet for sizes 2" and 2-1/2". Ratio of net free area of screen to pipe free area greater than 3.5. Provide with blowdown valve, ball type, with 3/4" NPT male end connection. Valve manufacturer shall be listed as an "Acceptable Manufacturer" in the hydronic piping system specification section.
  2. Copper Piping Systems 3" and Larger: Bronze or ductile iron body, "Y" type, flanged end connections, 150 lb class (rated 150 psi steam working pressure at 400 deg F minimum), brass or stainless steel screen with 3/64" perforations for 3" and 3/32" perforations for larger sizes; with gasketed threaded retainer cap. Ratio of net free area of screen to pipe free area greater than 3. Provide with blowdown valve, ball type, with 3/4" NPT male end connection. Valve manufacturer shall be listed as an "Acceptable Manufacturer" in the hydronic piping specification section.
  3. Steel Piping Systems: Ductile iron, cast iron, or carbon steel construction, "Y" type, 250 lb class (rated 250 psi steam working pressure at 450°F minimum), with stainless steel screen. Screen shall be 20 mesh for strainers up to 2" in size, and have 3/32" perforations on larger sizes. Sizes 2-1/2 inch and less shall have threaded end connections; larger sizes shall have flanged end connections. Provide with bolted and gasketed strainer cap on flanged strainers; provide threaded gasketed retainer cap on threaded strainers. Provide with blowdown valve, ball type, with 3/4" NPT male end connection. Valve manufacturer shall be listed as an "Acceptable Manufacturer" in the hydronic piping system specification section.

- B. Pump Suction Diffusers: Cast iron body, angle type, with steel straightening vanes, steel orifice cylinder (shall be stainless steel on open cooling tower systems), 16 mesh bronze start-up strainer, and permanent removable magnet. Orifice cylinder shall be designed to withstand differential equal to pump shutoff head (maximum 75 psi) and shall have a free area equal to 5 times cross section area of pump suction opening. Straightening vanes shall extend the full length of the orifice cylinder and shall be replaceable. Unit shall be rated for 175 psi service up to 250 degrees F. Suction diffuser inlet shall match system piping (or next pipe size to), outlet shall match pump inlet. Unit shall have an adjustable foot support and minimum 3/4-inch NPT blowdown tapping and 1/4-inch NPT gauge tapping.

## 2.5 UNIONS

- A. Dielectric Unions: Shall not be used. Provide "dielectric connector" with standard union where union is required at connection point of dissimilar materials.
- B. Unions on Copper Pipe:
1. General: Pressure and temperature ratings to match (or exceed) piping system being installed in; minimum Class 125.
  2. 2-Inch Pipe and Smaller: Wrought copper solder joint copper to copper union, complying with ASTM B16.18.
  3. 2-1/2-Inch Pipe and Larger: Brass flange unions.
- C. Unions on Steel Pipe:
1. General: Pressure and temperature ratings to match (or exceed) piping system being installed in; minimum Class 150.
  2. Threaded: Malleable iron union, threaded connections, with ground joints, complying with ASME B16.39. Provide with brass-to-iron seat (except provide iron-to-iron seat where the conveyed material is detrimental to brass).
  3. Welded and Flanged: Flange unions; see individual system specification sections.
- D. Dielectric Connector: Schedule 40 steel pipe nipple, zinc electroplated, with internal thermoplastic lining which is NSF/FDA listed and meeting all code requirements for potable water applications. Suitable for continuous use up to 225 deg F and 300 psi. "Clearflow" dielectric waterway (or approved). For systems operating at temperatures greater than 225 deg F provide flanged connections with insulating gaskets.

## 2.6 FLEXIBLE CONNECTORS

- A. Pump Flexible Connectors: Twin sphere type, constructed of peroxide cured EPDM with Kevlar tie cords, multilayered. Embedded solid steel rings shall be used at raised face flanged ends. Shall have an external ductile iron reinforcement ring between spheres. Rated minimum 225 psi at 230°F. Control rods shall be used as recommended by the manufacturer for the application; rods shall have 1/2-inch thick neoprene bushings, washers and accessories sized to accommodate system loads and conditions. Same size as pipe installed end, with end connections to suit connecting piping. Mason Industries "SafeFlex" SFDEJ Series, and SFDCR Series.
- B. Piping Flexible Connectors:
1. General Use: Corrugated hose type with outer braided wire sheath covering. Corrugations shall be close pitch annular type. Minimum working pressure of 250 psig, minimum length of 12 inches (or 12 times the connector's nominal diameter,

whichever is more), and screwed or flanged end connections. Metal for hose shall be bronze or stainless steel; braided sheath shall be stainless steel, any type of ASTM 300 series.

2. Fuel Gas Piping 1-1/4 inch and Smaller: Factory fabricated flexible gas connector, constructed of type 304 stainless steel tubing, corrugated, with brass or stainless steel threaded end fittings, and heavy PVC coating. Listed for use in fuel gas piping systems; complying with ANSI Z21.24 and IFGC. Size flexible connector to match pipe size shown on plan, with reducer after the flexible connector to match the equipment connection size (where connecting to equipment). Length as required to accommodate equipment movement relative to piping; minimum 18-inch length for sizes 1/2-inch diameter and less; minimum 24-inch length for larger sizes. Where used on appliances that require to be moved for cleaning or servicing, provide type listed for mobile appliance application, with adequate length to allow for appliance movement, and with a restraining cable and mounting hardware to prevent strain applied to gas connector.
3. Fuel Gas Piping Larger than 1-1/4 inch: Factory fabricated flexible gas piping connector, constructed of series 304 or 321 stainless steel, with braided exterior, carbon steel (or stainless steel) threaded or flanged end connections, rated for 350 psig working pressure, for use with fuel gas piping systems and complying with IFGC. Size flexible connectors to match pipe size shown on plan, with reducer after the flexible connector to match the equipment connection size.

## 2.7 TEST PORTS

- A. Temperature/Pressure Type: Test port for installation in tee in piping allowing insertion of probe for measurement of pressure and/or temperature. Valve shall be of brass construction, have 1/4-inch or 1/2-inch NPT male connection, with dual valves to prevent leakage and gasketed cap with attachment to test port. Rated for minimum 500 psi and 275 deg F. Provide extended length on insulated piping systems so that insulation does not cover the test port.

## 2.8 ACCESS DOORS

- A. Shall comply with section 083113.

## 2.9 ESCUTCHEONS

- A. Type: Circular metal collar to seal pipe penetrations at building elements (i.e. walls, floors, cabinets, and ceilings); one piece type except that split hinge type may be used for applications on existing piping.
- B. Construction: Constructed of chrome plated brass or polished stainless steel, sized to tightly fit pipe exterior surface (or pipe insulation where insulated) and to fully cover the building element penetration.
- C. Projection: Shallow face type with maximum projection from wall not to exceed 1.2 times inner diameter of escutcheon.
- D. Special Applications: For sprinkler heads and similar special applications see items' specification Section.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Thermometers: Install thermometers and thermal wells in piping at locations indicated, and so as to be easily read.
- B. Pressure Gauges: Install pressure gauges at inlet and outlets of all pumps; at each side of pressure reducing valves; and as indicated. Provide with ball-type isolation valves.
- C. Strainers: Install strainers ahead of each control valve, and as indicated. Provide valve in blow-off connection on strainers, valve shall be same size as blow-off tapping.
- D. Suction Diffusers: Install suction diffusers on all base mounted pumps and where indicated.
- E. Unions: Install unions in pipe connections to control valves, coils, regulators, reducers, all equipment, and where it may be necessary to disconnect the equipment or piping for repairs or maintenance; and as indicated. Where flanged connections occur at equipment additional unions are not required unless indicated otherwise. Dielectric unions shall not be used.
- F. Dielectric Connectors: Install connectors between all connections of copper and steel piping (or equipment), and other dissimilar metals. Where flanged connections occur use insulating type flanges. Dielectric unions shall not be used.
- G. Flexible Connectors - Pumps: Install at all suction and discharge connections (except not required on pumps 1 HP and less).
- H. Flexible Connectors - Piping: Install at pipe connections to equipment with rotating elements (except not required at hydronic heating/cooling coils unless specifically noted), at building expansion joints, and where indicated. Provide flexible connector in gas piping connections to all equipment; size flexible connectors to match pipe size shown on plan, with reducer after the flexible connector to match the equipment connection size.
- I. Test Ports: Install at locations shown on drawings and where needed by Balancer to allow measurements for flow adjustments.
- J. Access Doors: Provide access doors where indicated on the drawings and where needed to provide access to trap primers, water hammer arresters, cleanouts, valves, coils, controls, mechanical spaces, and similar items requiring service or access that would otherwise be inaccessible. Consult architectural drawings and coordinate location and installation of access doors with trades which are affected by the installation. Access doors are typically not shown in the plans. Review ceiling and wall types and locations of items requiring access to determine quantity and sizes of access doors required.
- K. Escutcheons: Provide at all pipe penetrations through building elements, except where penetration is concealed (unless specifically noted otherwise). Items located in accessible cabinet spaces (e.g. below sinks) are not considered concealed.

END OF SECTION

## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Pipe Hangers and Supports.
- B. Duct Hangers and Supports.
- C. Mechanical Equipment Anchors and Supports.

### 1.3 QUALITY ASSURANCE

- A. Pipe Hanger Standards: Manufacturers Standardization Society (MSS) Standards SP-58, SP-89, SP-69, and SP-90.
- B. General: All methods, materials and workmanship shall comply with Code; including IBC, IMC, UPC, NFPA Standards, and ASME standards.

### 1.4 SUBMITTALS

- A. General: Submittals shall comply with Section 220500.
- B. Product Data: Submit product data for all hangers, supports, and anchors. Data to include finish, load rating, dimensions, and applicable agency listings. Indicate application for all items by system type, size, and other criteria as appropriate to project.
- C. Shop Drawings:
  - 1. General: Shop drawings shall clearly indicate dimensions, anchor and support type, anchor and support size, anchor and support spacing, finish, configuration, and systems/equipment to be applied to.
  - 2. Attachments: Submit shop drawings for proposed attachment methods to building structure where the method of attachment has not been shown on the drawings, or where attachment methods other than those shown on the drawings are desired to be used.
  - 3. Fabricated Supports: Submit shop drawings for all fabricated supports.
  - 4. Finished Areas: Submit shop drawings for all supports that will be exposed in finished areas.

### 1.5 GENERAL REQUIREMENTS

- A. Seismic: Provide adequate hangers, supports, anchors, and bracing to serve as seismic restraints. Seismic restraints shall comply with Section 220548. Provide seismic restraint calculations and information per Section 220548 and as required by code.

- B. Design and Manufacture: All pipe hangers and supports shall be designed and manufactured in accordance with MSS-SP 58.

## 1.6 REFERENCES

- A. ADC: Air Duct Council - Flexible Duct Performance and Installation Standard, 5th Edition.
- B. ASHRAE-F: American Society of Heating, Refrigeration, and Air Conditioning Engineers, Handbook of Fundamentals.
- C. ASME B31.1: Power Piping.
- D. ASME B31.9: Building Services Piping.
- E. ASTM A36: Standard Specification for Carbon Structural Steel.
- F. ASTM A108: Standard Specification for Steel Bar, Carbon and Alloy, Cold - Finished.
- G. ASTM A123: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- H. ASTM A153: Standard specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- I. ASTM A653: Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc Iron Alloy-Coated (Galvannealed) by the Hot Dip Process.
- J. ASTM A907: Standard Specification for Steel, Wire, Epoxy - Coated.
- K. ASTM A924: Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot Dip Process.
- L. IBC: International Building Code.
- M. IMC: International Mechanical Code.
- N. Federal Spec QQ-W-461H: Wire, Steel, Carbon (Round, Bare, and Coated).
- O. Mason SRG: Mason Industries Seismic Restraint Guidelines for Suspended Piping, Ductwork, Electrical Systems and Floor Mounted Equipment, 6th Edition.
- P. MSS SP-58: Pipe and Hangers and Supports - Materials, Design and Manufacture.
- Q. MSS SP-69: Pipe and Hangers and Supports - Selection and Application.
- R. MSS SP-89: Pipe Hangers and Supports - Fabrication and Installation Practices.
- S. MSS SP-90: Guidelines on Terminology for Pipe Hangers and Supports.
- T. SMACNA-DCS: HVAC Duct Construction Standards Metal and Flexible, 3rd Edition.
- U. SMACNA SRM: Seismic Restraint Manual Guidelines for Mechanical Systems, 2nd Edition.



V. UPC: Uniform Plumbing Code.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Products shall comply with Section 220500, Paragraph 2.1, Acceptable Manufacturers.
- B. Hangers and Supports: Grinnell, B-Line Systems, Unistrut, Erico, PHD, Basic-PSA, Pate, Caddy, Unisource, Metraflex, American Insulation Sales, Thermal Pipe Shields, FNW.
- C. Anchors: Rawplug, Phillips, Hilti, Michigan, Simpson, Fastenal, Grinnell, B-Line Systems, Unistrut, PHD, Basic-PSA, Metraflex.

2.2 GENERAL

- A. Finish:
  - 1. Indoor Applications: Electro-plated zinc in accordance with ASTM B 633, or hot-dip galvanized after fabrication in accordance with ASTM A 123; except that hanger straps may be formed from pre-galvanized steel.
  - 2. Outdoor Applications: Hot-dip galvanized after fabrication in accordance with ASTM A 123, ASTM A 153, or ASTM A 653 (as applicable to item).
  - 3. Identification: Steel pipe hangers and supports shall be stamped with the manufacturer's name, part number, and size.
- B. Hanger Rods: Threaded hot rolled steel. Hanger rods shall be sized so that the total load imposed (including pipe or duct, insulation, hangers, and fluid) does not exceed the following:

<u>Nominal Rod Diameter</u>	<u>Maximum Load</u>
1/4 Inch	240 Pounds
5/16 Inch	440 Pounds
3/8 Inch	610 Pounds
1/2 Inch	1130 Pounds
5/8 Inch	1810 Pounds
3/4 Inch	2710 Pounds
7/8 Inch	3770 Pounds
1 Inch	4960 Pounds

- C. Hanger Straps: Galvanized steel, minimum 1" x 22 gauge (except where required by Code to be heavier or noted otherwise), of lock-forming grade conforming to ASTM A924, G90 (minimum) galvanized coating conforming to ASTM A 653. Minimum yield strength of 30,000 psi. Straps shall be sized so that the total load imposed does not exceed the following:

<u>Strap Size</u>	<u>Maximum Load</u>
1" x 22 Gauge	230 Pounds
1" x 20 Gauge	290 Pounds
1" x 18 Gauge	380 Pounds
1" x 16 Gauge	630 Pounds
1-1/2" x 16 Gauge	990 Pounds

- D. Beam Attachments: Constructed of malleable iron or steel, MSS standard types designed for clamping to building structural support beam. "C" clamp type shall have cup point set screws with locknuts and retaining straps. Center loaded type beam clamps shall have horizontally adjustable clamping bolt (or rod with nuts).
- E. Concrete Anchors: Wedge type expansion anchors, with hex nut and washer, and stainless steel split expansion rings. Tested to ASTM E 488 criteria, UL listed, with exposed anchor head stamped with code to identify anchor length.
- F. General Anchors (Screws, Nuts, Bolts, Fasteners):
  - 1. General: Constructed of materials suitable for the conditions exposed to and materials being joined, with minimum 50 year service life. Stainless steel construction where exposed to corrosive conditions. Configuration, size and grade to suit application, accommodate expected forces, and provide anchoring to structural element (or allow for proper fastening of items). Minimum safety factor of 2.5 (or as required by code, whichever is greater). Comply with ASTM A307, SAE J429, SAE J78, or ASTM A 563; bolts and nuts shall have unified inch screw threads (course, UNC).
  - 2. Test Reports: Provide independent test report indicating fastener strength (pullout and shear) as installed in the materials and applications of this project.
  - 3. Finish: In finished areas, the portion of fastener exposed to view shall match the exposed finish of item being fastened.
- G. Manufactured Strut Systems:
  - 1. Channels: Minimum 12 gauge, 1-5/8 x 1-5/8" (unless noted otherwise), with slots/holes to suit application.
  - 2. Accessories: Channel nuts press formed, machined and hardened with gripping slot, fabricated from steel conforming to ASTM A 108 or ASTM A 36. Fittings fabricated from steel in accordance with ASTM A 907.
  - 3. End Caps: Vinyl cap, capable of withstanding high temperatures without degradation, manufactured specifically for use with manufactured strut. Unistrut Series P2859 or P2860 (or approved).
- H. Steel: Structural steel per ASTM A 36.
- I. Wood: Only allowed to be used where building structural elements are of wood construction same type, grade used for building structural members. Where located outdoors shall be the pressure treated type; with all cut portions of wood painted with wood preservative.
- J. Field Galvanizing Compound: Brush or spray applied galvanizing treatment; consisting of a premixed ready to apply liquid organic zinc compound, with 95% metallic zinc content by weight in dry film. ZRC worldwide "ZRC Cold Galvanizing Compound".
- K. Rooftop Pipe Supports: Designed for rooftop support of piping to distribute load evenly over roof surface; factory fabricated. Shall be constructed of thermoplastic, polycarbonate, or polyethylene material, with attached strut support for anchoring of pipe, pipe attachment hardware, and sized to suit piping used with and so that pressure on roof does not exceed 150 pounds per square foot. Provide style with height to match pie height requirements above the roof. Strut and hardware shall be hot-dipped galvanized or have electro-galvanized finish. Plastic materials shall have UV stabilizers to resist UV deterioration. For piping systems subject expansion and contraction, provide roller type support allowing pipe movement,

having a foam bottom to minimize roof abrasion. Caddy “Pyramid ST”, Pyramid 50”, “Pyramid 150”, Pyramid RL”.

- L. Rooftop Equipment Sleepers: Factory fabricated sleepers, constructed of minimum 18 gauge galvanized steel, all joints fully welded, with integral base plate pressure treated top wooden nailer, and integral top flashing having side turndown over wood nailer. Size to suit equipment supported, with minimum height above roof as indicated, and configuration to suit roof and roof insulation used with. Pate Co. “es-Equipment Supports”, Thybar “TEMS”, (or approved equal).

### 2.3 PIPE HANGERS AND SUPPORTS

- A. Copper Pipe: All hangers used directly on copper pipe shall be copper plated or have a factory applied 1/16-inch thick (minimum) plastic coating on all contact surfaces.
- B. Cushion Clamps: Pipe clamps with a vibration dampening insert between the pipe and clamp, with a nylon inserted lock-nut on clamp. Insert shall be constructed of a thermoplastic elastomer, designed to tightly fit and match pipe size and clamp used with; suitable for system temperatures.
- C. Type: Shall be MSS type selected in accordance with MSS-69; except that MSS type 24, 26, and 34 shall not be used.
- D. Trapeze Hangers: Shall be constructed of carbon steel angles, manufactured strut channels, or other structural shapes with flat surface (or installed saddle) for pipe support. Provide steel washer where hanger rod nuts bear on trapeze hanger. Pipe anchors shall be two piece clamp type designed for use with trapeze style (i.e. inserted into strut channel opening) or one piece type designed for welded or bolted attachment to trapeze; shaped to match pipe size (or pipe size plus insulation thickness on insulated systems). Pipe guides shall comply with paragraph titled “Alignment Guides”; or be steel angles with vertical leg height equal to pipe diameter (or pipe diameter plus insulation thickness on insulated systems); or be two piece clamp type pipe anchors sized and installed to serve as a guide.
- E. Insulated Pipe Supports:
  - 1. Insulation material at pipe support shall consist of expanded perlite, calcium silicate or high density phenolic. Where located outdoors or used on chilled water piping, insulation material, shall be water resistant. Insert shall have a flame resistant jacket of nylon reinforced kraft paper bonded to aluminum foil cover on insulation, with galvanized steel shield. Insulation material shall have no more than 5% deformation at 100 psi and a thermal conductivity no more than 0.32 Btu/hr-sf-deg F-inch (rated at 75 deg F). Insulation shall be suitable for temperatures and conditions it will be exposed to without degradation over a 30 year life.
  - 2. All insulation and materials shall have a fire hazard rating not to exceed 25 for flame spread and 50 for smoke development, as tested by ASTM E84.
  - 3. Insert shall be same thickness as adjoining pipe insulation, sized to match pipe diameter used on.
  - 4. Minimum insulation and shield lengths, and minimum shield gauge:

Nominal Pipe Diameter	Insulation Length	Shield Length	Minimum** Shield
<u>In Inches</u>	<u>In Inches</u>	<u>In Inches</u>	<u>Gauge</u>
1/2 to 1	*	4	20

1-1/4 to 2	6	4	20
2-1/2 to 6	6	4	18
Larger Sizes	9	6	16

\* Insert not required; shield at insulation is acceptable.

\*\* Provide with 360° shield where pipe is clamped (or has a 360° anchor).

F. Expansion Joints:

1. General: Type to suit application (i.e. where located in middle of pipe run provide type to accept expansion/contraction in both directions; where installed at end of pipe run provide type to accept pipe expansion/contraction in one direction). Size to match piping installed in. Provide with axial movement as noted, or (where not noted) as Contractor calculated plus 25 percent excess travel, and in accordance with expansion joint manufacturer's sizing recommendations.
2. Systems Below 200 deg F:
  - a. Bellows Type - Steel Piping: Corrugated bellows type, suitable for 150 psi working pressure at 380 degree F temperature. Bellows shall be of type 304 or 316 stainless steel construction. Able to accept expansion in either direction longitudinally. Metraflex Series MNLC or MN (or approved).
  - b. Bellows Type - Copper Piping: Externally pressurized, packless, bellows type, suitable for 150 psi working pressure at 500 degree F temperature, copper construction. Able to accept expansion in either direction longitudinally. Hyspan Series 8500 (or approved).
  - c. Mechanically Coupled Slip Type: Where mechanically coupled joint systems are allowed on steel piping systems; slip type expansion joint providing up to 3-inch axial end movement, with mechanically coupled pipe ends, rated for 150 psi working pressure and 230 degrees F. Victaulic Style 150 (or approved).
  - d. Mechanically Coupled Systems: Where mechanically coupled joint systems are allowed, and system expansion/contraction can be accommodated by pipe joints having appropriate end gaps and appropriate quantity of mechanically coupled joints. See Section 232115.

G. Alignment Guides: Steel "spider" type alignment guides, with anchoring legs. Provide with calcium silicate insulation where used on cold pipe lines. Metraflex "Style IV", "PG-PRE" (or approved).

H. Pipe Anchors - Expansion: For use on pipe runs having expansion/contraction devices.

1. Contractor Fabricated: Anchors shall consist of riser clamp and welded pipe or steel angles anchored to structure, or similar arrangement (unless indicated otherwise). Provide with calcium silicate insulation insert rated for 900 psi compressive strength, and vapor barrier where used on cold pipe lines.
2. Factory Fabricated: Carbon steel anchors to force pipe expansion into system expansion/contraction devices, with paint finish. Provide with calcium silicate insulation insert rated for 900 psi compressive strength, and vapor barrier, where used on cold pipe lines. Metraflex "PA", "PAPI" (or approved).

## 2.4 DUCT HANGERS AND SUPPORTS

- A. Hangers: As shown in SMACNA-DCS except that wire shall not be used and all materials used shall comply with these specifications.

- B. Vertical Duct Supports at Floor: 1-1/2" x 1-1/2" x 1/8" (minimum) galvanized steel angle and to support ducts, maximum 12 foot on center, and as shown in SMACNA-DCS. For ducts over 30 inches wide provide riser reinforcing with hanger rods between the riser support and riser reinforcing.
- C. Vertical Duct Supports at Wall: 1-1/2" x 1/8" (minimum) strap or 1-1/2" x 1-1/2" x 1/8" (minimum) angle bracket and as shown in SMACNA-DCS.
- D. Hanger Attachments to Structure: As shown in SMACNA-DCS to suit building construction and as allowed on structural drawings. Provide washers at all fasteners through hanger straps (regardless of SMACNA-DCS allowances). Where C-clamps are provided, retainer clips shall be used. Friction beam clamps shall not be used.
- E. Hanger Attachments to Ducts: As shown in SMACNA-DCS except that wire shall not be used as any form of support or attachment for ducts.
- F. Flexible Duct Strap: Woven polypropylene hanging strap, minimum tensile strength of 400 lbs, minimum 1.75-inches wide, designed and intended for flexible duct support.
- G. HVAC Support Wire: Steel, minimum 12 gauge, soft-annealed wire, complying with Federal Specification QQ-W-461H, and IBC for support of ceilings and accessories installed in ceilings.

## PART 3 EXECUTION

### 3.1 INSTALLATION - GENERAL

- A. General: Provide all necessary bolts, nuts, washers, fasteners, turnbuckles, hanger rods, rod connectors, stanchions, wall/roof/floor backing and attachments, bridging between structural members, and any other miscellaneous accessories required for the support and anchoring of all pipes, ducts, and mechanical equipment. All supports, whether from floor, walls, or hung from structure, are Contractor's responsibility. Anchors and supports shall be adequate to accommodate forces equipment will be exposed to. Any field cut pieces of galvanized materials shall be hot-dip galvanized after cutting; or be solvent and wire brushed clean and receive field applied galvanizing treatment. This field applied galvanizing (only allowed with prior permission for minor localized cuts) shall use multiple coats to provide as near equal protection as possible to factory (or hot-dip) applied coatings.
- B. Backing: Install steel or wood backing in walls (anchored to studs) and in ceiling (anchored to joists or trusses), as required to provide support for items.
- C. Installation: Install all inserts, anchors, and supports in accordance with manufacturer's instructions, code requirements, and best professional practices. The most restrictive criteria governs.
- D. Welded Assembly Finish: All welded steel support assemblies shall have a power wire brush and primer paint finish where installed indoors and be have factory applied hot-dip galvanized finish where installed outdoors (or subject to moisture); unless another finish is specified.

- E. Attachments: Attach to anchoring element (i.e. building structure, concrete pads, etc.) as shown on drawings (reference structural drawings). Where not detailed on the drawings, the Contractor shall design and submit shop drawings of proposed attachment methods to the Engineer for review.
- F. Application:
  - 1. Where not detailed on the drawings (or otherwise indicated), the selection and design of supports is the Contractor's responsibility, in compliance with code and Contract Document requirements; subject to submittal review and acceptance by the Engineer.
  - 2. Exposed supports in finished areas shall be arranged to minimize their visibility; be free of dents, scratches and labels, and be configured in a manner to match the decorum and finish of the room they are installed in. Exposed supports in finished areas shall be cleaned to allow for field painting (unless a chrome, stainless steel, or similar finish has been indicated).
  - 3. HVAC Support wire and flexible duct strap shall only be used for support of ceiling air inlets and outlets, or at flexible duct supports.
- G. Manufactured Strut ("Unistrut"): Provide end caps on all strut ends at the following locations:
  - 1. Where exposed to view in finished areas.
  - 2. Where near maintenance access paths.
  - 3. Where personnel injury could occur if the ends were not covered.
- H. Seismic: Provide bracing and added supports to restrain movement in a seismic event. Items serving as seismic restraints shall comply with Section 220548.

### 3.2 INSTALLATION OF PIPE HANGERS AND SUPPORTS

- A. General: Aboveground pipe shall be anchored to the structure to prevent sagging, to keep pipe in alignment, and to resist the forces the pipe will be exposed to; piping shall be supported independent of equipment so that no loads bear on the equipment. Underground pipe shall be evenly supported in trenches with proper bedding materials; see Section 220590; except that piping below structural slabs (or where soil conditions will not provide suitable support) shall be supported of the structure that same as for aboveground piping. See drawings for extent of structural slab areas.
- B. Adjustment: All pipe supports shall be provided with a means of adjustment for the aligning and leveling of the pipe after installation.
- C. Applications: Selection, sizing, and installation of pipe supports and accessories shall be in accordance with the manufacturers recommendations, standards MSS SP-89 and MSS SP-69, UPC, and IMC. Refrigerant piping and similar piping subject to vibration (i.e. high pressure tubing) shall be installed with cushion clamps.
- D. Support Spacing: Provide piping support spacing according to the most restrictive of the following: UPC, IMC, ASME B31.1, B31.9, local codes, manufacturers recommendations or Contract Documents specific requirements. Provide supports at each change in direction of piping and at each side of concentrated loads (such as in-line pumps, valves greater than size 5", and similar items). On hubless cast iron piping provide supports at each branch connection; and hubless cast iron piping greater than size 2" shall have supports on both side of piping couplings.

- E. Trapeze Hangers: Four or more pipes running parallel may be supported on trapeze hangers provided the slopes of such pipes allow use of common trapeze. Suspend trapeze hanger from the building structure using hanger rods; attach to the building structure using concrete inserts, beam clamps, or other approved methods. Where trapeze width exceeds 30 inches, and where building attachment restrictions require more anchor points, provide three (or more) hanger rod supports. Provide pipe anchors to secure piping to trapeze on minimum 20 foot spacing; size and install pipe anchor to allow longitudinal movement of pipe (unless noted otherwise) with minimal vertical and transverse movement; where pipe is subject to expansion/contraction provide anchoring and alignment guides per paragraph titled "Thermal Expansion/Contraction".
- F. Vertical Piping Supports: Support piping at each floor line with pipe clamps and at intermediate points as required so that hanger spacing does not exceed allowable spacing and as required to prevent excessive pipe movement and so as to comply with the maximum spacings cited above. Support all pipe stacks at their bases with a concrete pier or suitable support. For vertical pipe drops which occur away from a wall or similar anchoring surface, provide angled bracing from nearest structure on two sides of drop to provide rigid anchoring of pipe drop. Provide riser clamps and vertical supports on all vertical vent piping where the vertical pipe length exceeds 5'.
- G. Pre-Insulated Pipe Supports: Protect all insulated pipe at point of support with pre-insulated pipe supports. Such supports shall be in place at time of installing pipe.
- H. Underground Pipe: Shall be evenly supported on approved bedding materials, as appropriate for the type of piping being used. Such bedding and backfilling shall be as specified in Section 220590.
- I. Thermal Expansion/Contraction:
  - 1. General: All expansion devices and associated system features to accommodate pipe thermal expansion/contraction shall be Contractor designed (except where a specific design has been provided), in accordance with MSS SP-69, ASME B31.9, ASME B31.1, ASHRAE-F, and expansion joint manufacturer's guidelines. See Section 220548 for requirements to accommodate building movement and system vibration.
  - 2. Locations: Where straight pipe runs exceed 50 feet in length, and where piping is subject to expansion and contraction of 1/2-inch lengthwise or more, provide expansion joints or expansion loops (use specific type where indicated) to accommodate system expansion/contraction.
  - 3. Expansion: Unless expansion/contraction lengths have been indicated, calculate expansion contraction using worse case temperatures system will be exposed to (e.g. installed seasonal temperature of system versus high/low operating temperature, or system high/low operating values, etc.) and pipe expansion factors from ASHRAE-F.
  - 4. Supports, Guides, Anchors: Pipe shall be supported with roll type or anti-friction plate type supports to allow movement relative to expansion devices without imparting movement to hangers; brace hangers as needed in order to prevent movement. On systems operating below 125 deg F roll type or anti-friction plate type supports are not required provided the required expansion/contraction can be accommodated by direct movement of the pipe (or pipe insert) on the installed supports. Provide alignment guides on each side of expansion devices and at intermediate points to maintain pipe alignment as recommended by alignment guide manufacturer. Provide pipe anchors at the end of runs to ensure pipe expansion into expansion devices.

### 3.3 INSTALLATION OF DUCT HANGERS AND SUPPORTS

- A. General: Provide anchors and supports for all ductwork. Supports and hangers shall comply with SMACNA-DCS, except that hanger spacing and hanger maximum loads shall be governed by whichever is more restrictive between these specifications or SMACNA-DCS.
- B. Hanger Spacing -- Rectangular Duct:
- | <u>Duct Area</u>      | <u>Maximum Spacing</u> |
|-----------------------|------------------------|
| Up to 4 Square Feet   | 8 Feet                 |
| 4.1 to 10 Square Feet | 6 Feet                 |
| 10 Square Feet and Up | 4 Feet                 |
- C. Hanger Spacing -- Round Duct:
- | <u>Duct Area</u>            | <u>Maximum Spacing</u> |
|-----------------------------|------------------------|
| Up to 24 Inch Diameter      | 8 Feet                 |
| 25 Inch to 48 Inch Diameter | 6 Feet                 |
| 49 Inch Diameter and Up     | 4 Feet                 |
- D. Hanger Spacing - Flexible Duct: 4 feet, and at changes of direction as needed to maintain duct elevation and smooth airflow.
- E. Vertical Ducts: Support at each floor level, but in no case less than on 12 foot intervals.
- F. Flexible Duct: Support with methods shown in ADC. Metal strap in contact with the flexible duct shall have minimum 1.5-inch width.
- G. Fittings: Provide supports at each change in direction of duct for ducts with 4 square foot area or more, or for ducts larger than 24 inch diameter. Locate hangers at inside and outside corners of elbows--or at each end of fitting on each side.
- H. Concentrated Loads: Provide additional supports at each side concentrated loads such as modulating dampers (24" x 24" and larger), duct heaters (18" x 18" and larger), sound attenuators (all sizes), and similar items.
- I. Exterior Duct: Provide supports for exterior ductwork as shown in SMACNA-DCS; spacing as specified herein.
- J. End of Duct: At end of duct run, hanger shall be located no more than 1/2 the allowed hanger spacing from the end of the run.

### 3.4 CEILING SERVICES

- A. Less than 20 Pounds: Ceiling mounted services, air inlets/outlets, and accessories weighing less than 20 pounds shall be positively attached to the ceiling suspension main runners (or ceiling support members) or to cross runners with the same carrying capacity as the main runners (or support members).
- B. 20 to 56 Pounds: Ceiling mounted services, air inlets/outlets, and accessories weighing 20 pounds but not more than 56 pounds, in addition to the above, shall have two No. 12 gauge wire hangers (or minimum 1" x 22 gauge hanger straps) connected from the terminal or



service to the ceiling system hangers or to the structure above. These added hangers may be slack.

- C. Greater Than 56 Pounds: Ceiling mounted services, air inlets/outlets, and accessories weighing more than 56 pounds shall be supported directly from the building structure by approved hangers.

### 3.5 MECHANICAL EQUIPMENT ANCHORS AND SUPPORTS

- A. General: Provide anchoring and supports for all mechanical equipment. All equipment shall be anchored to (or supported from) the building structure. In lieu of anchoring to the building, anchor outdoor equipment to the concrete pad serving the equipment.
- B. Suspended Equipment: Support as indicated on the plans. Where not indicated use the methods shown (or consistent with) Mason SRG and SMACNA-DCS; submit shop drawings of the proposed methods to the Engineer for review.
- C. Roof Mounted Equipment: Install on roof curbs or roof sleepers as indicated. Anchor equipment to the curb (or sleeper), with the curb (or sleeper) in turn anchored to the building structure.
- D. Vibration Isolation: Equipment shall be supported and anchored in such a way so that no equipment vibration is transmitted to the building structure.
- E. Seismic: Coordinate with requirements of Section 220548; provide anchors and bracing to resist seismic forces.

END OF SECTION



## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Pipe Sleeves.
- B. Duct Sleeves.
- C. Duct Closure Collars.
- D. Firestop Seals.
- E. Non-Firestop Seals.

### 1.3 DEFINITIONS

- A. Firestop System: Specific firestop materials or combination of materials installed in a specific way in openings in a specific rated assembly to restore (or maintain) the fire rating and smoke passage resistance properties of the assembly.
- B. Firestop Seal: Same as "Firestop System".
- C. Rated Assembly: Wall, floor, roof, ceiling, roof/ceiling or other construction which is required (by code or the Contract Documents) to have a fire-resistance rating, be a smoke barrier, or to limit the passage of smoke.

### 1.4 SUBMITTALS

- A. General: Shall comply with Section 220500.
- B. Product Data: Provide product data on all material to be use. Provide MSDS for all sealants, caulks and similar materials.
- C. Shop Drawings – General: Shop drawings of proposed sealing/flashing assembly for roof and exterior wall penetrations.
- D. Shop Drawings – Firestop: Provide firestop system shop drawings showing:
  - 1. Listing agency's detailed drawing showing opening, penetrating items, and firestop materials. Drawing shall be identified with listing agency's name and number or designation, fire rating achieved, and date of listing for each firestop system.
  - 2. Identify where each firestop system is to be used on the project.
  - 3. Manufacturer's installation instructions.

4. For proposed systems that do not conform strictly to the listing, submit listing agency's drawing marked to show modifications and stamped approval by the firestop system manufacturer's fire protection engineer.
5. Other data as required by the AHJ.

## 1.5 REFERENCES

- A. ASTM A 36: Standard Specification for Carbon Structural Steel.
- B. ASTM C534: Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- C. ASTM E 84: Standard Test Method for Surface Burning Characteristics of Building Materials.
- D. ASTM E 814: Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
- E. UL 1479: Standard for Fire Tests of Through-Penetration Firestops.
- F. UL 723: Surface Burning Characteristics of Building Materials.
- G. SMACNA-DCS: SMACNA HVAC Duct Construction Standards, Third Edition.
- H. SMACNA-ARCH: SMACNA Architectural Sheet Metal Manual, Seventh Edition.
- I. USGBC LEED: US Green Building Council LEED Reference Guide for Green Building Construction.

## 1.6 GENERAL REQUIREMENTS

- A. Corrosion Protection: All sleeves exposed to water, moisture, chemicals, or subject to corrosion shall be constructed of corrosion resistant materials suitable for the exposure. Steel sleeves shall be hot dip galvanized after assembly. Provide additional coatings as noted or as required to resist corrosion.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Products shall comply with Section 220500, Paragraph 2.1, Acceptable Manufacturers.
- B. Firestop Seal Materials: 3M, Dow Corning, Hilti
- C. Non-Firestop Seal Materials: 3M, GE, Dow Corning, Tremco, Pecora, Sonneborn, Pipeline Seal & Insulator.

### 2.2 PIPE SLEEVES

- A. Diameter:

1. Belowground: Inside diameter of belowground pipe sleeves shall be at least 2 inch larger than the outside diameter of the pipe or pipe covering (for covered piping systems), so as to allow free movement of piping.
  2. Aboveground: Inside diameter of aboveground pipe sleeves shall be at least 1-inch larger than the outside diameter of the pipe or pipe covering (for covered piping systems), so as to allow free movement of piping.
  3. Large Movement: Provide larger sleeves where a larger space around pipe exterior is required by code, where specifically noted, where expansive soils or other unusual conditions are present and where required to accommodate large piping movement.
- B. Length: Horizontal sleeves through finished areas (where sleeve is exposed to view) shall be sized to be flush with finished surfaces; other horizontal sleeves may terminate flush to 2-inches past the element being penetrated. Vertical sleeves shall be sized to extend one inch above the final floor elevation.
- C. Structural Type: Fabricated from schedule 40 steel pipe. Waterstop shall consist of fully welded 2-inch larger diameter collar, minimum 1/4 inch thick steel, located on sleeve so as to be centered within the element being penetrated. Provide waterstop on sleeves where sleeves are installed in the following locations: in cast-in-place concrete, where any part of the sleeve ends are exposed to water, where installed in floors with water-proofing or water stopping membranes, in rooms with floor drains, and where needed for anchoring/support purposes. Prime paint all surfaces with rust-inhibiting paint.
- D. Non-Structural Type:
1. Non-Waterstop Type: Fabricated from 18 gauge galvanized sheet metal or 22 gauge spiral seam galvanized steel duct. Provide with galvanized steel angle tabs, collars, or similar to allow for anchoring where sleeve cannot be retained in place by element being penetrated.
  2. Waterstop Type: Fabricated from 18 gauge galvanized sheet metal or 22 gauge spiral seam galvanized steel duct. Cold galvanize cut edges of sleeve. Waterstop shall be constructed of same material as sleeve, be fully welded to sleeve, 2-inch larger diameter, located on sleeve to allow sealing of gap between sleeve and element being penetrated.
- E. Flexible Type: Flexible cellular elastomeric insulation, complying with ASTM C 534, Type 1, minimum 1/2-inch thick. Water vapor permeance shall not exceed 0.08 perms. Operating Temperature Limits -20 degrees F to 180 degrees F. Provide in sheet or pre-fabricated pipe size; provide multiple wraps as required.

## 2.3 DUCT SLEEVES

- A. Size: Inside dimension of duct sleeves shall be at least 1-inch larger than the outside dimension of the duct or duct covering (for covered duct systems). For duct system conveying air or gases operating above 200 deg F provide sleeve dimension minimum 2-inch larger than duct or duct covering (for covered duct systems). Provide larger sleeves where a larger space around duct exterior is required by code, by duct or flue system manufacturer, to provide required thermal clearances, where specifically noted, where unusual conditions are present and where required to accommodate large movement.
- B. Length: Horizontal sleeves through finished areas (where sleeve is exposed to view) shall be sized to be flush with finished surfaces; other horizontal sleeves may terminate flush to 2-

inches past the element being penetrated. Vertical sleeves shall be sized to extend one inch above the finished floor.

- C. Structural Type: Fabricated from schedule 40 steel pipe for round openings and 3" x 3" x 3/8" welded steel angles for other openings (unless noted otherwise). Prime paint all surfaces with rust-inhibiting paint.
- D. Non-structural: 24 gauge spiral seam galvanized steel duct or 20 gauge longitudinal seam galvanized steel duct for round openings. Fabricated of 18 gauge galvanized sheet metal for other openings; configured to suit duct.

## 2.4 DUCT CLOSURE COLLARS

- A. General: Closure collars shall provide closure of opening between duct and opening in element penetrated and shall abut tight up to and overlap duct and shall consist of rolled angle material (for round ducts) and welded framed angles (for rectangular and round ducts).
- B. Size: Closure collars shall be sized to match duct and opening applied to and shall have minimum 2-inch overlap on duct side and 2-inch overlap at opening/penetrated element side but shall completely cover opening in element penetrated with minimum 1-inch overlap to undisturbed element (i.e. wall, floor, etc.).
- C. Material: Closure collars shall be fabricated of 20 gauge galvanized steel for ducts 15 inches diameter and less and shall be fabricated of 18 gauge galvanized steel duct for all larger ducts and all square and rectangular ducts.

## 2.5 FIRESTOP SEALS

- A. Shall comply with section 078400 Firestopping.

## 2.6 NON-FIRESTOP SEALS

- A. Shall comply with section 079200 Joint Sealants.

# PART 3 EXECUTION

## 3.1 PIPE SLEEVES

- A. General: Provide sleeves for all piping passing through walls, floors, partitions, roofs, foundations, footings, grade beams, and similar elements. Except that sleeves are not required at core drilled penetrations through solid concrete or where formed openings equivalent to a core drilled opening are provided. Sleeves shall be the following type (horizontal/vertical refer to position of sleeve):
  - 1. Horizontal, Aboveground:
    - a. Concrete and Masonry Walls: Structural type.
    - b. Other Walls: Non-structural type.
  - 2. Vertical, Slab on Grade: Structural type; except at piping serving individual fixtures or individual heating units in finished areas, the flexible type may be used. Where not installed to be concealed (as in a plumbing chase) install height of flexible type so it is concealed by the floor finish, cabinet base, or an escutcheon.
  - 3. Vertical, Not Slab on Grade:

- a. Concrete Floors/Roofs: Structural type.
  - b. Other Floors/Roof: Non-structural aboveground type. Use waterstop type in rooms with floor drains, at plumbing chases, and similar areas.
- B. Installation: Set sleeves plumb or level (or sloped as required for sloped pipes) in proper position, tightly fitted into the work. Set sleeves properly in element for specified projection past adjacent surfaces (see sleeve product specification); cut ends of sleeve as necessary.
- C. Insulation: Insulation shall run continuous through sleeves (unless noted otherwise).

### 3.2 DUCT SLEEVES

- A. General: Provide sleeves for all ducts passing through walls, floors, partitions, roofs, foundations, footings, grade beams, and similar elements, except that sleeves are not required at core drilled penetrations through solid concrete or where formed openings equivalent to a core drill and provided and where no floor drain serves the room where the penetration occurs. Sleeves shall be the following type:
- 1. Concrete and Masonry Walls: Structural type.
  - 2. Other Walls: Non-structural type.
- B. Installation: Set sleeves plumb or level (or sloped as required for sloped duct) in proper position, tightly fitted into the work. Set sleeves properly in element for specified projection past adjacent surface (see sleeve product specification); cut ends of sleeve as necessary.
- C. Insulation: Insulation shall run continuous through sleeves (unless noted otherwise).

### 3.3 DUCT CLOSURE COLLARS

- A. General: Closure collars shall be provided for all exposed ducts on each exposed penetration where the duct passes through any floors, walls, ceilings, roofs, partitions, and similar elements. Closure collars shall additionally be provided where so noted on the drawings and at all duct penetrations into mechanical rooms, boiler rooms, and rooms housing mechanical equipment (on both sides of the penetration).
- B. Installation: Collar shall be installed tight against surfaces and shall fit snugly around the duct or duct covering. Sharp edges of the collar around insulated duct shall be ground smooth to preclude tearing or puncturing the insulation covering or vapor barrier of insulated ducts. Collars shall be anchored to element penetrated, with fasteners appropriate to material fastening to, on maximum 6 inch centers.

### 3.4 FIRESTOP SEALS

- A. General: At each through-penetration and membrane-penetration in rated assemblies, where required to limit the passage of smoke, and as required by code or in the Contract Documents, provide a firestop system. Firestop system shall be installed in accordance with the manufacturer's instructions and listing.
- B. System Selection: Contractor is responsible to select the firestop systems to be utilized, corresponding to the construction of the assembly penetrated, and types of penetrations. Contractor shall submit proposed firestop systems to be utilized, shall also review such systems with the AHJ and obtain AHJ approval.

- C. Preparation: Prepare surfaces as recommended by firestop material manufacturer. Examine and confirm that conditions are acceptable to proceed with the installation. Provide maskings and temporary coverings to prevent contamination or defacement of adjacent surfaces.
- D. Installation Review:
  - 1. Notify Architect/Engineer when firestopping work is complete and ready for review. Provide minimum 7 days notice to allow scheduling of review. An independent testing agency may be utilized to perform an inspection.
  - 2. Notify AHJ when firestopping work is complete and ready for inspection. Provide sufficient advance notice to allow scheduling of the inspection without adversely impacting project schedule.
  - 3. Do not cover or conceal firestopping until all inspections have been satisfactorily completed.

### 3.5 NON-FIRESTOP SEALS

- A. General: Provide seals around all ducts, conduit, and piping passing through sleeves, walls, floors, roofs, foundations, footings, partitions, and similar elements. Seals shall be watertight where the penetration may be exposed to water or moisture. Provide type of sealant to suit the application. Provide smoke and sound type at all penetrations of rooms which contain mechanical equipment on both side of element penetrated to a depth of 5/8-inch (unless noted otherwise).
- B. At Sleeves:
  - 1. Between Sleeve and Penetrated Element: Fill openings around outside of pipe sleeve with same material as surrounding construction, or with material of equivalent fire and smoke rating and properties that allow a tight seal between the sleeve and the surrounding construction. Seal full depth of sleeve for vertical penetrations.
  - 2. Between Pipe and Inside of Sleeve: Provide sealant between outside of pipe or pipe covering (for covered piping systems) and inside of sleeve. Seal depth shall be minimum 1-inch each side. Provide Link Seal type for belowground penetrations, vault wall penetrations, and slab-on-grade penetrations (not required where flexible type sleeves are used).
- C. No Sleeves: Provide "Link-Seal" type for belowground penetrations, vault wall penetrations, and slab-on-grade penetrations. Provide sealant at other areas, type to suit the application. Fully seal between outside of pipe or pipe covering (for covered piping systems) and surrounding construction. Seal depth shall be minimum 1-inch each side.
- D. Plumbing Fixtures: Provide sealant between fixture and abutting building surfaces. Seal so no water or overspray from fixture can enter building construction. See Section 224000.
- E. High Temperature Systems: On piping systems operating above 200 deg F, use "Specialty" seal; pack full depth of penetration with silicon type sealant applied 1/2-inch depth over packing, each end.
- F. Preparation: Remove loose materials and foreign matter impairing adhesion of seal. Perform preparation in accordance with recognized standards and sealant manufacturers recommendations. Protect elements surrounding area of work from damage or disfiguration due.



- G. Installation: Install sealants immediately after joint preparation. Install sealants free of air pockets, foreign embedded matter, ridges, and sags. Tool exposed joint surface concave and with a neat finished appearance.

END OF SECTION



## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Vibration Isolation.
- B. Seismic Restraints.

### 1.3 DEFINITIONS

- A. "Equipment" is defined to mean any item with power connections (fans, HV units, AHU units, etc.), and also to include all hoods; but does not include pumps less than 3 hp.
- B. "Equipment Requiring Vibration Isolation" is defined to be any equipment (as defined above) with rotating components (e.g. pumps, fans, etc.).

### 1.4 SUBMITTALS

- A. General: Submittals shall comply with Section 220500.
- B. Product Data:
  - 1. Submit product data on all items to be used.
  - 2. Submit calculations showing vibration isolation selection for all isolation devices provided under this specification section (i.e. where isolation is not furnished integral with the equipment or by the manufacturer of the equipment).
- C. Shop Drawings: Submit shop drawings for all fabricated support assemblies.
- D. Submit calculations showing seismic restraint calculations, restraint selection, proposed locations of all seismic control bracing, and details of bracing construction.

### 1.5 GENERAL REQUIREMENTS - VIBRATION ISOLATION

- A. General:
  - 1. Select and provide all vibration isolation devices for all equipment requiring vibration isolation so as to provide complete installed mechanical systems free of the transmission of vibration and vibration generated noise to the structure.
  - 2. Vibration isolation is shown on the drawings for various items but is not shown for all items requiring isolation. Provide all isolation as indicated and specified herein.
- B. Supplier: Where not provided by the equipment manufacturer, all vibration isolation devices and support assemblies shall be supplied as a coordinated package by a single vibration isolation manufacturer, under this specification section.

- C. Equipment Manufacturer Items: Isolation devices furnished by equipment manufacturer shall comply with this specification section and be selected by the manufacturer to suit, and provide satisfactory performance, for the applications of this project.

#### 1.6 GENERAL REQUIREMENTS - SEISMIC RESTRAINTS

- A. General: Mechanical equipment, piping, and ductwork seismic restraints are typically not shown on the drawings but are to be provided as specified herein. Contractor is responsible to select and provide all seismic anchoring devices for all mechanical equipment, all piping, and all ductwork.
- B. Fire Sprinkler: Seismic bracing for fire sprinkler system shall be as specified per NFPA 13 but in no case be less than that required in this Section.
- C. Seismic Restraint Systems:
  - 1. The Contractor shall retain a specialty consultant or equipment manufacturer to develop a seismic restraint system and perform seismic calculations in accordance with code and requirements specified in this section. Calculations, restraint selections, and installation details shall be done by a professional experienced in seismic restraint design and installation and licensed in the State where the project is located.
  - 2. The seismic design, consisting of calculations, restraint selection, installation details, and other documentation, shall be submitted. This submittal shall be signed and sealed by a professional Engineer.
  - 3. The seismic restraint design shall clearly indicate the attachment points to the building structure and all design forces (in X, Y, and Z direction) at the attachment points. The seismic restraint engineer shall coordinate all attachments with the building's structural engineer of record, who shall verify the attachment methods and the ability of the building structure to accept the loads imposed.
  - 4. The seismic restraint design shall be based on actual equipment data (dimensions, weight, center of gravity, etc.) obtained from submittals or the manufacturers. The equipment manufacturer shall verify that the attachment points on the equipment can accept the combination of seismic, weight, and other loads imposed.
  - 5. Analysis should include calculated dead loads, static seismic loads, wind loads, and the capacity of materials utilized for the connection of the equipment or system to the structure. Analysis should detail anchoring methods, anchoring materials, anchor sizes, embedment, and related details. All seismic restraint devices should be designed to accept, without failure, the calculated seismic forces.
  - 6. Forces shall be calculated in accordance with accepted engineering practice and code requirements, using appropriate seismic "zone" and other factors for the building type, systems involved, and project location.

#### 1.7 REFERENCES

- A. IBC: International Building Code.
- B. IMC: International Mechanical Code.
- C. MASON: Mason Industries Seismic Restraint Guidelines for suspended piping, Ductwork, Electrical Systems and Floor Mounted Equipment, 2005 6<sup>th</sup> Edition.

- D. OSHPD: Office of Statewide Health Planning and Development, State of California, Fixed Anchorage.
- E. SMACNA/SRM: Seismic Restraint Manual Guidelines for Mechanical Systems, 2<sup>nd</sup> Edition.
- F. UPC: Uniform Plumbing Code.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Products shall comply with Section 220500, Paragraph 2.1, Acceptable Manufacturers.
- B. Products: Mason, Peabody, Kinetics Noise Control, Vibration Eliminators, Amber-Booth.
- C. Expansion Devices/Flexible Connectors: Unisource Manufacturing, Twin City Hose, and as specified in Section 220519, 232113, and 233300.

### 2.2 NEOPRENE ISOLATORS

- A. Isolation Pads: Oil resistant bridge bearing neoprene pads, minimum 3/4-inch thick, with cross-ribbed or waffle design. Size pads for not more than 50 psi or as recommended by vibration isolator manufacturer. Provide load distribution plates (minimum 3/8" plate steel) to evenly load pads. Mason Type SW (or approved).
- B. Floor Mounted Isolators: Double deflection neoprene mounts, sized for minimum deflection of 0.30-inch. All metal surfaces shall be neoprene covered, base plate shall have mounting holes, and top shall have threaded steel plate or threaded steel insert. Element shall be color coded or labeled with molded symbols to identify capacity. Neoprene shall be bridge bearing type. Mason Series ND (or approved).
- C. Suspension Isolators: Double deflection neoprene type, with isolator encased in open steel bracket, and sized for minimum 0.30-inch deflection. Hanger rod shall be isolated from steel bracket with neoprene grommets. Mason Series HD (or approved).
- D. Washer Bushings: Bridge bearing neoprene washer insert to provide isolation between anchor bolt and washer from support member/equipment. Mason Series HG (or approved).

### 2.3 SPRING ISOLATORS

- A. General: The load carried by each isolator shall be carefully calculated and isolators selected so that the static deflection will be the same and the supported equipment will remain level. Isolators shall be so designed that the ends of the springs will remain parallel during and after deflection to operating height. At operating height, springs shall have additional travel to complete (solid) compression equal to at least 50 percent of the operating deflection. Suspension isolator springs shall have a static deflection not less than 1-inch (unless noted otherwise), except that for units with components rotating at 1000 rpm and less, the static deflection shall be not less than 2-inches (unless noted otherwise). Floor isolator springs shall have deflection of not less than 1-inch. All isolators shall provide at least 95% isolation efficiency. Deflections other than these may be used where circumstances warrant and more

optimum isolation results can be achieved; provided that a written explanation is submitted for Engineer review and approval.

- B. Suspension Type Spring Isolators: Shall consist of a rigid steel frame with a stable steel spring in the bottom part of the frame, and double deflection neoprene (or rubber) isolating pad at the top of the frame. Where supporting rods pass through the frame, a clearance of not less than one-half rod diameter shall be provided all around the rod and neoprene bushings provided to prevent steel to steel contact. Mason Series DNHS or Series 30N (or approved).
- C. Vibration Isolating Roof Curbs-HVAC Equipment Applications: Curb mount type.: Separate spring mounted curb for mounting on top of HVAC unit manufacturer's standard curb, with size, configuration, and capacity to suit equipment served. Shall be of extruded aluminum construction, with welded corners and supporting members, and electro-plated steel spring isolators. Spring isolators shall provide minimum 3" deflection, with minimum 50% travel to solid, spring diameter shall be no less than 0.8 of the spring height at the rated load. Spring isolators shall be sized by vibration isolation curb manufacturer to suit equipment weight served. Curb shall have internal resilient snubbers and suitable clearances to accommodate unit movement under normal wind forces (up to 35 mph) without hindering normal spring action. Curb shall remain captive under anticipated maximum seismic and wind forces, unless an exterior anchoring means is utilized. Curb shall be designed with top member overlapping the bottom member to allow for water runoff, and shall have a flexible EPDM continuous perimeter weather seal between these two members. Where unit length exceeds 10 feet, unit may be shipped in sections with a field splice kit to join sections; splice kit shall include overlapping EPDM and overlapping top and bottom members. All hardware shall be cadmium or zinc electroplated. Assembly shall have self adhering closed cell sponge gasketing, to be applied between curb and vibration isolation assembly, and between vibration isolation assembly and HVAC equipment.

## 2.4 SEISMIC RESTRAINTS

- A. General: Comply with code, SMACNA-SRM and MASON.
- B. Materials:
  - 1. Steel shall be per ASTM A36; hangers and other devices shall be per Section 220529 and as shown in SMACNA-SRM or MASON. Sheet metal used for bracing shall be no less than 16 gauge. Material for straps shall be galvanized steel, no less than 18 gauge.
  - 2. Cabling: Cables shall be minimum 1/8" diameter, 7 x 19 strand, galvanized steel with clear vinyl coating. Provide with galvanized thimble, clamps, and accessories. End termination and clamping/application shall comply with SMACNA-SRM.
- C. Flexible Connectors:
  - 1. Piping Systems:
    - a. Flexible Connectors: As specified in Section 220519.
    - b. Seismic "V" Connectors: "V" design connector with braided hose and attachment fittings. Shall be constructed of type 321 stainless steel hose and braid with carbon steel elbows and ends (for steel piping systems); and bronze hose and braid with copper elbows and ends (for copper piping systems). Unit shall allow for 2" movement in all planes, and have minimum 150 psi working pressure at the system temperature installed. Unisource Manufacturing (or approved).
  - 2. Ductwork: Flexible connectors as specified in Section 233300.

## PART 3 EXECUTION

### 3.1 VIBRATION ISOLATION

- A. General: Provide vibration isolators for all rotating equipment so that no vibration is transmitted to the structure. Isolators shall be the type indicated; except where not shown, type shall be as selected by vibration isolation manufacturer (or equipment manufacturer) to provide adequate isolation.
- B. Installation: Install all vibration isolators in accordance with isolator manufacturer's instructions and isolated equipment manufacturer's recommendations.
- C. Inadequate Isolation: Should vibration isolators prove inadequate to prevent transmission of vibrations to the building structure or limit equipment vibration generated noise, such isolators shall be replaced with isolators having the largest deflection that can be practically installed or otherwise modified/replaced to produce satisfactory isolation. Such replacement shall be at no additional cost to the Owner.
- D. Equipment with Rotating Components Not Requiring Isolation:
  - 1. Pumps.
  - 2. Split system ductless air conditioning and heat pump units; indoor portion.
  - 3. Boilers.

### 3.2 SEISMIC RESTRAINTS

- A. General: Provide seismic restraints as required by code and as specified. Comply with SMACNA-SRM, and MASON. Anchoring system and restraints shall be able to withstand anticipated seismic forces. Coordinate with equipment manufacturers for proper equipment anchor attachments to withstand anticipated forces. Coordinate with project structural engineer for attachment of seismic restraints to building.
- B. Piping: Longitudinal and transverse bracing shall be required for all piping 2-1/2-inch diameter and larger and on all fuel gas piping 1-inch and larger. Bracing shall be applied as follows:
  - 1. Transverse bracing shall occur at maximum intervals of 40 feet, except on fuel gas piping on maximum intervals of 20 feet.
  - 2. Longitudinal bracing shall occur at maximum intervals of 80 feet, except on fuel gas piping on maximum intervals of 40 feet. Transverse bracing for one pipe section may also act as a longitudinal bracing for a pipe section connected perpendicular to it, if the bracing is installed within 2 feet of the elbow or tee of similar size. Piping conveying fluids at 100 degrees F and higher shall have expansion devices provided in-between longitudinal braces to allow for thermal expansion.
  - 3. Bracing may be omitted when the top of the pipe is suspended 12 inches or less from the supporting structural member and the pipe is suspended by an individual hanger.
- C. Ductwork: Longitudinal and transverse bracing shall be required for all round ducts 28 inches in diameter and larger, for rectangular ducts 6 square feet and larger, and on all duct systems used for life safety and smoke control installed in either the horizontal or vertical position. Bracing shall be applied as follows:
  - 1. Transverse bracing shall occur at maximum intervals of 30 feet (20 feet for essential facilities), at each duct turn and at the end of a duct run.

2. Longitudinal bracing shall occur at maximum intervals of 60 feet (40 feet for essential facilities). Transverse bracing for one duct section may also act as longitudinal bracing for a duct section connected perpendicular to it, if bracing is installed within 4 feet of the intersection and sized and installed on the larger duct.
  3. Groups of ducts may be combined in a larger size frame using overall dimensions and maximum weight of ducts. At least two sides of each duct must be connected to the angles of the brace.
  4. Walls, including non-bearing fixed partitions which have ducts running through them, may replace a transverse brace.
  5. Bracing may be omitted when the top of the duct is suspended 12 inches or less from the supporting structural members and on roof top ductwork.
- D. Equipment:
1. Equipment Not Requiring External Vibration Isolation:
    - a. General: Shall be rigidly connected to the structure per Section 220529. Restraints (where required) shall utilize welded steel frames, steel braces, straps, or cables. Provide elastomeric (or neoprene) pads (1/4" thick) between seismic straps and equipment.
    - b. Base Mounted Equipment:
      - 1) Provide anchorage per Section 220529 and bracing as needed to maintain equipment anchorage with anticipated seismic forces.
      - 2) All equipment shall have seismic bracing where the height of the equipment is 3 or more times the smallest base dimension and where the equipment anchorage alone is not adequate to maintain equipment anchorage with anticipated seismic forces.
      - 3) All water heaters shall have seismic bracing. Equipment which utilizes (or contains) flammables, combustibles, or hazardous materials shall have seismic bracing where the equipment anchorage alone is not adequate to resist anticipated seismic forces.
    - c. Other Equipment: All equipment located 31" or more from the point of attachment to the supporting structure shall have seismic bracing. Equipment which utilizes (or contains) flammables, combustibles, or hazardous materials shall have seismic bracing.
  2. Equipment with External Vibration Isolation:
    - a. General: Restraints shall not impede operation of vibration isolators, and shall use methods complying with SMACNA-SRM or MASON.
    - b. Base Mounted Equipment:
      - 1) All equipment shall have seismic bracing where the height of the equipment is 3 or more times the smallest base dimension and where the equipment vibration isolation components are not adequate to maintain equipment in place with anticipated seismic forces.
      - 2) Provide housed spring isolators, seismic snubbers, padded welded steel angle restraint assembly (with minimum 1/4" clearance between pad and equipment), or slack cable restraints.
    - c. Other Equipment:
      - 1) All equipment located 31" or more from the supporting structure shall have seismic bracing. Equipment which utilizes (or contains) flammables, combustibles, or hazardous materials shall have seismic bracing.
      - 2) Utilize slacked cable bracing to accommodate equipment movement due to vibration isolator operation but installed so as to prevent more than 2-inch movement in any direction.



- E. Bracing Arrangements:
  - 1. Do not use branch ducts or piping to brace main runs or consider as braces for equipment.
  - 2. Do not brace items to dissimilar parts of a building or dissimilar building systems that may respond in a different mode during an earthquake. (Examples: wall and roof, solid concrete wall and lightweight roof, existing building structure and new isolated building structure.)
- F. Building Expansion Joints: At building expansion joint crossings, provide seismic “V” connectors in piping allowing at least 1-inch movement in all directions and flexible connectors in ductwork (on both sides of expansion joint) allowing at least 1/2-inch movement in all directions. Provide multiple connectors as required. Provide flexible connectors in ductwork in four places, and of sufficient length to allow relative duct movement (i.e. from one side of building expansion joint to the other) of at least 1-inch in all directions; provide hanger types that will not hinder such movement.

### 3.3 TEST AND INSPECTION

- A. Field Inspections: Prior to initial operation, the vibration isolators and seismic devices shall be inspected for conformance to drawings, specifications, and manufacturer's data and instructions. Check all flexible connectors/expansion devices for proper location, guiding, and end anchoring.
- B. Vibration Isolator Inspection: After installation of isolators and seismic restraint devices, remove all shipping blocks and other items that may prevent proper isolator operation. Inspect isolators to verify that the machinery moves freely on its spring isolators within limits of stops or seismic restraint devices. Eliminate or correct interferences.
- C. Tests: Check for vibration and noise transmission through connections, piping, ductwork, foundations, and walls. Adjust, repair, or replace isolators as required to reduce vibration and noise transmissions to specified levels. Re-balance, adjust, or replace machinery with noise or vibration levels in excess of those given in the machinery specifications or machinery manufacturer's data. Check for proper operation of expansion devices and associated items during system warm-up.

END OF SECTION



## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Excavation.
- B. Trenching.
- C. Shoring and Trench Protection.
- D. Bedding.
- E. Backfilling.
- F. Compaction.
- G. Verification of Existing Utilities.
- H. Protection of Utilities.
- I. Dewatering.
- J. Identification Warning Tape.

### 1.3 DEFINITIONS

- A. "Utility Bedding" is defined to mean "material placed beneath the utility for utility support, and material placed adjacent to the utility to the centerline of the utility."
- B. "Utility Zone Backfill" is defined to mean "backfill material that is placed in the area from the centerline of the utility up to the specified height above the top of the utility, and is located above the utility bedding and below the final backfill material."
- C. "Trench Backfill" is defined to mean "backfill material that is placed above the utility zone backfill, and up to rough or finished grade."
- D. "Underground Mechanical Structures" are defined to mean "vaults, tanks, interceptors, separators, manholes, and similar structures buried partially or completely underground."
- E. "Unstable Material" is defined to mean "material that depresses more than 1/4-inch under a load of 2000 pound/square foot, is not firm and stable, or in any way appears incapable of supporting the loads to be imposed."

#### 1.4 QUALITY ASSURANCE

- A. Inspection of Job Conditions: Prior to starting work and during work, the installer shall examine the work by others, site and job conditions under which excavation, trenching, and backfilling for underground mechanical utilities work will be performed, and not proceed with work until unsatisfactory conditions have been corrected.
- B. Codes and Standards: Comply with all applicable codes and standards.
- C. Experience: Only contractors fully experienced and entirely knowledgeable in the type of work required shall work on this project. By providing bids for this project the Contractor is acknowledging that he has such expertise, and will staff the project with personnel experienced and knowledgeable in the work to be performed.
- D. Compaction Testing: Contractor shall provide testing to confirm that the specified compaction levels are being met. Contractor shall keep a record of the location and results of such tests, name of individual performing, and how performed, and have the records on site for Engineer and Owner review. The Owner will retain their own Special Inspector to perform tests (at their discretion) to confirm contract compliance. Notify the Owner of work schedule and coordinate with the Special Inspector to accommodate inspections and tests.

#### 1.5 GENERAL REQUIREMENTS

- A. Safety: Contractor is solely responsible for worker safety and for selecting and designing all trench shoring methods, trench protection methods, site utility protection means and other aspects of the work. All such means, methods, and safety measures shall comply with applicable codes and standards, and the requirements of the Contract Documents.
- B. Coordination: Coordinate all work with other trades. Coordinate with other Divisions the location and termination of all work of other trades and interconnections with Division 22 work.
- C. Scheduling: Schedule work to avoid impacts to other trades due to open trenches, dewatering, and other activities.
- D. Existing Utilities: Verify location of all existing utilities that lay in the route of intended work. Verify the location of all existing utilities that will be connected to prior to beginning work for any new utilities.
- E. Discrepancies: Notify the Architect/Engineer of any discrepancies or conflicts within the Contract Documents or between the Contract Documents and field conditions. Do not proceed with any work or purchasing of any materials for the area(s) of conflict until obtaining written instruction from the Architect/Engineer on how to proceed. Any work done after discovery of such discrepancies or conflicts and prior to obtaining the Architect/Engineer's instructions on how to proceed, shall be done at the Contractor's expense. In case of a conflict between Division 22 requirements and other project requirements, the most stringent and expensive (as judged by the Architect/Engineer) shall prevail.

#### 1.6 REFERENCES

- A. ASTM D 1557, Laboratory Compaction Characteristics of Soil Using Modified Effort.

- B. ASTM D 2487, Soils for Engineering Purposes (Unified Soil Classification System).

## PART 2 MATERIALS

### 2.1 GENERAL MATERIALS

- A. General: All materials used for bedding, backfill, and drainage purposes shall be free of debris, roots, wood, vegetation, refuse, soft unsound material, frozen material, deleterious or other objectionable material.
- B. Sand: Clean, free flowing, coarse grade sand, as defined by ASTM D 2487.
- C. Pea Gravel: 3/8-inch washed pea gravel; durable particles composed of small, smooth, rounded stones or pebbles meeting the following for grading and quality:

<u>Sieve Size</u>	<u>Percent Passing (By Weight)</u>
1/2" square	100
3/8" Square	85-100
5/8" Square	50-100
U.S. No. 4	10-30
U.S. No. 8	0-10
U.S. No. 16	0-5

### 2.2 BEDDING MATERIALS

- A. Standard: Gravel backfill material, with characteristics of size and shape to allow for compaction, no dimension exceeding 1-1/2 inches, and meeting the following for grading and quality:

<u>Sieve Size</u>	<u>Percent Passing (By Weight)</u>
1-1/2" Square	100
1" Square	75-100
5/8" Square	50-100
U.S. No. 4	20-80
U.S. No. 40	3-24
U.S. No. 200	10.0 max.
Sand Equivalent	35 min.

- B. Special: Pea gravel or sand (per paragraph titled "General Materials").

- C. Bedding Material Application:

<u>Utility</u>	<u>Bedding Material</u>	<u>Minimum Thickness*</u>
Cast Iron Piping	Standard (or Special)	4"
Steel Piping/Conduit	Standard (or Special)	4"
Ductile Iron Piping	Standard (or Special)	4"
Plastic Piping/Conduit	Special**	4"***
Copper Piping	Special	4"
Conductors/Cable	Special	4"
Underground Mechanical Structures	Special	6"

\* Below bottom of utility (unless noted otherwise).

\*\*Except that HDPE piping shall use sand bedding with minimum 6-inch thickness.

## 2.3 UTILITY ZONE BACKFILL MATERIALS

A. Standard: Same as specified for standard bedding materials.

B. Special: Minus 3/8"-inch washed gravel, or sand.

C. Utility Zone Backfill Material Application:

<u>Utility</u>	<u>Backfill Material</u>	<u>Minimum Thickness*</u>
Cast Iron Piping	Standard (or Special)	4"
Steel Piping/Conduit	Standard (or Special)	4"
Ductile Iron Piping	Standard (or Special)	4"
Plastic Piping/Conduit	Special****	4"****
Copper Piping	Special	4"
Conductors/Cable	Special	4"
Underground Mechanical Structures	Special	12"

\*\*\* Above top of utility (unless noted otherwise).

\*\*\*\*Except that HDPE piping shall use sand backfill with minimum 6" thickness above utility.

## 2.4 PIPE TRENCH BACKFILL

A. Standard: Gravel backfill material, with size and shape to allow for compaction, no dimension exceeding 3 inches, and meeting the following:

<u>Sieve Size</u>	<u>Percent Passing (By Weight)</u>
2-1/2" Square	75-100
U.S. No. 4	22-100
U.S. No. 200	0-10
Dust Ratio	2/3 max.
Sand Equivalent	30 min.

B. Satisfactory Native Material: Excavated material from trenching (or other excavation on site), complying with 2.1 A., having no clods or rocks greater than 3 inches in any dimension.

C. Material Application: Either standard or satisfactory native materials may be used (unless noted otherwise).

## 2.5 DUCT TRENCH BACKFILL

A. Standard: Gravel backfill material, with size and shape to allow for compaction, no dimension exceeding 3 inches, and meeting the following:

<u>Sieve Size</u>	<u>Percent Passing (By Weight)</u>
2-1/2" Square	75-100
U.S. No. 4	22-100
U.S. No. 200	0-10

Dust Ratio	2/3 max.
Sand Equivalent	30 min.

- B. Satisfactory Native Material: Excavated material from trenching (or other excavation on site), complying with 2.1 A., having no clods or rocks greater than 3 inches in any dimension.
- C. Material Application: Either standard or satisfactory native materials may be used (unless noted otherwise).

## 2.6 GENERAL BACKFILL MATERIALS

- A. Drain Backfills: Gravel backfill for drains shall conform to the following gradings:

<u>Sieve Size</u>	<u>Percent Passing (By Weight)</u>
1" Square	100
3/4" Square	80-100
3/8" Square	10- 40
U.S. No. 4	0-4
U.S. No. 200	0-2

- B. Underground Mechanical Structure Backfill: Excavated material from trenching (or other excavation on site), complying with 2.1 A. (from top of utility zone backfill layer up to rough or finished grade).
- C. Conductors/Cables/Raceway: Excavated material from trenching (or other excavation on site), complying with 2.1 A. (from top of utility zone backfill layer up to rough or finished grade).

## 2.7 BURIED UTILITY WARNING AND IDENTIFICATION TAPE

- A. General: Polyethylene plastic tape manufactured specifically for warning and identification of buried utility lines. Tape shall be minimum 6" wide, acid and alkali resistant.
- B. Detectable Type: Minimum 0.004 inch thick, with integral wire, foil backing, or other means to allow detection of tape location. Encase metallic element in protection jacket or other means to provide corrosion protection.
- C. Non-Detectable Type: Minimum 0.003 inch thick.
- D. Labeling: Tape shall be imprinted with bold black capital letters continuously and repeatedly over the entire tape length. Warning shall read "CAUTION BURIED (utility type) BELOW" or similar wording. Lettering identifying the utility type shall match as closely as possible the designation noted on the plans. Tape lettering shall be permanent and be unaffected by moisture or other materials contained in trench backfill.

- E. Tape Colors:

<u>Utility</u>	<u>Color</u>
Electric	Red
Fire/Water	Blue
Sewer	Green
Gas	Yellow

Water	Blue
Chilled Water	Yellow
Heating Water	Yellow

## PART 3 EXECUTION

### 3.1 GENERAL

- A. Shoring and Trench Protection: Contractor is responsible to design and provide all necessary trench shoring and trench protection to:
  - 1. Provide safe conditions.
  - 2. Provide conditions that comply with applicable codes and AHJ requirements.
  - 3. Prevent undermining of pavement, foundation, slabs, utilities, and other structures.
  - 4. Prevent movements in adjacent slopes or banks.
- B. Workmanship: Work shall abide by best professional practices as described in referenced standards, and as recognized by accredited professionals.
- C. Compaction: Provide compaction to percent indicated per ASTM D 1557, of laboratory maximum density. Compact to 95 percent (unless noted otherwise). Compaction shall be accomplished by approved tamping rollers, pneumatic-tired rollers, three-wheel power rollers, or other approved compaction equipment.
- D. Grading: Provide grading to prevent surface water from flowing into areas of work to maintain the stability of the work area, and suitable working conditions.
- E. Dewatering: Provide dewatering system for the collection and disposal of surface and subsurface water encountered during construction in order to maintain conditions suitable for the work. Provide all pits, drainage conveyances, pumps, dikes, etc. as required to accomplish the work.
- F. Underground Utilities: Location of utilities indicated is approximate. Verify the location of all existing utilities prior to beginning work; utilize field electronic detection equipment, pipe cameras, visual site surveys, and careful exploratory digging at key locations. Coordinate with other trades routing and locations of all new utilities to avoid conflicts and ensure proper connections.
- G. Machinery and Equipment: Movement of construction machinery and equipment over buried and backfilled pipes during construction shall be at the Contractor's risk. Repair, or remove and provide new pipe for existing or newly installed pipe that has been displaced or damaged. Pressure testing of piping before final Owner acceptance is required to verify no damage has occurred.
- H. Protection: Protect all areas of work from traffic, erosion, weather, settlement or other damaging effects. Protect all existing utilities from damage.
- I. Jacking, Boring and Tunneling: Unless otherwise indicated, excavation shall be by open cut, except that sections of a trench may be jacked, bored or tunneled if the utility can be safely and properly installed and backfill can be properly tamped in such sections.



- J. Buried Warning and Identification Tape: Provide buried utility lines with utility identification tape. Bury tape 12 inches below finished grade. Provide detectable type over non-metallic piping systems. Piping systems installed within the building footprint does not require identification tape.

### 3.2 EXCAVATION - GENERAL

- A. General: Provide all excavation as necessary to allow for the work indicated. Excavations for underground mechanical structures shall be sufficient to provide a minimum of 12 inches clearance between their surfaces and the sides of the excavation.
- B. Excavated Material:
  - 1. Stockpiles: Stockpile materials satisfactory for backfilling in an orderly manner at a safe distance from the excavation to avoid overloading the sides of the excavated area and to prevent slides or cave-ins.
  - 2. Protection: Protect stockpiles from contamination with unsuitable backfill materials. Provide adequate drainage at stockpiled areas to prevent water retention in material. If the Contractor fails to protect the stockpiles and any material becomes unsatisfactory as a result, such material shall be removed and replaced with satisfactory on-site or imported material from approved sources at no additional cost to the Owner.
  - 3. Disposal: Excavated material not required or not satisfactory for backfill or other uses on site shall be removed and disposed off site.

### 3.3 TRENCH EXCAVATION

- A. General: Excavate trenches to accommodate utility, required utility slopes, depths of connecting utility, existing and new utilities, required cover depth, and site conditions.
- B. Removal of Unsuitable Material:
  - 1. Unstable Material: Where unstable material is encountered in the bottom of the trench, such material shall be removed by over excavation of the trench bottom 4 inches below the depth otherwise required. Contractor is responsible for reviewing the soils report and overall site conditions and, for all costs associated with removal and replacement of unstable materials. For bidding purposes, assume that a minimum of 10% of all excavated bottom utility bearing areas will have unstable material.
  - 2. Rocks and Stones: Stones of 6 inches or greater in any dimension, and any rock or stone of any size/orientation that may disrupt the pipe bedding thickness or pipe supports shall be removed. Rock shall be removed to 4 inches below the bottom of the pipe bearing elevation. Review soils report and Civil drawings notes for special rock conditions that exist.
  - 3. Other: Any wood, refuse, waste, organic material, or other material which would adversely affect pipe support shall be removed. For bidding purposes, assume that 5% of all trench bottom area will have objectionable material as described in this paragraph.
  - 4. Replacement Material: Replace removed unsuitable material with "Utility Foundation Material" as specified under paragraph titled "General Backfill Materials", or with bedding material specified for the piping to be placed in the trench.
- C. Bottom Preparation: Bottoms of trenches shall be accurately graded to provide uniform bearing and support for each section of pipe (or other utility) after bedding placement, and proper slope of piping.

- D. Depth: Trench shall be adequate to provide a minimum depth of cover required to meet connecting utilities; and as follows:
  - 1. Water Lines: 3.5 feet (or deeper if required by the AHJ); except that branch piping to fixtures within the building footprint shall have a minimum of 1 foot of cover.
  - 2. Other: As required to meet connecting utilities; but minimum 1 foot of cover (unless indicated otherwise).

### 3.4 BEDDING

- A. Pipe Bedding: Provide even bedding placement along the entire length of the pipe to support pipe on a uniformly dense unyielding foundation, without load concentration at joint collars or bells. Bedding shall be installed and compacted prior to installing pipe. Bedding located beneath piping shall have minimum thickness specified in Part 2 of specifications, and be compacted to 90% maximum density. Recesses shall be excavated as necessary at each joint or coupling to eliminate point bearing and to allow uniform pipe support by the bedding material the entire pipe length. Haunching shall be installed in maximum 4 inch lifts, hand placed and carefully worked under the pipe haunches and then compacted to 90% maximum density. All adjustment to line and grade shall be made by scraping away or filling in with bedding material under the body of the pipe and not by blocking or wedging. Bedding disturbed by pipe movement, or by removal of shoring movement of a trench shield or box, shall be reconsolidated prior to backfill.
- B. Other Utility Bedding: Provide even bedding to allow for full support of the installed item on a uniform dense unyielding foundation. Bedding shall be installed and compacted before installing ducts or underground mechanical structures. Bedding shall have minimum of thickness specified in Part 2 of specifications, and be compacted to 95% maximum density.

### 3.5 BACKFILLING

- A. General: Provide backfill of all trenches and underground mechanical structures to grade. Provide adequate initial backfill to allow proper pressure tests, and inspections by AHJ and Architect/Engineer. Leave joints and couplings uncovered as necessary to discover pipe leaks. Do not conceal underground utilities until AHJ and Architect/Engineer have reviewed utilities.
- B. Utility Zone Backfilling: Backfill shall be placed in loose layers and compacted to 90 percent maximum density. Backfill shall be placed in horizontal layers no more than 6-inches thick. Backfill shall be brought up simultaneously on each side of the utility to the top of the utility, and onto the specified height above the utility (see Part 2 of specifications). Backfill and compact in a manner to avoid damaging or disturbing the completed utility.
- C. Pipe Trench Backfilling: Backfill above the pipe zone backfill shall be accomplished in such a manner that the pipe will not be shifted out of position nor damaged by impact or overloading. Where pipe is outside the building footprint, backfill shall be placed in horizontal layers no more than 6 inches thick and compacted to 95 percent maximum density. Where pipe is inside the building footprint, backfill shall be placed in horizontal layers no more than 6 inches thick and be compacted to 85 percent maximum density.
- D. Underground Mechanical Structure: After structure has been installed (or the concrete has been allowed to cure for the filed constructed items), backfill shall be placed in such a manner that the structure will not be damaged by the shock of failing backfill. The backfill

shall be placed in such a manner as to prevent eccentric loading and excessive stress on the structure. Backfill shall be placed in horizontal layers no more than 12 inches thick, and be compacted to 95% maximum density.

- E. Other Utility Backfill: Backfill shall be accomplished in such a manner that the utility will not be shifted out of position nor damaged by impact or overloading. Backfill shall be placed in horizontal layers no more than 6 inches thick and be compacted to 95 percent maximum density.

END OF SECTION



## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Air Balancing.
- B. Hydronic Balancing.
- C. Plumbing System Water Balancing.
- D. Report.

### 1.3 SUBMITTALS

- A. General: Comply with Section 220500.
- B. Company: Submit name of Company proposed to do the balancing and sample balancing forms. Where the Company has not been pre-qualified, and substitutions are allowed after bidding (see Division 00 and 01), submit information regarding firm qualifications.
- C. Personnel: Submit list of personnel that will be assigned to the project and their qualifications, and list of past projects.
- D. Reports: Preliminary and final balancing reports.

### 1.4 REFERENCES

- A. AABC-NS: Associated Air Balance Council, National Standards for Field Measurements and Instrumentation.
- B. ASHRAE: Handbook of Fundamentals.
- C. ACGIH-IV: American Conference of Governmental Industrial Hygienists, Industrial Ventilation, A Manual of Recommended Practice.
- D. NEEB-PS: National Environmental Balancing Bureau Procedural Standard for Testing, Adjusting and Balancing Environmental Systems.

### 1.5 GENERAL REQUIREMENTS

- A. General: Balancing shall be done by a company which specializes in this type of work and is totally independent and separate from the Company which has installed the systems to be balanced.

B. Balancers Qualifications:

1. General: Work of this Section shall be performed by balancing firms meeting the following and having prior approval from the Engineer:
    - a. Professional Affiliation: Firm shall be an Associated Air Balance Council (AABC) member balancer or National Environmental Balancing Bureau (NEBB) certified balancer.
    - b. Experience: Firm shall have satisfactorily completed the balancing work for at least 5 similar projects in the last 3 years. Similar is defined to mean: within 10% of the same quantity of units and air inlets/outlets, involve same type of systems, be the same type of facility (i.e. school, hospital, etc.). The lead field balancer (i.e. the individual who will be on site directing and participating in the balancing efforts) shall have at least 5 years of experience performing balancing work on similar projects.
    - c. References: Have five references for similar projects which have been completed in the last three years that will give a good or better performance rating. References shall be engineers, architects, or building owners. As part of the qualification process at least three of these references will be contacted and a rating obtained for the following: timeliness of work (i.e. able to complete work on schedule), cooperative nature of balancer's staff (i.e. ability to work well as a team with other project trades and professionals), overall quality of balancing work, quality of balancing report. Each item will be rated on a scale of 1 to 5 (5 being excellent), with the result averaged, score must be of 4 or better.
  2. Pre-Qualified Balancers: As a convenience to the Contractor, the following balancing firms have been pre-qualified. This is not in any way intended to limit competition or prevent other firms from submitting qualifications, but is intended as an aid to Contractors by identifying firms that have been confirmed as meeting the qualification requirements.
    - a. Neudorfer Engineers
    - b. Hardin and Sons
    - c. Precision Air
  3. Qualification Process: Firms not pre-qualified who desire to perform the balancing work shall submit a substitution request form in accordance with Contract Document requirements (reference Division 00 and 01). In addition to the information required on the substitution request form, submit: Company information, resumes of staff to be assigned, lists of projects, and references (with name of project, staff assigned to project, and contact name and phone number).
- C. Balancing Issues: Notify the Engineer in writing of all problems or discrepancies between actual conditions and what design documents show as work proceeds.
- D. Engineer's Authority: The Balancer shall be directly responsible to the Engineer and shall perform this work and make system adjustments as directed by the Engineer.
- E. Lead Balancer: The Balancer shall assign an individual as "lead balancer" to work in the field to directly supervise the balancing work and field technicians. This lead field balancer shall have at least 5 years of experience performing balancing work on similar projects.
- F. Added Site Visit: The Balancer shall include in his bid three extra site visits and associated time to access system readiness for balancing and resolution of balancing issues. Include added site visit and 8 hours of field balancing time, plus report amendment time to provide added balancing as directed by the Engineer. Such work may occur during the project's

construction period or during the warranty period.

- G. Commissioning: See Division 01 and Section 220800 for commissioning efforts required by the Balancing Contractor.

## PART 2 PRODUCTS

### 2.1 GENERAL INSTRUMENTATION

- A. General: Balancing equipment shall comply with Associated Air Balance Council recommendations for field measurement instrumentation.
- B. Calibration: All measuring instruments shall be accurately calibrated and maintained in good working order. Calibration dates and certifications shall be available at Engineer's request.
- C. Instruments: Shall be capable of:
  - 1. Air velocity instruments, direct reading in feet per minute with 2% accuracy.
  - 2. Static pressure instruments, direct reading in inches water gauge with 2% accuracy.
  - 3. Tachometers, direct reading in revolutions per minute with 1/2% accuracy; or revolution counter accurate with 2 counts per 1,000.
  - 4. Thermometers, direct reading in degrees Fahrenheit with 1/10 of a degree accuracy.
  - 5. Pressure gauges, direct reading in feet of water or psig with 1/2% accuracy.
  - 6. Water flow instruments, direct reading in feet of water or psig with 1/2% accuracy suitable for readout of balancing valve provided.

## PART 3 EXECUTION

### 3.1 GENERAL

- A. Workmanship: All measurements and adjustments shall be in accordance with AABC-NS, NEEB-PS, and ACGIH-IV and recognized best balancing procedures. Measurements and adjustments of equipment shall be executed in a manner consistent with the manufacturer's recommendations.
- B. Flow Rates:
  - 1. General: All air and water systems shall be completely balanced and adjusted to provide the flow rates indicated (within tolerances indicated in this specification Section), and to produce an even heating and cooling effect and control response and to produce even water circulation.
  - 2. Balancer Determined: Where flow rates have not been indicated the balancer shall determine such flow rates using acceptable practices in accordance with AABC-NS, NEEB-PS, and ASHRAE standards and submit the proposed flow rates to the Engineer for review.
  - 3. Confirmation: Prior to beginning balancing confirm any flow rate changes since design with the submittals and flow rates indicated therein, and with the Engineer to confirm changes made since design. Assume that new flow rates will be issued.
- C. Controls: Consult and coordinate with the Control Contractor for the adjustment and setting of all control devices to allow for the balancing work, and for proper system operation and proper flow rates. Set all controls and valves as required to maintain design flow rates and

temperatures as shown on the drawings. Make measurements and provide data to the Control Contractor to allow for proper control of items.

- D. Comfort Adjustments: Make final adjustments for flow rates in order to optimize each space's comfort, including such considerations as temperature, drafts, noise, pressurization, and air changes. Where variances are made from design values, state reasons in report (e.g., "too noisy", "too drafty," etc.). All such variances are subject to approval by the Architect/Engineer.
- E. Deficiency Reports: Submit deficiency reports where the work does not allow balancing to occur or balancing issues develop. Indicate date, system and equipment involved, location, description of deficiency, and related information to allow for diagnosing the problem. Provide suggestions for resolution where possible.

### 3.2 AIR BALANCING

- A. Pre-check of System: Prior to beginning balancing, perform, as a minimum, the following:
  - 1. Verify that clean filters have been installed, that system is free from debris, and that all inlets/outlets are not obstructed.
  - 2. Check all fans and equipment to verify that proper start-up and system preparation has been done by the installing contractor.
  - 3. Check all door/window and similar building opening status to insure building is ready and proper pressurization can be obtained.
  - 4. Open all dampers to full flow position, check positions and operation of all motorized dampers to allow full system flows.
  - 5. Review controls and sequences of operation.
- B. Tolerances: All air flow rates (supply, return, and exhaust) shall be adjusted to within plus 5 percent and minus 5 percent of the values shown in the contract documents, except that relative space-to-space pressure relationships shall always be maintained (e.g., restrooms shall be negative relative to other areas, general offices shall be positive, etc.).
- C. Draft and Noise Adjustments: All diffusers, grilles, and registers shall be adjusted to minimize drafts and to eliminate objectionable noise.
- D. Filters: Air balancing shall be done with new, clean air filters installed. Adjust air deliveries so that design quantities will be obtained when filters are half dirty. This condition shall be simulated by covering a portion of the filter area.
- E. Fan Speeds and Drives:
  - 1. Adjust fan speeds and fan drives (adjustable sheaves) as required to produce design flow rates.
  - 2. Where new sheaves are required, calculate sizing of new sheave and coordinate requirements with the Division 23 Contractor for Division 23 Contractor to furnish the new sheave. Replace existing sheave with new one furnished by the Division 23 Contractor; include bid costs for sheave replacements on all 50% of belt driven fans.
  - 3. Adjust belts for proper tension.
- F. Marking: Upon completion of flow readings and adjustments permanently mark the balanced position of all balancing valves by stamping the indicator plate of the valve.



- G. Duct Traverse: Rectangular duct traverses shall measure the center of equal areas in the air flow stream, with centers not more than 6 inches apart. Round duct traverses shall measure at least 20 locations, with locations being the centers of equal annular area. Reference ACGIH Industrial Ventilation Manual.
- H. One Open Run: Balance each branch run so that there is at least one wide open run; balance branches relative to one another so that at least one branch damper is wide open (except that where unique conditions exist, and the Engineer gives prior approval, one open damper on runs or branches is not required).
- I. Data: Data to be measured/recorded and provided in report for all air handling systems and equipment:
  - 1. Floor plans clearly showing and identifying all diffusers, grilles, OA louvers, ducts and all other items where air flow rates were measured.
  - 2. Identify manufacturer, model number, size, and type of all air inlets/outlets.
  - 3. Initial, trial, and final air flow measurements for all diffusers, grilles, OA louvers, ducts, and all other items where air flow rates were measured.
  - 4. Design air flow rates and percentage final air flow rates are of design values.
  - 5. Final damper (or other balance device) final position (as a percentage of full open).
  - 6. The connected voltage and corresponding nameplate full load amps, and the initial and final amperages of all fan motors.
  - 7. Initial and final RPMs of all fans.
  - 8. Static pressures on inlet and outlet of all fans.
  - 9. Fan initial and final CFMs.
  - 10. Outdoor air CFMs (record minimum and maximum values).
  - 11. Entering and leaving air temperatures across coils with coils operating at 100% capacity.
  - 12. Static pressure drop across each filter bank and coil.
  - 13. Final position of any speed controls (as percent of full).
  - 14. In addition to data noted elsewhere, provide the following for all equipment which are part of balanced systems:
    - a. Equipment name and number (as used on drawings).
    - b. Service.
    - c. Equipment manufacturer and model number.
    - d. Sheave and belt sizes (where applicable).
    - e. Filters sizes and quantities (where applicable).
    - f. Motor manufacturer and complete nameplate data.
    - g. Design operating conditions.
    - h. Actual operating conditions (flows, pressure drops, rpm, etc.).
- J. Main Duct Airflows: Air flow measurements in main ducts shall be made with a duct traverse using a pitot tube and micromanometer. Summation of air terminal outlets and inlets is not sufficient. Quantity of duct leakage (difference between main duct airflow and sum of air inlets/outlets) shall be indicated.

### 3.3 HYDRONIC BALANCING

- A. Pre-check of System: Prior to beginning balancing, perform, as a minimum, the following:
  - 1. Verify that all strainers have been cleaned.
  - 2. Examine fluid in system to verify system treatment and cleaning.
  - 3. Check for proper rotation and operation of all pumps.

4. Verify that expansion tanks are not air bound and properly charged and that system is full of fluid.
  5. Verify that all air vents at high points in the fluid system are properly installed and are operating freely. Verify that all air has been removed from the circulating system.
  6. Open all valves to full flow position, close any bypass valves, and open fully balancing valves. Set temperature controls so that automatic valves are open to full flow.
  7. Check operation of automatic bypass valves and similar flow/pressure controls.
  8. Check and set operating temperature of equipment to design requirements when balancing by temperature drop.
  9. Check equipment for proper start-up and system preparation by installing contractor.
  10. Review controls and sequences of operation.
- B. Tolerances: All water flow rates shall be adjusted to within plus 5 percent and minus 5 percent of the values shown in the contract documents.
- C. Control Valve Bypass: Adjust control valve bypass valves so that pressure drop is the same for full flow-through bypass valve as for full flow-through control valve and controlled equipment.
- D. Marking: Upon completion of flow readings and adjustments permanently mark the balanced position of all balancing valves by stamping the indicator plate of the valve.
- E. Requirements for All Hydronic Systems: Data to be measured/recorded and provided in report:
1. Floor plans or schematics showing and identifying all valves, coils, pumps and other items where temperatures, pressure drops, or water flow rates were measured.
  2. Identify manufacturer, model number, size and type for all balancing devices.
  3. Initial, trial, and final water flow measurements (pressure drops, temperatures, and GPMs) for all items where measurements were made.
  4. Design water flow rates, and percentage final water flows are of design values.
  5. The connected voltage and corresponding nameplate full load amps, and the initial and final amperages of all pump motors.
  6. Pump operating suction and discharge pressures and final total developed head.
  7. Pump initial and final GPMs.
  8. Entering and leaving fluid temperatures at coils and major equipment.
  9. GPM flow of each coil and major equipment.
  10. Pressure drop across each coil and major equipment.
  11. Pressure drop across bypass valve.
  12. Final position of all valves (percent open or setting position on valve).
  13. Final position of any speed controls (as percent of full).
  14. In addition to data noted elsewhere, provide the following for all equipment which are part of balanced systems:
    - a. Equipment name and number (as used on drawings).
    - b. Service.
    - c. Equipment manufacturers and model number.
    - d. Equipment capacities.
    - e. Motor manufacturer and complete nameplate data.
    - f. Design operating conditions.
    - g. Actual operating conditions (flows, pressure drops, etc.).

### 3.4 BALANCING REPORT

- A. General: A balancing report shall be submitted as specified herein, documenting all balancing procedures and measurements.
- B. Report Organization: The report shall be divided into logical sections consistent with the building or system layout (i.e. by floors, building wings, air handling units, or other convenient way). Tabulate data separately for each system. Describe balancing method used for each system.
- C. Preliminary Report: Two preliminary review copies of the balancing report shall be submitted to the Architect/Engineer when the balancing work is 90% complete (or as near 90% complete as possible due to uncompleted work of other trades). In addition to containing all the information required of the final report, the preliminary report shall contain a list of all the work required of other trades in order to allow the balancing work to be completed. The Architect/Engineer will review the preliminary report and inform the Contractor of any additional items or revisions required for the final report. Preliminary reports may be omitted where the Architect/Engineer grants approval.
- D. Final Report: Shall be included in the Operation and Maintenance Manual. Submit reports to Contractor for inclusion in Manuals (or, when manuals have been already sent to Engineer, send report to Engineer who will insert report into Manual). Provide number of reports as required to match quantity of O&M Manuals, but in no case less than five.
- E. Format: 8-1/2" x 11" size, neat, clean copies, drawings accordion folded. Report shall be typed, shall have a title page, table of contents, and divider sheets with identification tabs between sections. Information shall be placed in a three hole notebook, with the front cover labeled with the name of the Job, Owner, Architect/Engineer, Balancing Contractor, and Report Date.
- F. Electronic Copy: Provide copy of reports in \*.pdf format; submit final report with closeout documents and in O&M Manual. Provide two CD's with each having an electronic copy of the report in pdf file format. Label CD neatly same report labeling. Provide electronic pdf files to others for inclusion in electronic record documents.
- G. General Balancing Information Required:
  - 1. At the beginning of the report, include a summary of problems encountered, deviations from design, remaining problems, recommendations, and comments.
  - 2. List of instruments used in making the measurements and instrument calibration data.
  - 3. Names of personnel performing measurements.
  - 4. Explanation of procedures used in making measurements and balancing each system.
  - 5. List of all correction factors used for all diffusers, grilles, valves, venturi meters, and any other correction factors used.
  - 6. Areas where difficulties were encountered in obtaining design flow rates, or where unstable operating conditions may exist.
  - 7. Note any parts of the system where objectionable drafts or noises may be present and efforts made to eliminate same and why they may still be present.
  - 8. Note where variances from design values occur; explain why.
  - 9. All specified measurements, balancing data, any additional recorded data, and observations.

END OF SECTION



## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Duct Insulation.
- B. Pipe Insulation.
- C. Equipment and Specialties Insulation.
- D. Acoustical Wrap.

### 1.3 DEFINITIONS

- A. R: Thermal resistance of insulation, in units of hr-sf-deg F/Btu.
- B. Rainleader Piping: Any piping or conduit that is used to carry rain water, including overflow drain piping, that is located within the building or enclosed by any building construction.
- C. Subject to Damage: Items installed exposed less than 8 feet above the walking surface (i.e. floor, platform, roof, grade, etc.) adjacent to the item.
- D. Cold Surfaces: Surfaces that will have operating temperatures below the temperature of the surrounding air by at least 5 deg F or more; includes chilled water piping, cooling condensate piping, air conditioning ductwork, outdoor air ductwork, and similar systems. Surfaces shall be considered a cold surface unless specifically indicated otherwise.

### 1.4 QUALITY ASSURANCE

- A. All insulation and materials shall have a fire hazard rating not to exceed 25 for flame spread and 50 for smoke development, as tested by ASTM E 84, NFPA 255, and UL 723.

### 1.5 SUBMITTALS

- A. General: Comply with Section 220500.
- B. Product Data: Provide product data on all insulation materials to be used. Indicate thicknesses to be used.

### 1.6 GENERAL REQUIREMENTS

- A. Code Compliance: Contractor shall insulate all systems with the materials and thicknesses as required by code, but in no case shall the insulation be less than that specified herein. In

some cases the specified insulation exceeds code, and shall be provided as specified. Not all systems requiring insulation by code are specified, but shall be provided with insulation where required by code.

- B. Insulation at Hangers: Insulation shall be continuous through hangers on all insulated systems (except ductwork). Inserts at hangers are specified in Section 220529 and are considered as part of the hanger and support system. Inserts are required to be installed at the time of pipe installation and are intended to be installed by the Contractor installing the pipe hangers/supports. See Section 220529.

## 1.7 REFERENCES

- A. ASTM A 653: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process.
- B. ASTM B 209: Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- C. ASTM C 411: Standard Test method for Hot-Surface Performance of High Temperature Thermal Insulation.
- D. ASTM C 547: Standard Specification for Mineral Fiber Pipe Insulation.
- E. ASTM C 1136: Standard Specifications for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
- F. ASTM C 1290: Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
- G. ASTM E 84: Standard Test Method for Surface Burning Characteristics of Building Materials.
- H. NCIIS: National Commercial & Industrial Insulation Standards, published by Midwest Insulation Contractors Association, 5th Edition.
- I. NFPA 255: Standard Method of Test of Surface Burning Characteristics of Building Materials.
- J. UL 723: Tests for Surface Burning of Building Materials.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Products shall comply with Section 220500, Paragraph Part 2.1, Acceptable Manufacturers.
- B. Insulation: Johns Manville, Armacell, Owens-Corning, Knauf, Rubatex, Aeroflex, Pittsburgh Corning, GLT, Halstead, Gilsulate.
- C. Accessories: Johns Manville, Armacell, Owens-Corning, Knauf, Rubatex, Aeroflex, Pittsburgh Corning, GLT, Halstead, Duro Dyne, Gustin Bacon, Childers, RPR, Tee Cee, Lewco Specialty Products, JPS, Buckaroos.

D. Acoustical Wrap: Kinetics Noise Control.

2.2 DUCT INSULATION

A. Flexible Glass Fiber:

1. Type: Flexible blanket type, constructed of inorganic glass fibers bonded by a thermosetting resin, complying with ASTM C 1290, Type III. Johns Manville "Microlite" (or approved).
2. Jacket: FSK type, vapor proof, consisting of an aluminum foil cover reinforced with glass fiber mesh, and laminated to kraft. Water vapor permeance shall not exceed 0.05 perms. Provide with joint sealing tape, minimum 2 inches wide, constructed of jacket material with adhesive to seal all joints.
3. Thermal Conductivity: Shall not exceed 0.27 Btu-in/hr-sq ft-deg F at 75 deg F.
4. Operating Limits: 40 degrees F to 250 deg F.

B. Duct Insulation Thickness:

1. General: Provide insulation densities and thicknesses to achieve the following R values. R values are for the insulation only, in their installed thickness, considering installed duct wrap stretch and in accordance with code.
2. Lining: Where ducts have internal lining, the insulating properties of the lining may be credited toward meeting the required insulation R value; use R-3.65 per inch of installed liner.
3. Supply Air Ductwork:
  - a. Inside Building and Within Building's Thermal Envelope: R-3.3 (except where ran exposed in conditioned spaces, no insulation is required).
  - b. Inside Building but Not Within Building's Thermal Envelope: R-7.3.
  - c. Outside of Building: R-8.
  - d. Underground: R-8.
4. Return Air Ductwork:
  - a. Inside Building and Within Building's Thermal Envelope: No insulation required; except where duct contains air that may vary by 10 deg F or more from the space the duct passes through, R-3.3 insulation shall be provided.
  - b. Inside Building but Not Within Building's Thermal Envelope: R-7.3.
  - c. Outside of Building: R-8.
  - d. Underground: R-5.3.
5. Outside Air Ductwork: Shall be insulated same as required for the building envelope; except where allowed by code to be insulated less than the building envelope, shall be R-8; insulation is not required where duct run outside the building.
6. Exhaust, Relief, and Special Ductwork:
  - a. Inside Building and Within Building's Thermal Envelope:
    - 1) Temperature of Air in Duct within 10 Deg F of Temperature of Air in Spaces Duct Passes Through: No insulation required except ductwork from the system's backdraft damper (or motorized damper) to outside the building shall be insulated same as required for the building envelope.
    - 2) Temperature of Air in Duct more than 10 Deg F Different from temperature of Air in Spaces Duct Passes Through: R-8.3; except ductwork from the system's backdraft damper (or motorized damper) to outside the building shall be insulated same as required for the building envelope (but no less than R-8.3).
  - b. Inside Building but Not Within Building's Thermal Envelope: R-8.3.

- c. Outside of Building: Ducts carrying air where condensation can occur (i.e. air from dryers, locker rooms, kitchens, hoods, process loads, etc.) R-8.3; other ducts no insulation is required.

## 2.3 PIPE INSULATION

### A. Glass Fiber:

1. Type: Rigid molded type, constructed of glass fibers bonded by a thermosetting resin, complying with ASTM C 547 Type I. Insulation factory molded to match pipe size applied to. Johns Manville "Micro-Lok" (or approved).
2. Jacket: ASJ type, vapor proof, consisting of a white kraft paper cover reinforced with glass fiber and bonded to aluminum foil, with longitudinal self sealing closure system. Provide with butt strips constructed of jacket material with adhesive to seal all joints. Water vapor permeance shall not exceed 0.02 perms.
3. Thermal Conductivity: Shall not exceed 0.24 Btu-in/ hr-sq ft-deg F at 75 deg F.
4. Operating Temperatures: 0 deg F to 850 deg F.

### B. Elastomeric Insulation:

1. Type: Flexible cellular elastomeric insulation, factory formed to match pipe sizes applied to, complying with ASTM C 534, Type 1. Armacell "AP/Armaflex SS" (or approved).
2. Thermal Conductivity: Shall not exceed 0.27 Btu-in/ hr-sq ft-deg F at 75 deg F.
3. Water Vapor Transmission: Water vapor permeance shall not exceed 0.08 perms.
4. Operating Temperatures: -200 deg F to 220 deg F; shall be able to withstand 250 deg F temperatures for 96 hours per ASTM C 411 without damage or deformation.
5. Weather Protection: Where installed outdoors provide with metal jacketing to protect from UV and weather exposure.

### C. Pipe Fittings: Shall be covered using any one of the following methods of the Contractor's choice:

1. Prefabricated segments of pipe insulation of same materials and thickness as the adjoining pipe insulation, formed to match pipe fitting.
2. Pre-cut fiberglass insulation and pre-molded high impact, gloss white, UV resistant, minimum 20 mil thick, PVC covers suitable for the pipe size and insulation thickness application, PVC cover shall be Johns Manville "Zeston 2000 PVC" (or approved).
3. Insulating plastic cement brought up the full height of the adjacent covering.
4. Except, where colored PVC jacketing is applied to piping, fittings shall use PVC covers of the same thickness and color as the PVC jacketing specified for the piping.

### D. Metal Jacket: Aluminum roll jacketing, factory formed to match pipe size and insulation application, with smooth surface, manufactured from 3003 or 5005 aluminum alloy, H-14 temper, conforming to ASTM B 209. Shall be minimum 0.020 inches thick, with an integrally bonded interior 1 mil thick heat bonded polyethylene moisture barrier over the entire surface in contact with the insulation. Fitting covers shall be fabricated of same material as pipe runs, factory formed to match fitting.

### E. Pipe Insulation Types:

1. Aboveground-Inside Building:
  - a. Hydronic Systems: Glass fiber.
  - b. Cooling Coil Condensate: Glass fiber or elastomeric.
  - c. Refrigerant Piping: Elastomeric.



- d. Other Systems: Glass fiber.
  2. Aboveground-Outside Building: Same as specified above, with metal jacket.
  3. Underground:
    - a. Refrigerant Piping: Cellular glass.
    - b. Hydronic and Steam/Condensate Systems: Trench insulation or cellular glass.
  4. Metal and PVC Jacketing: See "Part 3 - Execution".
- F. Pipe Insulation Thickness:
1. General: Provide minimum piping insulation thickness indicated, in inches.

INSULATION THICKNESS (INCHES)

Nominal Pipe Diameter (Inches)					
Fluid Design Operating Range, deg F	≤1	1< to 1-1/2	>1-1/2 to <4	4 to <8	≥8
Above 350	4.5	5.0	5.0	5.0	5.0
251 - 350	3.0	4.0	4.5	4.5	4.5
201 - 250	2.5	2.5	2.5	3.0	3.0
141 - 200	1.5	1.5	2.0	2.0	2.0
61 - 140	1.0	1.0	1.5	1.5	1.5
40 - 60	0.5	0.5	1.0	1.0	1.0
Below 40	0.5	1.0	1.0	1.0	1.5

2. Varying Temperatures: Where a system operates over temperature ranges calling for different insulation thicknesses, the thicker insulation requirements shall be met.
3. Condensate: Cooling system condensate piping (i.e. from a cooling coil) shall be considered to operate at 50 deg F.
4. Refrigerant Piping: Refrigerant piping (RG or RS piping) returning from an evaporator (i.e. cooling coil) to a compressor shall be considered to operate at 40 deg F. Refrigerant piping (RL piping) from a condenser to an evaporator does not require insulation (unless noted otherwise).
5. Outdoor Piping: Piping exposed to outside air or, located outside the building/thermal envelope, shall have insulation thickness increased by 0.5 inch from that indicated above.
6. Heat Recovery: Heat recovery piping shall be considered to operate at 120 degrees F (unless noted otherwise).
7. Cold Water: Cold water piping shall be considered to operate at 56 deg F (unless noted otherwise).

## 2.4 EQUIPMENT AND SPECIALTIES INSULATION

- A. P-traps and HW/CW Lines on ADA Compliant Sinks and Lavatories: Prefabricated insulation specially designed for p-trap application, with white elastomeric insulation, white high gloss pvc cover, and velcro closure. Provide section for insulating HW stop and CW stop and associated piping of same material. McGuire "Pro-Wrap" (or approved).
- B. Flexible Glass Fiber:
  1. Type: Flexible blanket insulation, constructed of inorganic glass fibers bonded by a thermosetting resin, complying with ASTM C 553, Type III. Johns Manville "812 Spin-Glas" (or approved).

2. Jacket: FSK type, vapor proof, consisting of an aluminum foil cover reinforced with glass fiber mesh, and laminated to kraft. Water vapor permeance shall not exceed 0.05 perms. Provide with joint sealing tape constructed of jacket material with adhesive to seal all joints.
  3. Thermal Conductivity: Shall not exceed 0.24 Btu-in/ hr-sq ft-deg F at 75 deg F.
  4. Operating Temperature Limits: 40 deg F to 450 deg F.
  5. Density: 1.5 lb/cu ft.
- C. High Temperature Flexible Glass Fiber:
1. Type: Flexible blanket insulation, constructed of "E" type glass filament mechanically needled together. GLT "Tempmat" (or approved).
  2. Thermal Conductivity: Shall not exceed 0.40 Btu-in/ hr-sq ft deg F at 300 deg F.
  3. Operating Temperature Limits: 40 deg F to 1200 deg F.
  4. Thickness: Two wraps of 1-inch thick each wrap.
  5. Jacketing: Wire inserted fiberglass cloth closure; minimum 32 Ounce/yard, rated for 100 deg F; with steel lacing and lacing anchors having self locking washers.
- D. Elastomeric:
1. Type: Flexible cellular elastomeric insulation, complying with ASTM C 534, Type II.
  2. Thermal Conductivity: Shall not exceed 0.30 Btu-in/ hr-sq ft-deg F at 75 deg F.
  3. Water Vapor Transmission: Water vapor permeance shall not exceed 0.08 perms.
  4. Operating Temperatures: -200 deg F to 220 deg F; shall be able to withstand 250 deg F temperatures for 96 hours per ASTM C 411 with damage or deformation.
  5. Weather Protection: Where installed outdoors provide with metal jacketing to protect from UV and weather exposure.
- E. Removable Insulation Blankets:
1. Type: Flexible blanket insulation pads, for insulating valves, unions, strainers and similar items. Constructed of exterior fabric enclosure sewn around interior insulation, held in position with a closure system that allows for removal of the blanket. Contractor or factory fabricated.
  2. Enclosure:
    - a. Hot Applications: Glass fiber cloth, 1/8-inch thick, noncombustible, service temperature up to 1200 degrees F. JPS Glass Fabrics "Glastex 2025" (or approved).
    - b. Cold Application: Silicone impregnated glass fiber cloth; chemical and oil resistant; water proof; flame and abrasion resistant; minimum 20 ounce/square yard weight. Lewco Specialty Products 3000 SA-2 (or approved).
  3. Insulation: Thermal insulating wool, 1-inch thick, complying with ASTM C 553. Maximum thermal conductivity 0.22 Btu-in/ hr-sq ft-deg F at 75 degrees F. Provide in layers to give equivalent R value to the adjacent insulated piping. Owens Corning "Fiberglas Brand TIW, Type II".
  4. Closure System: Velcro, zipper or steel lacing. Steel lacing anchors shall have spindles and self-locking washers, fabricated of minimum 14 gauge stainless steel, with stainless steel wire ties. AGM Industries "Series NLA" (or approved). Closure shall be configured to allow for complete coverage and closure of the insulation around the object being insulated. Closure for cold surfaces (surfaces that operate below ambient air temperature) shall provide a sealed vapor barrier so that no surfaces are exposed to ambient air and so that no condensation can occur; overlap enclosure ends (or any vapor barrier penetrations, as caused by using steel lacing anchors) with an added

vapor barrier cover, minimum 2-inches past the vapor barrier penetration; with Velcro (or equivalent) closure.

- F. Metal Jacket:
  - 1. Steel: Minimum 24 gauge galvanized steel complying with ASTM A 653. Provide with longitudinal slip joints and 2-inch laps.
  - 2. Aluminum: Minimum 0.020-inch thick aluminum, alloy 3003 or 5005, complying with ASTM B 209. Provide with longitudinal slip joints and 2-inch laps.
- G. Equipment and Specialties Insulation Types and Thickness:
  - 1. Unless a specific type of insulation is specified or noted, any of the insulation materials specified in this specification section may be used provided such application is in conformance with NCIIS.
  - 2. Insulation Thickness: Insulation thickness shall be the same as that specified for the piping or ductwork connected to the item, or as specified for the system the item is installed in (unless noted otherwise). Insulation thickness shall in no case be less than 1 inch thick.
  - 3. Valves:
    - a. 2 Inches and Smaller: Insulate with same material as piping system.
    - b. 2-1/2 Inches and Larger: Removable blanket insulation.
  - 4. Control Valves: Removable blanket insulation.
  - 5. All equipment and specialties where access is required shall have removable insulation blankets; other removable insulation materials per NCIIS may be used where pre-approved by the Engineer. Items requiring such removable insulation include, but are not limited to, the following:
    - a. Strainers.
    - b. Pumps.
    - c. Balancing valves.
    - d. Pressure/temperature/flow measuring devices.
    - e. Pump suction diffusers.
    - f. Heat exchanger heads.

## 2.5 ACCESSORIES

- A. Adhesive, Caulks, Mastics, and Coatings: As recommended by insulation material manufacturer and suited for the application.
- B. Bands: 1/2-inch wide, of stainless steel, galvanized steel, or aluminum construction, to match with materials used with.
- C. Weld-Attached Anchor Pins and Washers: Copper-coated steel pin for capacitor-discharge welding and galvanized speed washer. Pin length shall be as required for insulation thickness used with. Welded pin holding capacity 100 lb, for direct pull perpendicular to the attached surface. Style and type to suit application.
- D. Adhesive-Attached Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness used with. Adhesive as recommended by the anchor pin manufacturer as appropriate for surface temperatures and materials used with, and to achieve a holding capacity of 100 lb for direct pull perpendicular to the adhered surface. Style and type to suit application.

## 2.6 ACOUSTICAL WRAP

- A. Type: Composite material having an outer foil faced sound barrier wrap with an internal sound decoupling insulation. Kinetics Noise Control KNM-100ALQ (or equal).
- B. Construction: Outer sound barrier material shall be flexible 1.10 inch thick, 1 lb/sf (minimum) barium sulphate loaded limp vinyl sheet, bonded to an outside layer of aluminum foil. Interior sound decoupling insulation shall be 1 inch thick fiber glass batting quilted to a non woven porous scrim-coated glass cloth in a 4 inch diamond stitch pattern. Material shall be suitable for temperatures from 40 to 200 deg F.
- C. Acoustic Rating: STC (sound transmission coefficient) 28 (or better).
- D. Vibration Damping Material: Kinetics Noise Control KDD or KDC-E-162.

## PART 3 EXECUTION

### 3.1 GENERAL

- A. Pre-Insulation Review: No covering materials shall be applied until systems to be covered have had all tests satisfactorily completed, have had all required inspections, and have been satisfactorily reviewed by the Architect-Engineer. All systems shall be examined by the Contractor to confirm cleanliness and other conditions are appropriate to allow for insulation installation.
- B. Insulation Work Review: No insulated items shall be concealed in the building structure or buried until the insulation work has been satisfactorily reviewed by the Architect-Engineer, and has had all required inspections.
- C. Standards: Materials shall be installed in accordance with manufacturer's written instructions, NCIIS, and shall comply with materials and methods specified herein. The more stringent requirements govern.
- D. Joints/Seams: Joints shall be staggered on multi layer insulation. Locate seams and joints in least visible location.
- E. Insulation Protection: Insulation shall be kept clean and dry and shall be protected from dirt, damage, and moisture. Insulation that becomes dirty, damaged, or wet and cannot be restored to like new condition will be rejected, and shall immediately be removed from the jobsite.
- F. Insulation Interruptions: Insulation shall be neatly finished at all supports, protrusions and interruptions. Provide adhesive and tape seal to maintain vapor barrier integrity.
- G. Equipment and Floor Protection: Cover existing equipment and finished floors to protect such items from insulation fiber and dust. Keep all such existing areas in a "broom clean" condition at the end of each day. Take precautions in these areas to prevent glass fiber and insulation dust from entering ventilation systems or areas adjacent to the work.
- H. Glass Fiber Insulation - General:

1. Finish all insulation ends with joint sealing tape or vapor barrier mastic, no raw edges allowed.
  2. Joints: Tightly butt adjacent insulation sections together without any voids. Provide overlap of jacket material over all joints.
- I. Items to Be Insulated: Provide insulation on all ductwork, all piping, all items installed in these duct and piping systems, all air and liquid energy conveying systems and components, all air and liquid energy storage, all equipment, and all energy consuming devices, except where such insulation has been specifically excluded.
- J. Items Excluded from Being Insulated:
1. Sanitary sewer drain lines (except traps at handicap accessible fixtures).
  2. Double wall flues.
  3. Factory pre-insulated underground piping.
  4. Stops and risers at plumbing fixtures (except at handicap accessible fixtures).
  5. Factory insulated tanks.
  6. Electric motors.
  7. Fans.
  8. Factory insulated or factory lined HVAC, AHU, and AC units.
  9. Boilers.
  10. Chillers.
  11. Pumps handling hot water.
  12. Condensate receivers.
  13. Relief Valves and associated drain piping.
  14. Hose bibbs (except where used as drains hot water systems).
  15. Fuel piping.
  16. Heating system expansion tanks.
  17. Water meter.
  18. Underground cold water piping and associated underground items.

### 3.2 DUCT INSULATION INSTALLATION

- A. Types and Thickness: Insulate all ducts with insulation type and thickness (to provide the required R value) as specified in "Part 2 - Products".
- B. General: Insulation shall be firmly butted at all joints. All longitudinal seams for flexible insulation shall overlap a minimum of 2 inches. All joints and seams shall be finished with appropriate joint sealing tape. Installation shall provide a continuous sealed vapor barrier over all surfaces; seal all jacket penetrations with vapor barrier mastic or vapor barrier jacket tape.
- C. Attachment: For rectangular ducts over 24 inches wide, duct insulation shall be additionally secured to the bottom of the ductwork with mechanical fasteners on 18 inch centers to reduce sagging. Washers shall be applied without compressing the insulation. Protruding ends or fasteners shall be cut off flush after washers are installed. All seams, joints, penetrations, and damage to the facing shall be sealed with joint sealing tape or vapor retardant mastic or appropriate joint sealing tape.
- D. Outdoors: Outdoor insulated ductwork shall receive rigid insulation, weather barrier mastic coating (with mesh) and metal jacketing. Ductwork shall have jacketing lapped, secured, and sealed to provide a completely weatherproof enclosure; sealed watertight.

### 3.3 PIPE INSULATION INSTALLATION

- A. Types and Thickness: Insulate all piping with insulation type and thickness as specified in "Part 2 - Products". All piping shall be insulated except where specifically excluded.
- B. General: All ends shall be firmly butted together and secured with joint sealing tape. All jacket laps and joint sealing tape shall be secured with outward clinch staples at 4 inch spacing, or by use of a suitable adhesive. Installation shall provide a continuous sealed vapor barrier over all surfaces; seal all jacket penetrations with vapor barrier mastic or vapor barrier jacket tape.
- C. Elastomeric Pipe Insulation: Install with seams and joints sealed with rubberized contact adhesive. Insulation with pre-applied adhesive is not permitted. A brush coating of adhesive shall be applied to both butt ends to be joined and to both split surfaces to be sealed. Adhesive shall be allowed to set until dry to touch but tacky under slight pressure before joining the surfaces. Insulation seals at seams and joints shall not be capable of being pulled apart one hour after application. Provide added tape wrap around insulation to ensure seam and joint closure. Insulation that can be pulled apart one hour (or more) after adhesive installation shall be replaced. Provide metal jacketing over outdoor exposed insulation.
- D. Pipe Hangers: Provide insulation tight up to pre-insulated pipe supports at pipe hangers, seal all joints with joint sealing tape. Pre-insulated pipe supports are specified in Section 220529.
- E. Pipe Sleeves: Run insulation continuous full size through sleeve. Coordinate work with fire seals and confirm fire seal system is approved for use with insulated pipes; see Section 220530.
- F. Metal Jacketing:
  - 1. Applications: Provide metal jacket over piping insulation for the following:
    - a. Outdoor exposed piping.
    - b. Exposed piping; from finished floor and up 8 feet.
    - c. Exposed piping 4 inches and larger located in mechanical room; from finished floor and up 8 feet.
  - 2. Outdoor Installation: Where installed on outdoor piping locate seams on bottom side of horizontal piping. Seal all jacket seams to provide a completely weatherproof enclosure; water tight.

### 3.4 EQUIPMENT AND SPECIALTIES INSTALLATION

- A. Types and Thickness: All equipment and items installed in insulated duct and piping systems shall be insulated except where specifically noted not to be; reference paragraph 3.1. Insulation type and thickness shall be as specified in "Part 2 - Products".
- B. General: Apply insulation as close as possible to equipment by grooving, scoring, and beveling as necessary. As required, secure insulation to equipment with studs, pins, clips, adhesive, wires or bands. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. Comply with NCIIS.
- C. Removable: All equipment and specialties where access is required for maintenance, repair, service, or cleaning shall have insulation installed so that it can be easily removed and reinstalled without being damaged and without requiring new insulation. Removable

insulation shall completely cover the item being insulated with an overlap over adjacent insulation to cover all joints. Insulation on cold surfaces shall provide a sealed vapor barrier so that no surfaces are exposed to ambient air and so that no condensation can occur; overlap enclosure ends minimum 2-inches.

- D. ADA Compliant Lavatories and Sinks: Insulate P-trap and HW/CW supplies below lavatory and sink where exposed.
- E. Nameplates: Do not insulate over nameplates or ASME stamps; bevel and seal insulation around.

### 3.5 ACOUSTIC WRAP

- A. General: Install in accordance with manufacturers written instructions and NCIIS. Overlap all interior sound insulation joints with a minimum 2 inch overlap of the exterior sound barrier. Acoustical insulation shall not be compressed. Where installed over equipment or items requiring access, provide acoustic wrap in sections and in a manner that facilitates future removal and re-installation.
- B. Light Gauge Duct: Where the ductwork to which the wrap is to be applied is less than 20 gauge, apply vibration damping material on outside of duct before applying acoustic wrap.
- C. Insulated Items: Where installed on ducts or items that require thermal insulation, install thermal insulation over acoustic wrap.
- D. Locations: Provide acoustic wrap on the first 10 feet of supply (or discharge) duct off all air handling units, and at locations noted on plans.

END OF SECTION





## PART 1 GENERAL

### 1.1 SUMMARY

- A. The purpose of this section is to describe the commissioning process specific for those sections found in Division 22.

### 1.2 ADMINISTRATIVE REQUIREMENTS

- A. General Responsibilities: The Contractor's commissioning responsibilities applicable to the plumbing contractor are as follows:
  - 1. In each purchase order or subcontract written, include requirements for submittal data, commissioning documentation, O&M data and training.
  - 2. Attend a commissioning kick-off meeting and other meetings necessary to facilitate the Commissioning process.
  - 3. Contractors shall assist in clarifying the installation, operation, maintenance, and control of commissioned equipment if requested by the Commissioning Authority.
- B. Coordination
  - 1. Refer to Section 01 91 00 for a listing of all sections where commissioning requirements are found, for systems to be commissioned and for Pre-verification testing requirements.

### 1.3 SUBMITTALS

- A. General Submittals: Contractor shall provide to the Commissioning Authority, through established channels, normal cut sheets, shop drawing submittals, and manufacturer's installation and start-up checklists, for all commissioned equipment.

## PART 2 PRODUCTS

Not Used

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Installation Checklists: The Contractor shall complete the checklist(s) provided with and using the Facility Grid app.
  - 1. The completion of these checklists does not limit the Contractor's responsibilities for quality control and scheduling as indicated elsewhere in the documents, nor does this checklist

include all submittal, inspection, or quality assurance requirements for the work of this Section.

### 3.2 CLOSEOUT ACTIVITIES

- A. Pre-Verification Testing (PVT): The Contractor will perform the Pre-verification tests as provided with the Facility Grid app. When all pre-verification testing has been completed, the CA will schedule Functional Performance testing and substantial completion may be issued.
- B. Functional Performance Testing (FPT): The CA shall verify that the PVT's were done and complete by running the FPT's in the Facility Grid app.
- C. Operation and Maintenance Manuals: The approved complete manuals must be on site prior to training.
- D. Training: The Owner personnel shall be trained on procedures related to the list in 1.1A above.

### 3.3 DOCUMENTS REQUIRED

- A. The General Contractor will provide the following documentation before Final Acceptance:
  - 1. Completed Inspection Forms with approval signatures of all Authority Having Jurisdiction.
  - 2. Approval Signature of Engineer of Record
  - 3. Training Attendance Sheets with Agenda

END OF SECTION

## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Thermowells.
- B. Plumbing Control Tubing.
- C. Plumbing Control Valve Installation.

### 1.3 SUBMITTALS

- A. General: Comply with Section 220500.
- B. Product Data: Submit a complete list of equipment to be furnished, including product information for each item on the material list.

### 1.4 GENERAL REQUIREMENTS

- A. General: The control system is specified in Division 25. The Division 22 contractor is required to coordinate the work of this Division with the control system work to allow installation of items required for the plumbing control system, and to install the control items indicated.
- B. Plumbing Control Valves: Furnished under Division 25 and installed under this specification section.

### 1.5 REFERENCES

- A. ASTM B88: Standard Specification for Seamless Copper Water Tube.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Products shall comply with Section 220500, Paragraph 2.1, Acceptable Manufacturers.
- B. Thermowells: Trerice, Ashcroft, IPS, RTD, Texas Thermowell, Thermometrics.

### 2.2 THERMOWELLS

- A. Series 300 stainless steel or brass construction, with 2 inch lagging neck and extension type

well. Diameter and insertion length to suit application.

## 2.3 TUBING

- A. Soft Copper tubing, per ASTM B 88.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. General: Install items in accordance with manufacturer's instructions and control system requirements. Coordinate all work requirements with Division 25.
- B. Thermowells: Provide all plumbing system thermowells required by the control system. Install thermowells in accessible locations and to allow for proper control system operation.
- C. Tubing: Provide all control tubing necessary to properly connect all plumbing control devices (e.g. differential pressure sensors, gauges, etc.).
- D. Plumbing Control Valves: Install all control valves furnished by Division 25 and as necessary for proper functioning plumbing systems. Verify valve sizes, locations, porting arrangements, and other installation requirements. Provide unions at connections to valves (except not required on flanged valves).

END OF SECTION

## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Domestic Water Piping.
- B. Valves.
- C. Water Hammer Arrestors.
- D. Trap Primers.
- E. Backflow Preventers.
- F. Water Meters.
- G. Electric Heat Trace.
- H. Domestic Water Expansion Tanks.
- I. Water Service Connections.
- J. Testing and Inspection.
- K. Flushing and Disinfection.

### 1.3 DEFINITIONS

- A. "Lead-Free" means not containing more than 0.2% lead in solder and flux; and not more than a weighted average of 0.25% lead in wetted surfaces of pipes, pipe and plumbing fittings and fixtures.

### 1.4 SUBMITTALS

- A. General: Submittals shall comply with Section 220500.
- B. Product Data: Submit manufacturer's product information on all items to be used.
- C. System Tests and Inspections: Submit documentation showing systems have satisfactorily passed all pressure tests and code inspections.
- D. Cleaning and Disinfection: Submit documentation regarding completion of flushing, disinfection, bacteriological tests, and Health Department's acceptance of tests and system.

## 1.5 GENERAL REQUIREMENTS

- A. ANSI/NSF Compliance: All items in contact with potable water shall be lead free in accordance with ANSI/NSF 61. Plastic piping system components shall comply with ANSI/NSF 14. Only lead-free solder shall be used.
- B. Valves: Shall be dezincification resistant, and shall not contain more than 15% zinc in their chemical composition.

## 1.6 REFERENCES

- A. ASME B16.3: Malleable Iron Threaded Fittings.
- B. ASME B16.15: Cast Bronze Threaded Fittings: Classes 125 and 250.
- C. ASME B16.18: Cast Copper Alloy Solder Joint Pressure Fittings.
- D. ASME B16.22: Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- E. ASME B16.24: Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 400, 600, 900, 1500, and 2500.
- F. ASTM A53: Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless.
- G. ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials.
- H. ASTM A312: Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
- I. ASTM A403: Wrought Austenitic Stainless Steel Piping Fittings.
- J. ASTM A530: General Requirements for Specialized Carbon and Alloy Steel Pipe.
- K. ASTM A774: As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
- L. ASTM A 778: Welded, Un-annealed Austenitic Stainless Steel Tubular Products.
- M. ASTM B16.18: Seamless Copper Water Tube.
- N. ASTM B32: Solder Metal.
- O. ASTM D1784: Chlorinated Poly (Vinyl Chloride) CPVC Compounds.
- P. ASTM F437: Threaded Chlorinated Poly (Vinyl Chloride) CPVC Plastic Pipe Fittings, Schedule 80.
- Q. ASTM F439: Socket-Type Chlorinated Poly (Vinyl Chloride) CPVC Plastic Pipe Fitting.
- R. ASTM F441: Chlorinated Poly (Vinyl Chloride) CPVC Plastic Pipe.
- S. ASTM F493: Solvent Cement for Chlorinated Poly (Vinyl Chloride) CPVC Pipe and

Fittings.

- T. ASTM F876: Standard Specification for Cross-linked Polyethylene (PEX) Tubing.
- U. ASTM F877: Standard Specification for Cross-linked Polyethylene (PEX) Plastic Hot and Cold Water Distribution Systems.
- V. ASTM F1960: Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) Tubing.
- W. AWS A5.8: Filler Metals for Brazing and Braze Welding.
- X. AWWA B300: Hypochlorites.
- Y. AWWA B301: Liquid Chlorine.
- Z. AWWA M20: Water Chlorination and Chlorination Practices and Principles, 2nd edition.
- AA. ANSI/NSF Standard 14 Plastics Piping System Components and Related Materials.
- BB. ANSI/NSF Standard 61 Drinking Water System Components – Health Effects.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Products shall comply with Section 220500, 2.1, Acceptable Manufacturers.
- B. Pipe and Fittings: Elkhart, CTS, Mueller, Cerro, Cambridge-Lee, US Steel, Anvil International, Wheatland Tube, Weldbend, Exltube.
- C. Valves: Conbraco/Apollo, Nibco, Stockham, Walworth, Milwaukee, Kitz, Red-White, Watts, Hammond.
- D. Electric Heat Trace: Raychem, Chromalox, Nelson.
- E. Pressure Reducing Valves: Conbraco/Apollo, Watts, Cla-Val, Bell & Gossett, Zurn/Wilkins.
- F. Thermostatic Mixing Valves: MCC Powers, Leonard, Symmons.
- G. Backflow Preventers: Conbraco/Apollo, Febco, Watts, Ames, Zurn/Wilkins.
- H. Balancing Valves: Bell & Gossett, Taco, Armstrong, Red-White.
- I. PEX Tubing and Fittings: Uponor, Viega, Zurn, Watts.
- J. Additional manufacturers are as listed for each individual item.

### 2.2 PIPE AND FITTINGS - MATERIALS

- A. Copper Pipe and Fittings:

1. Pipe: Seamless copper water tube, hard temper (unless noted otherwise), type K or L as indicated, per ASTM B88.
  2. Fittings:
    - a. Solder-Joint: Wrought copper and bronze fittings per ASME B 16.22 and cast copper alloy fittings per ASME B16.18, cast bronze threaded fittings per ASME B16.15.
    - b. Flanged: Cast bronze fittings per ASME B16.24.
    - c. Solder Material: 95/5 tin-antimony solder per ASTM B32 or "Silvabrite 100" (95.5 tin/4 copper/0.5 silver) solder; lead free.
    - d. Brazing Material: AWS A5.8, BCuP-5.
- B. Stainless Steel Pipe and Fittings:
1. Pipe: Seamless or welded stainless steel per ASTM A778 or A312, type 304L or 316L, tolerances per ASTM A 530. Schedule 40 unless indicated otherwise.
  2. Fittings:
    - a. Threaded: Constructed of same material as piping, per ASTM A774 or A403, suitable for 150 psi swp.
    - b. Welded: Constructed of same material as piping, weld fittings, per ASTM A774 or A403, suitable for 150 psi swp.
    - c. Flanged: Constructed of same material as piping, 150 pound class.
- C. PEX Pipe and Fittings:
1. Pipe: Cross-linked polyethylene (PEX), manufactured per ASTM F876 and F877. Color shall be blue for cold water systems, and red for hot water and hot water recirculation systems. Piping used underground shall be continuous with no joints or fittings and be rated for underground use by the piping manufacturer.
  2. Fittings: Pipe manufacturer's standard methods, manufactured in accordance with recognized standards.
  3. Ratings: Minimum pressure rating of 100 psi at 180 deg F, and 80 psi at 200 deg F in accordance with the Plastic Pipe Institute standards.
  4. Firestop Penetrations: Piping system manufacturer (or fire seal manufacturers) shall have listed methods (acceptable to the AHJ) for piping penetrations through rated building elements (for the type of elements penetrated on this project).
  5. Ultraviolet (UV) Light Exposure: Piping shall be meet or exceed a 60 day exposure to UV light in accordance with ASTM F876. Piping which may be exposed to UV light after installation shall have an insulation jacket with UV protection (or equivalent method) approved by the piping manufacturer to protect the pipe from UV exposure.
  6. Chlorine Resistance: Piping and system components used shall be rated for use with 100% chlorine at 140 deg F in accordance with ASTM F876 per PEX 5006.

### 2.3 PIPE AND FITTINGS - APPLICATIONS

- A. Domestic Water Piping - Above Ground: Type L or K copper with flanged or soldered joints or stainless steel; except where run exposed in finished areas shall be stainless steel, or be chrome plated copper, or be copper piping with a chrome plated sleeve. For run outs to individual fixtures (pipe sizes 3/4" or less) PEX tubing is allowed.
- B. Domestic Water Piping - Below Ground: Type K copper tubing with silver brazed joints; except that piping within the building footprint serving individual fixtures may be type L (soft or hard temper) copper.



- C. Non-Potable Water Piping: Type L copper with solder or flanged joints.
- D. Trap Primer Piping: Type L or K "soft" or "hard" (bending temper) copper, with compression fittings or soldered joints. PEX tubing.

## 2.4 VALVES

### A. Ball Valves:

- 1. 2 Inches and Smaller: 600 psi non-shock cold working pressure, 100 psi at 300 deg F, bronze body, full port, 2 piece construction, anti-blowout stem, reinforced PTFE seats, stainless steel or chrome plated brass or silicon bronze ball, lever handle, solder or threaded connections. Provide with extended lever handle where valve is installed in systems with insulation thickness greater than 0.5 inch. Nibco S-585-66-LF, T-585-66-LF, Nibco S-585-80-LF, T-585-80-LF (or approved).
- 2. 2-1/2 Inches and Larger:
  - a. Cold Water Applications - Copper Alloy: 400 psi non-shock cold working pressure copper alloy body, full port, anti-blowout stem, PTFE seats, stainless steel or chrome plated brass ball, plated steel lever handle. Nibco T-FP-600A-LF (or approved).
  - b. Stainless: Class 150 stainless steel body, split-body full bore design, anti-blowout stem, carbon filled TFE seats, stainless steel ball, stainless steel trim, plated steel lever handle. Nibco F-515-S6-F-66-FS (or approved).
  - c. Cast Iron: Class 125 psi-swp, cast iron body, split-body full port, anti-blowout stem, PTFE seats, stainless steel ball and stem. Conbraco/Apollo 6P Series (or approved).

### B. Butterfly Valves:

- 1. 2 Inches and Smaller: 125 psi-swp bronze body, stainless steel disc and extended stem, with solder or threaded connections as required. Milwaukee "Butterball" Model No. BB2 (or approved).
- 2. 2-1/2 Inches and Larger: 200 psi non-shock cold water, ductile iron body, extended neck, molded-in seat EPDM liner, stainless steel stem, and aluminum bronze disc. Provided with lugs for dead-end service. Nibco LD-2000, WD-2000 (or approved).
- 3. Lug Type: Butterfly Valves installed at equipment or other system components which may be disconnected from the system shall be lug type suitable for dead end service.

### C. Check Valves:

- 1. 2 Inches and Smaller:
  - a. Horizontal: 125 psi-swp bronze body horizontal swing check valve, regarding type, y-pattern, renewable seat and disc, solder or threaded connection. Nibco S-413-LF or T-413-LF (or approved).
  - b. Vertical: 125 psi-swp bronze body vertical inline check valve, stainless steel or bronze disk holder, Buna-N disk, stainless steel spring actuated, solder or threaded connection. Nibco S-480-LF or T-480-LF (or approved).
- 2. 2-1/2 Inches and Larger:
  - a. Horizontal: 125 psi-swp iron body vertical inline "silent" check valve, wafer or flanged style, renewable seat and disk, stainless spring actuated, bronze disk. Nibco W-910 (or approved).
  - b. Vertical: 125 psi-swp iron body vertical inline "silent" check valve, wafer or flanged style, renewable seat and disk, stainless spring actuated, bronze disk. Nibco W-910, F-910 (or approved).

- D. Balancing Valves: Calibrated balance valve, ball or globe type, bronze body, with brass readout valves with integral EPT insert and check valve to minimize fluid loss during balancing. Valve shall have calibrated nameplate and memory stop. Rated for 200 psig working pressure at 250 degrees F. Valve shall be same size as pipe installed in. Bell & Gossett "Circuit Setter" (or approved).
- E. Drain Valves: Bronze ball valve, minimum 125 psi-swp, anti-blowout stem, stainless steel or chrome plated brass ball, reinforced TFE seat, solder or threaded inlet connection, male 3/4 inch hose thread outlet connection, with brass cap and chain. Nibco S-585-70-HC, T-585-70-HC (or approved).
- F. Pressure Reducing Valves:
  - 1. 2 Inches and Smaller: Bronze body construction, renewable nickel alloy or stainless steel seat, lead free, with integral strainer and union inlet connections. Adjustable range 25 to 75 lbs, suitable for inlet pressures up to 300 psi. Watts Series U5 (or approved).
  - 2. 2-1/2 Inches and Larger: Ductile iron or bronze body, bronze trim, 150 pound pressure class, with flanged or screwed ends. Valve shall be globe type, with adjustment range from 15 to 75 psi. Valve shall be a hydraulically operated, diaphragm-actuated pressure reducing valve. Diaphragm shall consist of a nylon fabric bonded with a synthetic rubber and shall not be used as a seating surface. Packing glands and/or stuffing boxes are not permitted, and there shall be no pistons operating the valve or pilot controls. All necessary repairs shall be possible without removing valve from the line. The pilot control shall be a direct-acting, adjustable, spring-loaded, normally open, diaphragm valve, designed to permit flow when controlled pressure is less than the spring setting. The control system shall include a fixed orifice, flow strainer, and speed control. Cla-Val Series 90-01 (or approved).
- G. Pressure Relief Valves: ASME rated pressure relief valve, bronze body, stainless steel spring, set for pressure indicated or as required to protect system from over pressure. Valve shall have minimum 400,000 BTU/HR relief capability (at set pressure) and no smaller than 3/4-inch connection sizes.

## 2.5 ACCESSORIES

- A. Water Hammer Arrestors: All metal, factory pre-charged with inert gas, sealed internal bellows; 125 psi working pressure. All wetted parts shall be type 300 stainless steel, brass or copper. PDI (Plumbing and Drainage Institute) sizes as indicated. Where not sized, provide sizes in accordance with PDI standards. Zurn "Shoktrol", Wade "Shokstop", or J.R. Smith "Hydrotrol".
- B. Trap Primer Valve - Electric: Bronze body solenoid valve, 115 volt, with 6 foot power cord, and recycle timer having manual on switch and fuse protection. Shall have integral 1" air gap and distribution manifold to serve 1 to 4 floor drains. Shall Provide minimum 2 oz water at 20 psi per drain served. Precision Plumbing Products "Mini-Prime" (or approved).
- C. Pressure Drop Type: Activated by drop-in water pressure. Constructed of corrosion resistant brass with integral backflow preventor, vacuum breaker ports, distribution manifold to suit number of drains served, adjustable to line pressure for water delivery. Precision Plumbing Products Model P-1 and P-2 (or approved).

## 2.6 BACKFLOW PREVENTERS

### A. Reduced Pressure Type:

1. General: Washington State approved, with air gap drain fitting and resilient seated full flow shutoff valves and test cocks. Same size as connecting pipe. Configuration to suit application. Conforming to AWWA C511.
2. 2 Inches and Smaller: Bronze body, stainless steel springs, bronze ball valves, 175 psi working pressure, threaded end connections.
3. 2-1/2 Inches and Larger: Ductile iron body, internal and external epoxy coating per AWWA C550, OS & Y gate isolation valves, bronze trim, stainless steel springs, 175 psig working pressure, Class 125 flanged end connections (grooved connections allowed where mechanically coupled piping systems are allowed).
4. Discharge: Discharge from intermediate relief valve assembly shall not exceed 190 gpm for 2-inch and smaller backflow preventers, and not exceed 560 gpm for larger backflow preventers (rated at 75 psig inlet pressure).

### B. Double Check Type:

1. General: Washington State approved, with resilient seated full flow shutoff valves and test cocks. Same size as connecting piping. Conforming to AWWA C510.
2. 2 Inches and Smaller: Bronze body, stainless steel springs, bronze ball valves, 175 psi working pressure, threaded end connections.
3. 2-1/2 Inches and Larger: Ductile iron body, internal and external epoxy coating per AWWA C550, OS & Y gate isolation valves, bronze trim, stainless steel springs, 175 working pressure, Class 125 flanged end connections (grooved connections allowed where mechanically coupled piping systems are allowed).

## 2.7 WATER METERS

- ### A. Hydronic System Make-up Water Meter-Electric Contact Type:
- Magnetic drive oscillating piston or turbine type. Shall be of bronze construction, with repeatability plus or minus 1%, accurate to plus or minus 1.5% over entire flow range, and suitable for 150 psi operating pressure. Meter shall have register reading in U.S. gallons, minimum 10,000 gallon capacity with sweep hand. Meter shall have electrical contacting register, with normally open "dry contacts," rated for 10 amps at 250 volts A.C.; contacts shall close at preset gallons/contact setting. Size as shown on the drawings. Carlon Model JSJ (or approved).

## 2.8 DOMESTIC WATER EXPANSION TANK

- ### A. Type:
- Diaphragm thermal expansion absorber. Amtrol "ST" Series (or approved).
- ### B. Construction:
- Welded steel construction, with polypropylene liner, butyl/EPDM diaphragm, stainless steel air charging valve, 175 psig working pressure, configuration/connections to suit installation, NSF 61 approved, and ASME certified.
- ### C. Capacity:
- As indicated on plans; where not indicated provide 4.0 gallon tank volume (minimum).

## PART 3 EXECUTION

### 3.1 GENERAL

- A. Workmanship: Installation of all items shall comply with code, best professional practices, manufacturers written installation instructions, and to allow for proper functioning of items being connected to.
- B. Complete System: Provide all piping as indicated and as required to allow supply connections to each fixture and equipment item requiring water supply. Provide offsets as required to accommodate building construction and access requirements per Section 220500. For multistory buildings include costs to offset vertical piping at each floor level since structural member locations will not be the same on each floor.
- C. Coordination: Coordinate installation of items with all trades that are affected by the work to avoid conflicts.
- D. Equipment by Others: Provide piping connections to equipment furnished by others in accordance with Section 220500.
- E. Hot Water Adjustment: Adjust the hot water circulation system for uniform circulation throughout the system; provide balancing of system where hot water circulation system has multiple branches with balancing valves (see balancing specification Section). Install, set, and adjust all system components for proper operation.

### 3.2 PIPE AND FITTINGS

- A. Concealed: All piping in finished areas shall be installed concealed unless specifically noted otherwise. Provide escutcheons where piping is allowed to be exposed and pipe passes through building elements (i.e. walls, floors, ceilings, etc.).
- B. Non-Obstructing: Install piping at such heights and in such a manner so as not to obstruct any portion of windows doorways, passageways, or access to any items requiring routine service, maintenance, or inspection. Offset or reroute piping as required to clear any interferences which may occur.
- C. Drawing Review: Consult all drawings for location of pipe spaces, ducts, electrical equipment, ceiling heights, door openings, window openings, and other details and report discrepancies or possible conflicts to Architect/Engineer before installing pipe.
- D. Insulation: Allow sufficient clearances for installation of pipe insulation in thickness specified. If interferences occur, reroute piping to accommodate insulation.
- E. Drainage: Slope all piping to low points to allow the system to be drained. Provide added drain valves where system cannot be drained through fixtures.
- F. Install all piping parallel to the closest wall and in a neat, workmanlike manner. Horizontal exposed straight runs of piping shall not deviate from straight by more than 1/4-inch in ten feet. Vertical piping shall not deviate from plumb by more than 1/8-inch in ten feet.
- G. Do not run any piping above electrical panels (and similar electrical equipment). Provide offsets around such panels as necessary.
- H. Prior to the joining of any section of pipe to a pipe run, the section shall be thoroughly cleaned inside and out, the ends shall be reamed to remove any cutting burrs and piping prepared as recommended by piping and fitting manufacturer.

- I. Threaded Connections: Cut piping carefully, ream, thread and work into place without springing. Use TFE tape or lead and graphite lubricant (on male threads only).
- J. Soldered Connections: Polish contact surfaces of fittings and pipes with emery cloth before fluxing male and female surfaces of joints. Steel wool and sandpaper not permitted for polishing.
- K. Unions: Install unions in pipe connections to valves, coils, and any other equipment where it may be necessary to disconnect the equipment or piping for repairs or maintenance; and as indicated. Where flanged connections occur at equipment additional unions are not required unless indicated otherwise.
- L. Insulating Unions: Install dielectric insulating connectors between all connections of copper piping and steel piping of steel equipment. Where flanged connections occur use insulating type flanges.
- M. PEX Tubing:
  - 1. Minimum Bend Radius (cold bending): No less than six times the outside diameter. Use a bend support as supplied by the PEX tubing manufacturer for tubing with a bend radius less than stated.
  - 2. Install tubing in accordance with the tubing manufacturer's recommendations and as indicated in the installation handbook.
  - 3. Do not install PEX tubing within 6 inches of gas appliance vents or within 12 inches of any recessed light fixtures.
  - 4. Do not solder within 18 inches of PEX tubing in the same waterline. Make sweat connections prior to making PEX connections.
  - 5. Do not expose PEX tubing to direct sunlight for more than 30 days.
  - 6. Ensure no glues, solvents, sealants or chemicals come in contact with the tubing without prior permission from the tubing manufacturer.
  - 7. Use grommets or sleeves at the penetration for PEX tubing passing through metal studs.
  - 8. Protect PEX tubing with sleeves where abrasion may occur.
  - 9. Use strike protectors where PEX tubing penetrates a stud or joist and has the potential for being struck with a screw or nail.
  - 10. Use tubing manufacturer supplied bend supports where bends are less than six times the outside tubing diameter.
  - 11. Minimum horizontal supports are installed not less than 32 inches between hangers in accordance with model plumbing codes and the installation handbook.
  - 12. PEX riser installations require epoxy-coated riser clamps installed at the base of the ceiling per floor.
  - 13. A mid-story support is required for riser applications.
  - 14. Pressurize tubing with air in accordance with applicable codes or in the absence of applicable codes to a pressure of 25 psi above normal working pressure of the system.
  - 15. Comply with safety precautions when pressure testing, including use of compressed air, where applicable. Do not use water to pressurize the system if ambient air temperature has the possibility of dropping below 32 deg F.
  - 16. At locations where the piping may be exposed to UV light, piping system shall be completely covered and protected to prevent such exposure.

### 3.3 VALVES

- A. Type: Ball type only; except that valves 2-1/2 inches and larger may be the ball or butterfly type; except that valves indicated to be a specific type shall be the type as noted.
- B. General: Provide isolation valves as shown on the drawings. In addition to those shown, provide added valves to allow for the isolation of each group of fixtures, all water heaters, and all individual equipment items (e.g. dishwashers, heat exchangers, etc.).
- C. Installation: Install valves so as to be easily accessible and oriented to permit ease of operation. Valve stem shall be directed toward operator in either the vertical or horizontal direction. Provide access doors for valves not otherwise accessible.
- D. Pressure Reducing Valves: Provide with by-pass line, isolation valves, unions (on valves with threaded connections), and pressure gauges. Set initial pressure and adjust as required so that all fixtures/devices served have sufficient water pressure.
- E. Drain Valves: Provide drain valves at the base of all risers (except not required where risers can be drained through plumbing fixtures or equipment drains). Provide drain valves at piping low points where the piping cannot be drained through fixtures, hose bibs, or equipment drains.
- F. Balancing Valves: Provide balancing valves in hot water circulation piping where indicated and where required to allow for equal distribution of hot water circulation flows.
- G. Thermostatic Mixing Valve: Provide inlet and outlet isolation valves and outlet thermometer.

### 3.4 ACCESSORIES

- A. Water Hammer Arrestors: Install per manufacturer's instructions, just upstream of last fixture on branch line. Provide water hammer arrestors on branch water lines serving fixtures with flush valves, washer machines, solenoid valves, and similar quick-acting valves. Water hammer arrestors are typically not shown on the plans, but shall be provided per this paragraph. Provide ball isolation valve in piping to arrestor. Where access cannot be provided at water line location, the water hammer arrestor piping may be extended vertically and the water hammer arrestor located above ceiling outside of plumbing chase.
- B. Trap Primers: Provide trap primers to all vented floor drains, floor receptors, and where required by the code. Install with an isolation valve in the branch line to the trap primer valve. Electronic type shall be used at boiler room, pressure drop type at all other locations.
- C. Access Doors: Provide access doors to all valves, water hammer arrestors, trap primers, backflow preventers, and any other piping accessories which would otherwise be inaccessible. See Section 220519 for access door specifications.
- D. Backflow Preventers:
  - 1. General: Provide backflow preventers as indicated in the Contract Documents and as required by code. Backflow preventers with threaded connections shall be installed with unions for ease of removal. Install to be accessible for testing and service. Pipe air gap drains to nearest floor drain or point of drainage.
  - 2. Inspection: Arrange and pay for inspection of backflow preventers as required by the local AHJ and obtain installation acceptance from the AHJ.
  - 3. Certification: Following inspection arrange and pay for testing of backflow preventers by certified individuals in accordance with applicable portions of the Washington

Administrative Code, other applicable regulations as set forth by the Washington State Department of Social and Health Services, and as required by the AHJ.

- E. Water Meters: Provide water meters of type, and in locations, as shown on the drawings.
- F. Domestic Water Expansion Tanks: Provide isolation valve for servicing expansion tank. All isolation valves between expansion tank and water heater shall be labeled, "Expansion Tank Service Valve: Must Be Open When System Is Operating."

### 3.5 WATER SERVICE CONNECTIONS

- A. Provide connection to water main outside the building as shown on the drawings.
- B. Provide sleeve in floor for entrance of service main into building, seal watertight; anchor service main firmly to building. See Section 220530 for sleeves and seals.

### 3.6 TESTING AND INSPECTION

- A. All piping shall be tested, inspected, and approved by the local authority having jurisdiction prior to being concealed or covered.
- B. Testing shall be witnessed by the plumbing inspector and the Architect/Engineer (at his option). Notify Architect/Engineer minimum 72 hours prior to date of testing, and mutually agreed upon times arranged.
- C. Piping shall be hydrostatically tested for a period of 2 hours (or as required by local authority having jurisdiction), during which time no drop in pressure or leakage shall occur.
- D. Test pressure shall be not less than 150 percent of the maximum to which the pipe will ordinarily be subjected; but in no case less than 75 psig.
- E. Any leaks or defective piping disclosed by testing and inspection shall be repaired with new materials and the system re-tested.
- F. Provide documentation to the Engineer indicating that the system has been completely pressure tested, and all portions inspected and accepted by the local authority having jurisdiction.

### 3.7 FLUSHING AND DISINFECTION

- A. System Flushing: After tests are completed, all water piping shall be flushed. In general, sufficient water shall be used to produce a minimum water velocity of 2.5 feet per second through piping being flushed. Flushing shall be continued until discharge water shows no discoloration. System shall be drained at low points. Strainer screens shall be removed, cleaned, and replaced in line. System valves and fixture faucets shall be opened and re-closed to completely flush system. After flushing and cleaning, systems shall be prepared for disinfection service by immediately filling water piping with clean, fresh potable water. Any stoppage, discoloration, or other damage to the finish, furnishings, or parts of the building during this process shall be repaired by the Contractor.
- B. Disinfection:

1. Upon completion of the job and prior to final acceptance, the plumbing system shall be disinfected with Chlorine solution. Review procedures and disinfection with the authority having jurisdiction to insure that all work complies with code requirements. Verify any deviations from specified procedures with the Architect/Engineer prior to proceeding. The chlorinating material shall be either liquid chlorine conforming to AWWA B301 or hypochlorite conforming to AWWA B300 (or as otherwise required by the authority having jurisdiction). Water chlorination procedure shall be in accordance with AWWA M20 (or procedure acceptable to AHJ and to the Architect/Engineer). The chlorinating material shall provide a dosage of not less than 50 parts per million and shall be introduced into the system in an approved manner. The treated water shall be retained in the pipe long enough to destroy all non-spore-forming bacteria.
  2. The retention time shall be at least 24 hours and shall produce not less than 10 ppm of chlorine at the extreme end of the system at the end of the retention period. All valves in the system being sterilized shall be opened and closed several times during the contact period. The system shall then be flushed with clean water until the residual chlorine is reduced to less than 1.0 ppm. During the flushing period all valves and faucets shall be opened and closed several times.
- C. Bacteriological Tests: The Contractor shall employ an approved agency to take test samples at several points of the system (i.e. end of each wing, each floor of building, etc.) in properly sterilized containers and arrange with the Health Department (or a test agency acceptable to the Health Department) having jurisdiction to test the samples. Test for coliform and other items as required by the AHJ. Should the samples not test satisfactory, the system shall be re-flushed and disinfected again until satisfactory samples are obtained.
- D. Submittal: Submit documentation stating that flushing and disinfection has been completed, copies of the bacteriological test results, and certification from the Health Department having jurisdiction stating that system has been found acceptable.

END OF SECTION



## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Domestic Circulators.

### 1.3 SUBMITTALS

- A. General: All submittals shall comply with Section 220500.
- B. Product Data: Provide product information and performance data for all pumps.
- C. Performance Data: Submit performance data, including pump curves, showing pump performance as head vs. GPM, BHP and NPSH vs. GPM, with system operating point clearly marked. (NPSH vs. GPM not required for pumps 1 HP and less.)

### 1.4 QUALITY CONTROL

- A. Manufacturer: Manufacturer shall be ISO-9001 approved.
- B. General: Provide quality assurance checks specified in Section 220500 prior to ordering materials.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Products shall comply with Section 220500, Paragraph 2.1, Acceptable Manufacturers.
- B. Wet Rotor Circulators: Bell & Gossett, Armstrong, Grundfos, Taco.

### 2.2 GENERAL

- A. Balancing: All rotating parts shall have been statically and dynamically balanced at the factory.
- B. Alignment: Pump and motors shall be factory aligned, and have alignment checked and reset once installed in place.
- C. RPM: Pumps and motors shall operate at 1750 rpm unless indicated otherwise.
- D. Pump Capacity: Shall be no less than the values listed on the Mechanical Equipment

Schedule on the drawings.

- E. Pump Types: The type of each pump is indicated on the Mechanical Equipment Schedule under the "Type" column, and corresponds to the types specified herein.
- F. Motors: Shall comply with Section 220500. Motors shall be of sufficient size so as to be non-overloading at any point on the operating curve and shall be no smaller than the size shown on the drawings. Motors shall be of drip-proof construction (unless indicated otherwise), resilient mounted with oil lubricated journal or ball bearings, and have built-in thermal overload protectors. Motors shall be for use with the voltage and phase as scheduled on the drawings.
- G. Domestic Water Applications: Pumps used on domestic water systems shall be of all-bronze construction, and NSF certified for domestic water use.
- H. Testing: All pumps shall be factory tested per the Hydraulic Institute standards and be thoroughly cleaned.
- I. Finish: Pumps shall have minimum one coat high grade machinery enamel finish, factory applied, manufacturer's standard color.
- J. Nameplate: Pumps shall have stamped metal nameplates identifying: manufacturer, model number, capacity (gpm and head), and date of manufacturer.

## 2.3 DOMESTIC CIRCULATORS

- A. Type: Centrifugal, single stage, in-line wet rotor pump for domestic water circulation. Bell & Gossett Series NBF, SSF (or approved).
- B. Operating Range: Pump shall be rated for continuous operation at 150 psi working pressure and 225 deg F.
- C. Construction: Bronze or stainless steel body, carbon bearings lubricated by circulating fluid, noryl or polypropylene or stainless steel impeller, ceramic or stainless steel shaft. Pump shall require no coupling or shaft seal for proper operation.
- D. Accessories:
  - 1. Automatic Timer Kit: 24 hour timer to control pump on/off based on preset times.
  - 2. Aquastat: Strap-on type, to control pump on/off based on system hot water return temperature. Set to turn pump on at 100 deg F and off at 120 deg F.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. General: Install pumps at locations shown on the drawings and in accordance with manufacturers instructions. Locate for ease of access.
- B. Connections: Decrease from line size to pump inlet size with long radius reducing elbows and minimum 5-pipe diameter straight pipe into pump. Where reducers (in the horizontal) are used on pumps, they shall be the eccentric type installed with taper on the bottom.

- C. Start-Up: Check pump operation to ensure that pump operates with correct sequence, that specified flows are provided and that no unused conditions exist (i.e.) motor overloading or pump cavitation. Notify the Architect/Engineer of any unusual conditions or performance other than as specified.

END OF SECTION



## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Soil, Waste and Vent Piping.
- B. Condensate, Overflow, Miscellaneous Drains.
- C. Cleanouts.
- D. Grease Interceptor.
- E. Testing and Inspection.
- F. Accessories.

### 1.3 SUBMITTALS

- A. General: Submittals shall comply with Section 220500.
- B. Product Data: Submit product information on all items to be used.

### 1.4 REFERENCES

- A. ASME B 16.4: Gray Iron Threaded Fittings.
- B. ASME B 16.12: Cast Iron Threaded Drainage Fittings.
- C. ASME B 16.15: Cast Bronze Threaded Fitting Classes 125 and 250.
- D. ASME B 16.18: Cast Copper Alloy Solder Joint Pressure Fittings.
- E. ASME B 16.22: Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- F. ASME B 16.23: Cast Copper Alloy Solder Drainage Fittings.
- G. ASME B 16.29: Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings (DWV).
- H. ASTM A 53: Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- I. ASTM A 74: Cast Iron Soil Pipe and Fittings.

- J. ASTM A 888: Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
- K. ASTM B 32: Solder Metal.
- L. ASTM B 88: Seamless Copper Water Tube.
- M. ASTM B 306: Copper Drainage Tube (DWV).
- N. ASTM C 564: Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- O. ASTM C 1277: Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
- P. ASTM D 1785: Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- Q. ASTM D 2235: Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
- R. ASTM D 2321: Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
- S. ASTM D 2447: Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter.
- T. ASTM D 2466: Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
- U. ASTM D 2564: Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
- V. ASTM D 2657: Heat Fusion Joining of Polyolefin Pipe and Fittings.
- W. ASTM D 2661: Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.
- X. ASTM D 2665: Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
- Y. ASTM D 2751: Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
- Z. ASTM D 2843: Density of Smoke from the Burning or Decomposition of Plastics.
- AA. ASTM D 3034: Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- BB. ASTM D 3212: Joints for Drains and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
- CC. ASTM D 3311: Drain, Waste, and Vent (DWV) Plastic Fittings Patterns.
- DD. ASTM D 4101: Polypropylene Injection and Extrusion Materials.
- EE. ASTM F 477: Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- FF. CISPI 301: Hubless Iron Soil Pipe and Fittings for Sanitary and Drain, Waste, and Vent Piping Applications.

- GG. CISPI 310: Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and for Sanitary and Storm Drain, Waste, and Vent Piping Applications.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Products shall comply with Section 220500, 2.1, Acceptable Manufacturers.
- B. Pipe and Fittings: Mueller, Cerro, Tyler, Charlotte Pipe and Foundry, AB & I Foundry, Spears Manufacturing, Cresline Northwest.
- C. No Hub Couplings: ANACO, Mission Rubber, Tyler, MG Coupling, Fernco, Clamp-All, Mifab, Pro-Flo.
- D. Cleanouts: Josam, Zurn, J.R. Smith, Wade, Sioux Chief.
- E. Grease Interceptor: Grease Guardian.

### 2.2 PIPE AND FITTINGS - MATERIALS

- A. No-Hub Cast Iron Pipe and Fittings:
  - 1. Pipe and Fittings: Service weight no-hub cast iron pipe and cast iron fittings, per CISPI 301 and ASTM A 888, for use with mechanical no-hub couplings.
  - 2. Couplings: Per CISPI 310 or ASTM C 1277, with a cast iron or stainless shield, and neoprene gasket per ASTM C 564.
- B. Hub and Spigot Cast Iron Pipe and Fittings: Service weight hub and spigot cast iron pipe and cast iron fittings per ASTM A 74, for use with compression gaskets. Gaskets shall conform to ASTM C 564.
- C. Copper DWV Pipe and Fittings: Copper drainage tube per ASTM B 306. Wrought copper and wrought copper alloy solder joint fittings per ASME B 16.29; or cast copper alloy solder joint fittings per ASME B 16.23.
- D. Galvanized Steel DWV Pipe and Fittings: Schedule 40 galvanized steel pipe per ASTM A 53, Grade B, Type 5. Cast iron drainage fittings, threaded, per ASME B 16.12; and cast iron screwed fittings per ASME B 16.4.
- E. Copper Pipe and Fittings: Seamless copper water tube, tube L or M, per ASTM B 88. Solder joint wrought copper and bronze fittings per ASME B 16.22 cast copper alloy fittings per ASME B 16.18, and cast bronze threaded fittings per ASME B 16.15 with 95/5 tin-antimony solder per ASTM B 32.
- F. PVC DWV Pipe and Fittings: Polyvinyl chloride drain pipe, solid wall pipe per ASTM D 1785 and ASTM D 2665 with solvent cement joints. Foam (i.e. cellular) core pipe NOT allowed. Polyvinyl chloride DWV fittings conforming to ASTM D 2665 or ASDTM F 1866, with solvent cement joints. Solvent cement shall comply with ASTM D 2564.
- G. ABS DWV Pipe and Fittings: Acrylonitrile-butadiene-styrene plastic drain pipe, solid wall pipe per ASTM D 2661 with solvent cement joints. Foam (i.e. cellular) core pipe NOT

allowed. Acrylonitrile-butadiene-styrene DWV fittings conforming to ASTM D 2661 or ASTM D 3311. Solvent cement shall comply with ASTM D 2235.

## 2.3 PIPE AND FITTINGS – APPLICATION

### A. Waste and Vent:

1. Piping 2-1/2 Inches and Smaller Located Above Ground: Galvanized steel DWV, no-hub cast iron, copper DWV, PVC DWV, or ABS DWV.
2. Piping 3 Inches and Larger Located Above Ground: No-hub cast iron, bell and spigot cast iron, copper DWV, PVC DWV, or ABS DWV.
3. All Piping Located Below Ground: No-hub cast iron, bell and spigot cast iron, copper DWV, PVC DWV, or ABS DWV.
4. High Temperature: Waste piping serving fixtures that may receive waste greater than 120 degrees F. shall be no-hub cast iron, bell and spigot cast iron, or copper DWV for minimum 40 feet downstream of fixture (i.e. dishwasher, three compartment sink, drains/receptors serving water heater and boiler, and similar items).
5. Piping Exposed to Temperatures Above 130 deg F: Galvanized steel DWV or no-hub cast iron.

### B. Cooling Condensate Drains: See Section 232128.

### C. Miscellaneous Drains: Copper DWV, copper, PVC DWV, or PVC; except that for corrosive fluids (or corrosive fluid venting) applications use the same materials as specified for the acid waste (or vent) systems, or use PVC.

### D. Piping Exposed in Finished Areas: Chrome or nickel plated brass; piping 2 inches and larger may be provided with chrome or nickel plated brass sleeves to conceal pipe and fittings.

### E. Boiler Condensate Drains: See Section 232129.

## 2.4 CLEANOUTS

### A. General:

1. All cleanouts shall have cast iron bodies with bronze countersunk rectangular slotted plugs, lubricated with a non-hardening teflon base thread lubricant and having a gasket seal.
2. Cleanouts located in waterproof membrane floors shall be provided with an integral cast flange and flashing device.
3. All cleanouts shall be the same size as the pipe which they are intended to serve (but not larger than 4-inch).
4. Pipe fittings for cleanouts which turn through walls or up through floors shall use long sweep ells or a "Y" and 1/8 bend.
5. All cleanouts and access covers shall be provided with vandal proof screws.

### B. Floor Cleanouts:

1. Areas with Floor Tile (or Linoleum): J.R. Smith No. 4140 Series adjustable floor cleanout with round heavy duty nickel bronze top with tile recess.
2. Areas with Bare Concrete Floors: J.R. Smith No. 4100 Series adjustable floor cleanout with round heavy duty nickel bronze top.



3. Areas with Terrazzo (and Similar Poured Floors): J.R. Smith No. 4180 Series adjustable floor level cleanout with round heavy duty nickel bronze top with terrazzo recess.
  4. Areas with Carpet: J.R. Smith 4020-X Series adjustable floor level cleanout with round heavy duty nickel bronze top and carpet clamp.
- C. Wall Cleanouts: Cast iron ferrule with cast bronze taper threaded plug, with plug tapped 1/4-inch, 20 thread, to accept access cover screw; with stainless steel access cover and vandal proof screw.
- D. Outside Cleanouts: Heavy duty, round, cast iron, double-flanged housing, having scoriated cast iron cover with lifting device, ferrule and bronze closure plug. Housing and lid shall be galvanized and have vandal resistant screws. J.R. Smith No. 4251 or 4256 Series.

## 2.5 GREASE INTERCEPTOR

- A. Type: Undersink, automatic grease interceptor with fog treatment, and self cleaning mechanisms.
- B. Construction: 16 gauge 304 stainless steel with bright finish.
- C. Capacity and Configuration: As noted on plans.

## 2.6 ACCESSORIES

- A. Vent Flashing:
1. General: Style and type to suit roofing system, match vent pipe size, and provide waterproof building penetration. Provide with adequate base size for proper flashing into roof system.
  2. EPDM or compression molded rubber; suitable for temperatures from -60 deg F to 270 deg F; resistant to ozone and UV light. Flashing shall have aluminum or galvanized steel base for flashing or attachment to roof (style to suit roof type). Provide stainless steel clamp.
  3. 2.5 lb sheet lead, extending as a sleeve all around vent pipe with base extended out minimum 10 inches all around; top counter-flashing overlap 2" and turned down inside vent pipe.

## PART 3 EXECUTION

### 3.1 GENERAL

- A. Installation of all items shall comply with code, best professional practices, manufacturers written installation instructions, and to allow for proper functioning of items being connected to.
- B. Provide all piping as indicated and as required to allow complete and proper waste, drain, and vent connections to each fixture and equipment item requiring connection. Provide offsets as required to accommodate building construction and access requirements per Section 220500. For multistory buildings include costs to offset vertical piping through each floor level since structural member locations will not be the same on each floor.

- C. Coordinate installation of items with all trades that are affected by the work to avoid conflicts.
- D. The work of this section shall include all waste (sanitary sewer), drain, and vent lines inside of the building and 5-feet outside of the building (unless indicated otherwise), to the point of and including connections to outside sanitary sewer lines or sanitary sewer manholes.
- E. Consult manufacturers data and architectural drawings for information on plumbing fixtures before beginning rough-in.
- F. Verify points of connection, invert elevations, and grade requirements before beginning installation or ordering materials.
- G. Stub all piping for all items requiring connections through wall or floor; cap and protect until connection to items is complete.
- H. Vents extending through roof shall terminate at least 10 inches above roofing; and not less than 10 feet from and 3 feet above any building opening. Provide vent flashing at each vent through roof; utilize water-proof method as required to best suit roofing material and roofing system manufacturer.
- I. Trap all fixtures and equipment items as required by governing code; provide proper venting for each trap.
- J. Provide drain piping for all drip pans, unit condensate drains, unit P-traps, etc. Run piping to nearest point of drainage, or as shown on drawings. Where routing is not shown, route to nearest point of proper drainage.
- K. Provide piping connections to equipment furnished by others in accordance with Section 220500.
- L. All excavation, trenching and backfilling shall comply with code and pipe manufacturers recommendations. Below ground plastic pipe installation shall comply with ASTM D 2321 and shall exceed those standards as specified.

### 3.2 PIPE AND FITTINGS

- A. All piping in finished areas shall be installed concealed unless specifically noted otherwise.
- B. Install piping so as not to obstruct access to any items requiring routine service, maintenance, or inspection. Offset or reroute piping as required to clear any interferences which may occur. Prior to running any piping, confirm with Architect/Engineer (unless is clearly noted to be ran exposed). Install exposed piping so as not to obstruct any portion of windows, doors, doorways, passageways, or items requiring service or access.
- C. Consult all drawings for location of pipe spaces, ducts, electrical equipment, structural elements, ceiling heights, door items requiring access, openings, window openings, and other details and report discrepancies or possible conflicts to Architect/Engineer before installing pipe.
- D. Install all horizontal soil or waste lines with a slope of 1/4-inch per foot unless noted otherwise. Coordinate with AHJ if written approval is required for exceptions to 1/4-inch per

foot slope.

- E. Make all changes of direction and junctions with Y fittings and 1/8 bends; use sanitary tee fittings in vertical pipe only.
- F. Provide escutcheons where exposed pipe passes through walls, floors, or ceilings.
- G. Install all piping parallel to the closest wall and in a neat, workmanlike manner. Horizontal straight runs of piping shall not deviate from straight by more than 1/4-inch in ten feet. Vertical piping shall not deviate from plumb by more than 1/8-inch in ten feet.
- H. Do not run any piping above electrical panels (and similar electrical equipment). Provide offsets around such panels as necessary. Such offsets are typically not shown on the plans, but are required per this paragraph.
- I. Prior to the joining of any section of pipe to a pipe run, the section shall be thoroughly cleaned inside and out, the ends shall be reamed to remove any cutting burrs and piping prepared as recommended by piping and fitting manufacturer.
- J. Threaded Connections: Cut piping carefully, ream, thread and work into place without springing. Use TFE tape or lead and graphite lubricant (on male threads only).
- K. Soldered Connections: Polish contact surfaces of fittings and pipes with emery cloth before fluxing male and female surfaces of joints. Steel wool and sandpaper not permitted for polishing.
- L. PVC and ABS Pipe:
  - 1. Solvent Joints: The outside of the PVC pipe shall be chamfered to a minimum of 1/16-inch at approximately 22 degrees. Chemicals used must penetrate the surface of both pipe and fitting which will result in complete fusion at the joint. Use solvent and cement only as recommended by the pipe manufacturer.
  - 2. Plastic to Metal Connections: Work the metal connection first. Use a non-hardening compound on threaded connections. Use only light wrench pressure. Connections between metal and plastic are to be threaded utilizing female threaded adapters only, not male adapters.

### 3.3 INSTALLATION OF CLEANOUTS

- A. General: Install cleanouts in all soil and waste piping:
  - 1. As shown on drawings.
  - 2. At no more than 100 foot intervals on horizontal runs (whether shown on drawings or not).
  - 3. At the end of all piping runs.
  - 4. At the base of all vertical risers.
  - 5. At all changes of direction for a run of 10 feet or over.
  - 6. Where needed to correct possible stoppage.
  - 7. As required by Code.
- B. Elevations:
  - 1. Floor cleanouts shall be installed so as to be flush with the finished floor; where recessed cleanout covers are used the recess shall be filled flush with material to match the surrounding finished floor.

2. Wall cleanouts in finished areas shall all be installed at the same height for a uniform appearance throughout the facility. Heights shall be selected so as not to interfere with base molding or other trim work; verify with other trades.
- C. Clearances and Access: Install cleanouts so as to assure proper clearances as required by governing code. Where cleanouts occur in concealed spaces provide extensions to floors above or to walls to allow access. Provide wall access covers or access doors for all wall cleanouts. See Section 220519 for access doors.
- D. Outside Building: All cleanouts located outside shall be provided with an access housing located in a 24" x 24" x 6" thick concrete pad, flush with (or up to 1/4" above) the adjacent finished grade. The pipe and cleanout shall be independent of this access housing and pad.

### 3.4 GREASE INTERCEPTOR

- A. Install in accordance with manufacturers written installation instructions. Set manholes/access even with grade (or finished floor, as applicable). Provide items with all internal piping and other accessories required for proper operation.
- B. Test for proper flow and no leakage.
- C. Fill with clean water.

### 3.5 TESTING AND INSPECTION

- A. All piping shall be tested, inspected and approved prior to being concealed or covered.
- B. Testing shall be by water or air, and comply with code.
- C. Testing shall be witnessed by the code official, the Owner's representative (at their option), and the Engineer (at their option). Prior to beginning testing confirm with the Owner and Engineer their level of involvement in the testing process and extent of witnessing; where they will be witnessing the testing notify them at least 72 hours in advance of the test and confirm their availability; coordinate and reschedule as necessary and arrange mutually agreed upon times for the tests and witnessing to occur.
- D. Water Testing:
  1. Fill system with water so that there is no less than 10 feet of head above the highest system section being tested.
  2. System shall hold pressure for a period of at least 15 minutes with no leakage before the inspection starts.
  3. The system shall be inspected and shall hold tight with no leakage at all points.
- E. Air Testing:
  1. Pressurize system with air so that there is no less than 5 psig of air pressure in the system.
  2. System shall hold pressure for a period of at least 15 minutes without the introduction of additional air before the inspection starts.
  3. The system shall be inspected and shall hold tight with no leakage at all points.
- F. All leaks shall be eliminated and the system re-tested before proceeding with work or concealing pipe.

- G. All repairs to piping shall be with new material and no caulking of screwed joints or holes is allowed.

END OF SECTION



## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Natural Gas Piping.
- B. Natural Gas Valves.
- C. Natural Gas Regulators.
- D. Natural Gas Accessories.
- E. Coordination with Gas Utility.

### 1.3 SUBMITTALS

- A. General: Comply with Section 220500.
- B. Product Data: Submit manufacturer's product data for all items to be used.

### 1.4 REFERENCES

- A. ANSI/ASCE 25-06: Earthquake Activated Gas Shut-off Devices.
- B. ASME B 6.5: Steel Pipe Flanges and Flanged Fittings.
- C. ASME B16.9: Steel Butt - Welding Fittings.
- D. ASME B16.11: Forged Steel Fittings, Socket Welding and Threaded.
- E. ASTM A53: Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless.
- F. ASTM A105: Carbon Steel Forgings for Piping Applications.
- G. ASTM A234: Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- H. ASTM B88: Seamless Copper Water Tube.
- I. ASTM B280: Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- J. ASTM D2513: Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.

- K. ASTM D3261: Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
- L. ASTM D3350: Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
- M. IFGC: International Fuel Gas Code.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. General: Products shall comply with Section 220500. See Section 220500, Paragraph 2.1 for Acceptable Manufacturer requirements.
- B. Pipe and Fittings: US Steel, Pioneer Pipe, Anvil International, American Piping Products.
- C. Valves: Milwaukee, Flowserve (Nordstrom), Stockham, Conbraco/Apollo, Nibco, Resun, ASCO.
- D. Regulators: Fisher, American Meter, Equimeter, Maxitrol.
- E. Vent Caps: Clay & Bailey, OPW, Morrison, Beckett.

### 2.2 PIPE AND FITTINGS

- A. Pipe: Black steel pipe conforming to ASTM A 53, Grade B, Type E or S. Schedule 40 unless indicated otherwise.
- B. Fittings:
  - 1. 2 Inches and Smaller - Exposed: Black malleable iron threaded type, Class 150 conforming to ASME B 16.3 and ASTM A 234.
  - 2. 2 Inches and Smaller - Concealed: Steel butt weld type, conforming to ASTM A 234, ASME B 16.9; or steel socket weld type, conforming to ASTM A 105 and ASME B 16.11.
  - 3. 2-1/2 Inches and Larger: Steel butt weld type, conforming to ASTM A 234, ASME B 16.9; or steel socket weld type, conforming to ASTM A 105 and ASME B 16.11.
  - 4. Flanges: Steel socket or welding neck type, Class 150, conforming to ASME B 16.5.
- C. Vent Pipe: Same as gas piping; except where routed exposed in mechanical rooms, may be hand drawn or annealed seamless copper conforming to ASTM B 280 or UNS number C12200 copper conforming to ASTM B 88, with wrought copper fittings, bronze fittings, and soldered joints.

### 2.3 VALVES

- A. General: Valves shall be designed for use on natural gas system and suitable for the pressures and temperatures to be encountered. Valves shall be UL listed (or CSA certified) for fuel gas use.
- B. Ball Valves: Bronze body, two piece body, blowout proof stem, full port, reinforced TFE seats, chrome plated brass ball, threaded connections, UL listed for LP gas and natural gas



shut-off, 250 psi non-shock LP or natural gas working pressure. Nibco T-585-70-UL (or approved).

- C. Plug Valves: Lubricated, wrench operated, regular pattern full port type plug valve. Gray iron body and plug per ASTM A 126, Class B. Rated for minimum 175 psi wog. Valves shall have a sealing and lubrication system for maintaining valve seals and operation. Valve shall be factory serviced with manufacturers recommended sealant suitable for the valve application. Valves 2 inch and smaller shall have threaded end connections; larger valves shall have flanged connections. Provide one standard lever type hand wrench for each valve. Resun Figure D-125, D-126 (or approved).
- D. Solenoid Valves: For use on low pressure fuel gas systems, two-way operation, normally closed, brass or die cast aluminum body, stainless steel springs, UL 429 listed, FM approved to Class 7400 "liquid and gas safety valves", and CSA (or UL) certified as an automatic gas safety shutoff valve. Same size as pipe installed. 120 volt or 24 volt AC; coordinate voltage selection with trade providing power and control of valve. ASCO Series 8215 (or approved).
- E. Seismic Valves: Automatic shut-off valve in a seismic event. Valve shall conform to ANSI/ASCE 25-06. Valve shall have visual indicator of open or closed status, and require manual reset. Valve shall be same size (or larger) as line installed in.

## 2.4 ACCESSORIES

- A. Piping Specialties: See Section 220519.
- B. Pressure Regulator: Cast iron body, die cast aluminum alloy diaphragm case, Buna-N diaphragm disc, 125 psi maximum pressure rating with over pressure positive tight lock-up, internal relief valve, and gray polyester paint finish. Regulator shall be sized by manufacturer based on inlet pressure, desired outlet pressure, and flow requirements. Regulators with vent openings located within 20 feet of ventilation air intakes or where the venting of gas would be unsafe shall be equipped (and labeled for use with) a vent limiting device.
- C. Vent Cap: T-style, constructed of aluminum or zinc coated cast iron, 30 mesh stainless steel screen. Morrison No. 155.
- D. Flexible Connectors: See Section 220519. Size flexible connectors to match pipe size shown on plan, with reducer after the flexible connector to match the equipment connection size.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. General: Comply with Section 220500. Install in accordance with manufacturer's written installation instructions, code, applicable standards and best construction practices.
- B. Complete System: Provide all piping as indicated and as required to allow connections to each fixture and equipment item requiring gas connections, and to provide complete and operational gas piping systems.
- C. Coordination: Coordinate installation of items with all trades that are affected by the work to

avoid conflicts. Review all drawings for location of pipe spaces, ducts, electrical equipment, ceiling heights, door openings, window openings, and other details and report discrepancies or possible conflicts to Architect/Engineer before installing pipe.

### 3.2 PIPE AND FITTINGS

#### A. General:

1. All piping in finished areas shall be installed concealed unless specifically noted otherwise.
2. Install piping at such heights and in such a manner so as not to obstruct any portion of windows doorways, passageways, or access to any items requiring routine service, maintenance, or inspection. Offset of reroute piping as required to clear any interferences which may occur.
3. Install all piping parallel to the closest wall and in a neat, workmanlike manner. Horizontal exposed straight runs of piping shall not deviate from straight by more than 1/4-inch in ten feet. Vertical piping shall not deviate from plumb by more than 1/8-inch in ten feet.

#### B. Escutcheons: Provide escutcheons where exposed pipe passes through walls, floors, or ceilings.

#### C. Electrical Items: Do not run any piping above electrical panels (and similar electrical equipment). Provide offsets around such panels as necessary. Such offsets are typically not shown on the plans, and are required per this paragraph.

#### D. Joints: Prior to the joining of any section of pipe to a pipe run, the section shall be thoroughly cleaned inside and out, the ends shall be reamed to remove any cutting burrs and piping prepared as recommended by pipe and fitting manufacturer.

#### E. Threaded Connections: Cut piping carefully, ream, thread and work into place without springing. Use TFE tape or lead and graphite lubricant (on male threads only).

#### F. Soldered and Brazed Connections: Polish contact surfaces of fittings and pipes with emery cloth before fluxing male and female surfaces of joints. Steel wool and sandpaper not permitted for polishing.

#### G. Welding: Shall conform to ASME B31.1 and ASME B31.9. Welders and welding operators shall be qualified as required by ASME B31.1, ASME B31.9, and governing code. Welded joints on piping system shall be continuous, without backing rings, and pipe ends beveled for butt weld connections. Gas cuts shall be square and free from burned material. Before welding, surfaces shall be thoroughly cleaned. Piping shall be carefully aligned, with no weld material projecting inside the pipe.

#### H. Unions: Install unions in pipe connections to valves, coils, and any other equipment where it may be necessary to disconnect the equipment or piping for repairs or maintenance; and as indicated. Where flanged connections occur at equipment additional unions are not required unless indicated otherwise.

#### I. Drip Legs: Provide drip legs in pipe connections to all equipment. Drip legs shall be located downstream of equipment isolation valves, and upstream of unit flexible connectors or unions. Provide adequate clearance for removal of drip leg cap.

- J. Flexible Connectors: Provide flexible connectors in piping at connections to all equipment. Size flexible connectors to match pipe size shown on plan, with reducer after the flexible connector to match the equipment connection size. Provide flexible connectors at crossing of building seismic or expansion joints. Install in a manner to allow for movement in any direction.
- K. Vents: Pipe regulator vent lines and all equipment gas train vents full size to outside of building; terminate with vent cap.
- L. Outdoor Piping - Painting: All aboveground piping outside of building shall be cleaned and prime painted with one coat of a rust-inhibiting paint and a final coat of finish paint (color to match adjacent building color, unless noted otherwise).
- M. Provide drip legs with removable caps upstream of all regulators; provide test tee with capped valve 10 pipe diameter downstream of all regulators.

### 3.3 VALVES AND ACCESSORIES

- A. Type: Ball type; except that valves 4 inches and larger and main line shut-off valves shall be the plug type; and valves indicated to be a specific type shall be the type as indicated.
- B. Applications: Provide isolation valves at piping connections to all equipment, at inlet of all pressure regulators, at inlet of all seismic shut-off valves, downstream of gas meters, at inlet to gas solenoid valves, and where indicated.
- C. Seismic Valve: Provide seismic shut-off valve at building gas meter; locate downstream of meter and downstream of system isolation valve.
- D. Solenoid Valves: Provide solenoid gas shutoff valves where indicated. Locate switches where shown (or, where not shown, at main exit from each room).

### 3.4 TESTING AND INSPECTION

- A. General: All piping shall be tested, inspected, and approved by the AHJ prior to being concealed or covered.
- B. Witnessing: Testing shall be witnessed by the AHJ and the Architect/Engineer (at his option). Notify Architect/Engineer minimum 72 hours prior to date of testing, and mutually agree upon times arranged.
- C. Testing:
  - 1. Piping shall be inspected, purged and pressure tested in accordance with IFGC (except where more restrictive requirements are specified herein, the most restrictive shall prevail).
  - 2. Test pressure shall be not less than 150 percent of the maximum to which the pipe will ordinarily be subjected; but in no case less than 50 psig.
  - 3. Components that may be damaged by the test pressure shall be removed or isolated from the piping system during testing.
  - 4. Portions of the system that are reconnected after system testing that could not be tested (e.g. low pressure equipment connections, separate portions of the system, etc.) shall be specifically tested with a non-corrosive leak detection fluid acceptable to the AHJ.
  - 5. Any leaks or defective piping disclosed by testing and inspection shall be repaired with

new materials and the system re-tested.

- D. Documentation: Provide documentation to the Architect/Engineer indicating that the system has been completely pressure tested, and all portions inspected and accepted by the AHJ.

END OF SECTION

## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Water Heaters.
- B. Flues and Combustion Air.

### 1.3 REFERENCES

- A. Boiler Code: State of Washington Boilers and Unfired Pressure Vessel Laws, Chapter 70.79 RCW, Chapter 296-104 WAC.
- B. NSF 61: Drinking Water System Components – Health Effects.

### 1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's product data for all items to be used.
- B. Manufacturer's Instructions: Submit manufacturer's installation instructions for water heaters.

### 1.5 GENERAL REQUIREMENTS

- A. NSF: Manufacturers shall fabricate and label equipment components that will be in contact with potable water per NSF 61.
- B. Quality Assurance: Provide quality assurance checks specified in Section 220500 prior to ordering products.
- C. Code Compliance: Water heater efficiency and insulation levels shall comply with code. Provide water heater with accessories (i.e. heat traps, relief valves, etc.) as required by code.
- D. Temperature Settings: Water heaters shall be able to be set at a leaving (or system) water temperature over a range. Low setting shall be at least 90 degrees F or 10 degrees F lower than the system water temperature indicated on the plans (whichever is lower). High setting shall be at least 10 degrees higher than the system water temperature indicated on the plans.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Products shall comply with Section 220500, Paragraph 2.1, Acceptable Manufacturers.
- B. Water Heaters – Tank Type: Bradford-White.

## 2.2 WATER HEATERS – GAS FIRED

- A. Type: High efficiency condensing natural gas fired domestic hot water heater, ASME labeled.
- B. Capacity: Shall have capacity and efficiency (minimum 95%) as indicated on the drawings; rated in accordance with recognized standards.
- C. Tank and Insulation: Steel tank, ASME constructed and labeled, rated for 160 psi working pressure, with glass lining applied to all water side surfaces after full tank assembly and welding. Tank shall have at least one handhole cleanout. Tank shall be insulated with foam to comply with local code requirements and no less than ASHRAE 90.1 (latest edition) for insulating rating and tank heat loss. Tank and insulation shall be fully enclosed within a steel enclosure having a baked-on enamel finish with access provided to unit components.
- D. Clearance: Approved for 0-inch clearance to combustibles.
- E. Cathodic Protection: Tank shall be protected from corrosion with powered anodes. System shall be selected by the manufacturer to suit typical water conditions at the general installation location and provide protection for the tank warranty periods.
- F. Electrical and Controls: Water heater(s) shall be equipped with a solid state temperature and ignition control system with integral diagnostics, LED fault display capability and a digital display of temperature settings. Heater(s) shall be provided with an automatic gas shutoff device and safety shutoff if flame is extinguished. Heater shall have controls to allow setting the hot water temperature over a range, and be able to maintain temperature plus or minus 2 degrees F of setpoint.
- G. Burner and Venting: Burner shall be down-fired power draft type, designed for burning natural gas with specified efficiency and capacity requiring no special calibration on start-up. Shall be able to have products of combustion direct vented to the outside using CPVC or ABS pipe. Unit shall allow combustion air from the room or piped with CPVC or ABS pipe to the outside; and be for use with concentric type vents.
- H. Accessories:
  - 1. ASME pressure and temperature relief valve, and tank drain valve.
  - 2. Condensate Neutralizer: Limestone (or manufacturer's recommended material) filled container for neutralizing acidic condensate from water heaters and water heater flues.
- I. Warranty: Tank shall have a 3 year warranty against corrosion and tank failure.
- J. Water Heater Venting:
  - 1. General: Materials shall comply with manufacturer and recommendations and code.
  - 2. Combustion Venting: CPVC with solvent joints.
  - 3. Outdoor Air Venting: CPVC or PVC with solvent joints.
  - 4. Concentric Vent: Water heater manufacturer's concentric vent kit, sized and designed to suit water heater used with; with inner vent pipe, outer combustion air pipe, weather proof cap, and roof jack/flashing to suit roof type used with.

## 2.3 WATER HEATERS – TANK ELECTRIC

- A. Type: Tank type electric water heater, constructed in accordance with ASME code, UL listed, and NSF approved. A.O. Smith DSE series (or approved).
- B. Capacity: Shall have capacity as indicated on the drawings.
- C. Tank and Insulation: Tank shall be of steel construction, constructed and stamped in accordance with ASME code for a minimum working pressure of 125 psi at maximum water heater operating temperature. All internal tank surfaces shall be glass coated; glass coating shall be an alkaline borosilicate composition, fused to tank by firing at a high temperature. Tank shall be insulated with foam to comply with local code requirements and no less than ASHRAE 90.1 (latest edition) for insulating rating and tank heat loss. Tank and insulation shall be fully enclosed within a steel enclosure having a baked on enamel finish and hinged access door to access unit controls and wiring.
- D. Cathodic Protection: Tank shall be cathodically protected with an extruded magnesium rod, full size of unit, selected by manufacture to suit typical water conditions at the installation general location and adequate to last the tank warranty period. Rod shall be removable through top of tank.
- E. Immersion Heaters: Minimum of three elements per immersion heater, incoloy sheathed, flange mounted and with factory wired terminal leads.
- F. Accessories: Water heater shall have brass drain valve with 3/4-inch hose thread male outlet and an ASME rated pressure and temperature relief valve.
- G. Electrical and Controls: Water heater shall be rated for use with electrical power of the voltage and phase as scheduled. Water heater shall have necessary contactors, controls, and safeties to control water heater temperature to within 5 degrees of value set. Contactors shall be magnetic type, rated for minimum 100,000 cycles. Unit shall have element fusing as required by local code and the NEC. Water heater control circuit shall be 120 or 24 volt, and unit shall have an integral control circuit transformer with fusing. Thermostat shall be the immersion type, shall control water heater temperature and be able to be set over a range. Water heater shall have a manual reset high limit to stop water heater operation at a high unsafe temperature. All wiring shall be color coded and labeled for ease of service.
- H. Warranty: Tank shall be warranted to be free from defects for three years.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. General: Comply with Section 220500. In accordance with manufacturer's written installation instructions, code, applicable standards, and best construction practices.
- B. Coordination: Coordinate the work with all trades that may be affected by the work to avoid conflicts and to allow for an organized and efficient installation of all systems.
- C. Connections: Connect and install all items shipped loose with equipment and as needed for proper system operation. Provide and connect all utilities and services to equipment as

required for proper equipment and system operation.

- D. Protection, Operation and Maintenance: Comply with Section 220500. Protect water heaters against use and damage during construction; provide guards and/or boxing as required.
- E. Relief Valves: Pipe all pressure relief valves to proper point of drainage.
- F. Vacuum Breakers: Provide vacuum breakers on water heaters where water heaters serve fixtures located below the water heater height.
- G. Clearances: Provide as required for maintenance or as required by Code; whichever is greater. Water heater sizes exceeding any of the following shall have minimum 18" clearance all around (or as required by Boiler Code for boilers; whichever is greater): 120 gallons, 160 psi, or 200,000 BTU/hr input.
- H. Anchorage: Provide seismic strapping and anchorage of water heater to building structure.
- I. Inspection: Inspect water heaters and connecting systems to confirm water heaters and system are ready for start-up and operation. As a minimum, check for: proper voltage and phase, correct gas pressure and regulator setting (for gas fired units), correct electrical connections, complete control connections, relief valve correctly sized and discharge piped, drain provisions installed, valving to water heater accessible and ready to be set in operating positions, and other items as listed by the manufacturer are properly provided and connected.
- J. Start-Up and Adjustment: Put water heater into service following manufacturer start-up procedures. Adjust water heaters for proper operation; set thermostats for required supply temperature. Check operation of water heater by flowing water and confirming proper operation.

END OF SECTION



## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Plumbing Fixtures and Trim.
- B. Installation/Connection of Equipment Specified Elsewhere.
- C. Adjustment and Cleaning.

### 1.3 DEFINITIONS

- A. "Plumbing Brass" means "P-traps, stops, strainers, tailpieces, flanges, and other brass fittings and accessories NOT including faucets or stops."
- B. "Trim" includes all plumbing brass items, faucets, and any fixture accessories.
- C. "Accessible" refers to the American's with Disabilities Act, and infers that these fixtures will meet Federal and local code requirements.
- D. "Lead-Free" means not containing more than 0.2% lead in solder and flux; and not more than a weighted average of 0.25% lead in wetted surfaces of pipes, pipe and plumbing fittings and fixtures.

### 1.4 REFERENCES

- A. UPC: Uniform Plumbing Code.
- B. NSF/ANSI Standard 61: Drinking Water System Components – Health Effects.

### 1.5 SUBMITTALS

- A. General: All submittals shall comply with Section 220500.
- B. Product Data: Submit product data for all plumbing fixtures, plumbing trim, and water heaters.

### 1.6 GENERAL REQUIREMENTS

- A. Fixture Quality: Provide new fixtures and fittings, approved, free from flaws and blemishes with finished surfaces clear, smooth and bright. Visible parts of fixture brass and accessories, and all items located in accessible cabinet spaces, shall be heavily chrome plated. All stops, P-traps and items exposed to view shall be chrome plated (except where

specifically noted otherwise).

- B. Code Compliance: All products and connections shall be in compliance with code, local Utilities Department standards, and Health Department requirements.
- C. Off-The-Floor Mounted Fixtures - Movement:
  - 1. General: Off-the-floor (i.e. wall) mounted fixtures shall be supported, anchored, and braced in a manner so that the fixture does not move more than the values indicated below with the imposed forces as indicated; nor shall the fixture or associated fittings leak or suffer damage of any kind. Deflection shall be measured at the front most part of the fixture (i.e. the point on the fixture furthest away from the wall containing the fixture supports), with the load imposed at the same location as the measured deflection. Deflection shall not be exceeded in any direction with the force imposed in any direction.
  - 2. Water Closets: 1/16-inch with a 300 pound force.
  - 3. Other Fixtures: 1/16-inch with a 150 pound force.
- D. Spare Parts: Provide two spare stop valves.

## 1.7 QUALITY ASSURANCE

- A. General: Provide quality assurance checks specified in Section 220500 prior to submitting product data. By submitting products for Engineer's review, the Contractor is confirming that such checks have been performed and that the products are suitable for the intended installation and use.
- B. Fixtures:
  - 1. Types: Verify specified fixture types with the Architectural and Plumbing drawings to confirm the requirements are consistent (e.g. fixtures are wall mounted versus floor mounted type, locations of ADA fixtures match, etc.). Where conflicts occur clearly identify the issue on the fixture submittal along with a proposed resolution; or resolve prior to making the submittal by the project RFI process.
  - 2. Space Verification: Prior to ordering any fixtures or making submittals, Contractor shall check the drawings and verify that all fixtures will fit the space available (i.e. fixtures fit any cabinets fixtures are to be installed in; fixtures have adequate access clearances for proper use; etc.).
- C. Lead-Free Requirement: All items in contact with potable water shall be lead free. Fixtures used to dispense potable water for drinking shall meet the requirements of NSF/ANSI 61.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Products shall comply with Section 220500, Paragraph 2.1, Acceptable Manufacturers.
- B. Water Closets: Kohler, American Standard, Eljer, Mansfield.
- C. Vitreous China (other than water closets) and Enameled Cast Iron Fixtures: American Standard, Kohler, Eljer, Mansfield.

- D. Water Closet Seats: Church, Beneke, Olsonite, Kohler, Bemis.
- E. Carriers: Josam, J.R. Smith, Wade, Zurn, Mifab.
- F. Wash Fountains: Bradley, Aquadesign.
- G. Stainless Steel Sinks: Just, Elkay, Franke.
- H. Service Sinks: Fiat, Stern and Williams, Swan, Kohler, Mustee.
- I. Drinking Fountains: Haws, Elkay.
- J. Hydrants and Hose Bibbs: J.R. Smith, Zurn, Josam, Mifab, Woodford.
- K. Floor Drains and Floor Receptors: J.R. Smith, Zurn, Josam, Mifab, Sioux Chief.
- L. Plumbing Brass: American Standard, Brasscraft, Chicago Faucet, Crane, Eljer, Frost, Kohler, Speakman, Symmons, T & S Brass, McGuire, Elkay.
- M. Faucets: Chicago Faucet (no substitutions).
- N. Stops: Brasscraft (no substitution).
- O. Flush Valves: Sloan, Zurn.
- P. Safety Fixtures: Haws, Guardian Equipment, Lawler, Acorn Safety.
- Q. Hot Water Temperature Limiting Valve: Symmons, Watts, Chicago Faucet, Acorn Controls, Leonard, Cash Acme.
- R. Shower Faucets: Chicago Faucet, Symmons (no substitutions).
- S. Shower Enclosures: Aquatic, Comfort Designs.

## 2.2 PLUMBING FIXTURES

- A. General:
  - 1. Plumbing Fixtures are listed below by reference numbers, corresponding to the reference number adjoining these items on the drawings.
  - 2. All vitreous china and enameled cast iron fixtures shall be finished white unless specifically noted otherwise.
  - 3. All stainless steel sinks shall be sound deadened, and shall have faucet ledge (except where noted specifically without ledge).
  - 4. In interests of Owner's Standardization, fixtures of similar type shall be product of one manufacturer; trim of similar type shall be product of one manufacturer.

- B. Water Closets:

- P-1A Water Closet - Wall Hung - ADA:

- Water Closet: Kohler "Kingston", No. K-4325, vitreous china, elongated bowl, wall mounted, siphon jet action bowl with 1-1/2" top spud, and 1.28 gallon flush.

Flush Valve: Sloan "Royal" 111-1.28 chrome-plated low consumption flush valve with vacuum breaker, quiet-action, and screw driver stop.

Seat: Kohler "Lustra", No. K-4670-SC, white plastic elongated seat, open-front and stainless steel self-sustaining check hinge.

ADA: Configure and install for ADA access. Verify with Architectural drawings for mounting heights and off-center stall dimensions. Provide with flush valve so that handle is on wide side of stall.

P-1B Water Closet - Wall Hung:

Same as P-1A fixture, except that fixture shall be mounted for normal use.

C. Urinals:

P-2A Urinal - Wall Hung - ADA:

Urinal: Kohler "Bardon" No. K-4991-ET vitreous china, wall hung, with 3/4" top inlet spud wall hangers, and 0.125 gallon flush, and strainer.

Flush Valve: Sloan "Royal" 186-0.125 chrome plated flush valve, with vacuum breaker, and screw driver stop.

P-2B Urinal - Wall Hung:

Same as P-2A, but mounted for normal use.

D. Lavatories:

P-3A Lavatory - Wall Hung - ADA:

Lavatory: Kohler "Greenwich", No. K-2030, 20-3/4" x 18-1/4", vitreous china lavatory with 4" faucet centers, for use with concealed arm carrier.

Plumbing Brass: Kohler No. K-7129 lavatory drain with perforated grate and 1-1/4" tailpiece; Kohler No. 9000 1-1/4" cast brass "P" trap with cleanout; stops and risers per "Specialties" in this specification section.

Faucet: Chicago Faucet No. 116.706.AB.1 electronic faucet. 4" centers, chrome plated, 1/2 GPM spout outlet.

Cover: TrueBro Model Series 2018 ADA-compliant, high-impact UV-protected vinyl cover, custom factory pre-cut to fit lavatory.

E. Multi-Lavatories:

P-4A Multi-Lav - 2 User - ADA:

Fixture: Bradley "Verge" LVG series, two user lavatory system, ADA accessible, fabricated of bio-based resin, quartz, and minerals, complying with ANSI Z124.3, with heavy duty stainless steel wall support frame, and minimum 20 gauge type 304 stainless steel skirting. Color as selected by Architect.

Faucet: Chicago Faucet No. 116.706.AB.1, electronic faucet, 4" centers, chrome plated, 1/2 GPM spout outlet/aerator. Provide quantity of faucets to match specified quantity of users.

Plumbing Brass: Manufacturers standard lavatory drain with perforated grate and 1-1/4" tailpiece; cast brass "P" trap; stops and risers per "Specialties" in this specification section.

Hot Water Temperature Limiting Valve: See paragraph 2.4 this Section. Provide one for

each faucet.

ADA: Configure and install for ADA access. Verify with Architectural drawings for mounting heights and space available.

F. Sinks:

P-5A Sink:

Sink: Elkay No. LR2219 multi-hole drill, 18 gauge, type 304, stainless steel, 19" front to back x 22" left to right x 7-1/2" deep self-rimming sink with rear faucet ledge.

Plumbing Brass: Elkay stainless steel cup strainer with 1-1/2" tailpiece and 1-1/2" cast brass "P" trap with cleanout; stops and risers per "Specialties" in this specifications section.

Faucet: Chicago Faucet No. 1100-HA8AE35ABCP top mount sink faucet on 8" centers, with No. 1000 handles, ceramic cartridges, No. HA8 swing spout, and 1.5 GPM outlet.

P-5B Sink:

Sink: Elkay No. LRADQ 3319, dual compartment, multi-hole drill, 18 gauge, type 304, stainless steel, 19-1/2" front to back x 33" left to right x 6-1/2" deep self-rimming sink with rear faucet ledge.

Plumbing Brass: Elkay stainless steel cup strainers with 1-1/2" tailpieces and 1-1/2" cast brass "P" trap with cleanout; stops and risers per "Specialties" in this specifications section.

Faucet: Chicago Faucet No. 1100-HA8XKABCP top mount sink faucet on 8" centers, with No. 1000 handles, ceramic cartridges, No. HA8 swing spout, and 1.5 GPM outlet.

P-5C Sink - Art:

Sink: Elkay No. LR2219 multi-hole drill, 18 gauge, type 304, stainless steel, 19" front to back x 22" left to right x 7-1/2" deep self-rimming sink with rear faucet ledge.

Plumbing Brass: Elkay stainless steel cup strainer with 1-1/2" tailpiece and 1-1/2" cast brass "P" trap with cleanout; stops and risers per "Specialties" in this specifications section.

Faucet: Chicago Faucet No. 1100-HA8AE35ABCP top mount sink faucet on 8" centers, with No. 1000 handles, ceramic cartridges, No. HA8 swing spout, and 1.5 GPM outlet.

Plaster Trap: J.R. Smith No. 8710 interceptor, galvanized steel or cast iron body with heavy duty, high quality white enamel finish inside and out, gasketed aluminum cover and removable stainless steel sediment bucket.

G. Service Sinks:

P-6A Service Sink - Floor Mount:

Sink: Swan No. MS-2424 molded fiberglass sink basin, 24" x 24" x 10" high, color white, with minimum 30" long heavy duty reinforced 5/8" diameter flexible hose for connection to 3/4" hose thread, spring loaded stainless steel hose bracket, vinyl rim guards.

Plumbing Brass: Combination dome strainer and lint bucket of minimum 16 gauge 302 stainless steel, with stainless steel screws and 3" drain connection.

Faucet: Chicago Faucet No. 897XP-CCP combination service sink fitting with 3/4" hose thread on spout, No. 369 handles, wall brace, pail hook, No. R-1/2" flanged female adjustable arms, integral stops, ceramic cartridges, polished chrome-plated.

H. Water Dispensers:

P-7A Refrigerator Box:

Guy Gray Model BIM875 stainless steel rough-in box with angle valve (1/2-inch inlet, 1/4-inch compression outlet).

I. Drinking Fountains/Bottle Fillers:

P-8A Drinking Fountain and Bottle Filling - ADA:

Elkay Model No. EZWS-EDFP217K bottle filling station and drinking fountain, wall mount, stainless steel type 304 14 gauge construction, with #4 satin finish, front push button operation, one-piece chrome-plated anti-squirt bubbler, anti-splash ridge, cabinet located, waste strainer, and 1-1/4" O.D. tailpiece. Shall have no-touch sensor activated operation and LED interface display, 120 volt/1 phase.

J. Hydrants and Hose Bibbs:

P-10A Wall Hydrant - Non-Freeze:

J.R. Smith No. 5519 recessed box type wall hydrant, non-freeze type, with polished bronze box and bronze hinged cover, bronze hydrant and casing, integral vacuum breaker, "T" handle key and 3/4" inlet, 3/4" hose outlet, and overall depth to suit wall thickness and provide suitable freeze protection.

K. Floor Drains:

P-11A Floor Drain:

J.R. Smith No. 2010-A cast iron body floor drain, with nickel bronze adjustable strainer head, round nickel bronze grate, vandal proof screws, reversible flashing collar, and trap primer connection. Size drain outlet to match pipe size shown on drawings.

P-11B Funnel Floor Drain:

Same as P-11A but with 6" diameter nickel bronze top funnel (No. 3581). Cut out strainer inside of funnel to prevent splashing.

P-11C Floor Receptor:

J.R. Smith Figure 3100 series, enamel coated floor receptor, 10" deep, with 12" square nickel bronze half grate and rim, sediment bucket, trap primer connection, vandal-proof screws. Size outlet to match pipe size noted on drawings. Where used at dishwasher, provide with 1/2 grate. Where serving equipment cut openings in grate to accept discharge.

L. Washer Fittings:

P-12A Washer/Dryer Fitting:

Guy Gray Model No. BB 200TS, 18 gauge steel cover and box, top supply, 1/2" connections, hot water and cold water valves having 3/4" hose bibb outlets, 2" drain pipe outlet with washer and locknut, and overflow lip. Caulk inside seam and screw holes to 1/2 inch above flood rim of overflow lip.

M. Safety Fixtures:

P-13A Emergency Eyewash:

Haws Model 7656WCSM surface-mounted cabinet, ADA, eye/face wash, stainless steel cabinet, drain pan, and signage. Complying with code and ANSI Z358.1

Eye/Face Wash: Two eye/face spray heads, 1/2-inch brass ball valve, inline strainer, and adjustable flow control (each head). Activated by pulling down eye/face wash compartment.

Mixing Valve: Bronze body thermostatic mixing valve. All components in contact with water shall be corrosion resistant. Valve shall be rated for 125 psig, and be furnished with inlet check valves. Valve shall be for use with hot water from 110 deg F to 180 deg F, and cold water from 35 deg F to 60 deg F. Valve shall maintain supply setpoint plus/minus 5 deg. F, with up to 30 deg. F changes in entering water temperatures and up to a 50% drop in supply pressures. Shall be set for 80 deg. F. Shall be fail-safe operation to prevent scalding. Unit shall be sized and selected by emergency fixture manufacturer to provide adequate flow as required by fixture(s) served. Provide with isolation valves on supply piping to mixing valve.

P-13B Emergency Eyewash - ADA:

Haws No. 7260BT-7270BT wall mounted eye/face wash with inverted laminar flow, anti-microbial treated eyewash head, and dust cover; polished chrome plated brass single action pull-down valve body, with universal emergency sign.

Mixing Valve: Bronze body thermostatic mixing valve. All components in contact with water shall be corrosion resistant. Valve shall be rated for 125 psig, and be furnished with inlet check valves. Valve shall be for use with hot water from 110 deg F to 180 deg F, and cold water from 35 deg F to 60 deg F. Valve shall maintain supply setpoint plus/minus 5 deg. F, with up to 30 deg. F changes in entering water temperatures and up to a 50% drop in supply pressures. Shall be set for 80 deg. F. Shall be fail-safe operation to prevent scalding. Unit shall be sized and selected by emergency fixture manufacturer to provide adequate flow as required by fixture(s) served. Provide with isolation valves on supply piping to mixing valve.

## 2.3 OFF-THE-FLOOR FIXTURE SUPPORTS (CARRIERS)

- A. General: Type to suit fixture and building construction, with added anchors, bracing, wall backing and accessories to comply with maximum specified fixture movement. Concealed in wall. Provide with all hardware and accessories for proper fixture support to suit the application. See Section 220529 for hangers and supports.
- B. Water Closets: Cast iron or steel construction, adjustable to support fixture, with positive sealing gasket fabricated of closed cell neoprene. Provide with rear anchoring lug on single units. J.R. Smith 100, 200 and 300 series with added anchors and accessories to comply with maximum specified fixture movement.
- C. Urinals: Steel construction, with high strength steel uprights welded to 4-inch square steel base plates for floor anchoring, top and bottom fixture support and bearing plates, adjustable. J.R. Smith Figure 635 and 637 with added anchors, bracing, wall backing and accessories to comply with maximum specified fixture movement.
- D. Lavatories: Steel construction, with 1-inch x 3-inch rectangular steel uprights welded to 4-inch square steel base plates for floor anchoring, and arms for lavatory support. J.R. Smith Figure 700 and 710 with added anchors, bracing, wall backing and accessories to comply with maximum specified fixture movement.
- E. Other Fixtures: Manufacturers' standard carrier to suite fixture and application, steel construction with anchors, bracing, wall backing and accessories to comply with maximum

specified fixture movement.

- F. Non-Standard Fixtures: For fixtures that standard carriers are not manufactured for provide 3/16" thick steel back plate for block walls and wood stud walls; or a 2" x 2" x 1/4" angle welded to at least four studs for metal stud walls, with through bolts and fasteners to support fixture and comply with maximum specified fixture movement.

## 2.4 SPECIALTIES

- A. General: Unless indicated otherwise, the following fittings and materials (i.e. specialties) shall be used.
- B. Fixture Traps: 17 gage seamless chrome plated cast brass tubing, with 2 inch minimum seal, and cleanout, size as required by Uniform Plumbing Code (unless a larger size is indicated), and configured to suit the application.
- C. Exposed Piping and Fittings: In finished areas and in accessible cabinets, provide piping with chrome plating or sleeved with chromed sleeves or of stainless steel construction/finish; all chrome to have a bright polished finish. No exposed copper allowed (includes accessible cabinet areas).
- D. Stops: Quarter turn ball valve with loose key, size as required.
- E. Risers: Flexible braided steel type; rated for 125 psig.
- F. Escutcheons: See Section 220519.
- G. Wall Box: 20 gauge hot dipped galvanized steel box with 18 gauge face plate, 1/2" inlet x 1/4" outlet compression angle valve. Guy Gray Model BIM875.
- H. Hot Water Temperature Limiting Valve: Thermostatic water temperature mixing valve with integral checks, complying with ASSE 1070 and UPC Chapter 4. Brass body with brass and stainless steel internal components. Leonard "ECO-Mix" 270 / Symmons "Maxline" Model 5-210.
- I. Sealant: See Section 220530. Sealant at fixtures shall be the silicone type, color to match fixture.

## 2.5 FOOD SERVICE ITEMS AND EQUIPMENT SPECIFIED ELSEWHERE

- A. Food Service Equipment: Refer to the kitchen equipment schedule, kitchen (or food service) equipment specifications, and kitchen (or food service) drawings. Under this Section of the specifications provide all plumbing services (HW, CW, drain lines, etc.), provide all plumbing fixtures, and install/furnish those items indicated to be Mechanical (M), Plumbing (P), or by Divisions 22, 22, or 23.

## PART 3 EXECUTION

### 3.1 INSTALLATION OF FIXTURES

- A. General: All fixtures shall be completely connected to piping as needed to make a complete



and operable installation.

- B. **Fixture Locations:** Mounting heights and locations of fixtures shall be as shown on the Architectural drawings and in accordance with Contract Document requirements. Locations shall be verified and coordinated with the various trades affected by the installation of these fixtures. When none indicated or shown, obtain mounting location and heights from the Architect/Engineer prior to installation. Floor drains shall be installed in proper locations and coordinated with floor slopes so that drains are set at low points to allow for floor drainage. Floor receptors (or floor sinks) shall be set flush with floors to allow drains to serve as both indirect drain receptors and as floor drains (unless noted otherwise or required to be elevated by code).
- C. **Rough-In:** Determine rough-in location of fixture utilities to suit fixture location, fixture dimensions, elements of construction (i.e. beams, studs, electrical, ducts, etc.), access requirements, casework dimensions, items which may drain/connect to fixture, use of fixture, and related considerations. The fixture rough-in locations indicated on the plans is schematic, and is not to be used for final rough-in purposes. Coordinate fixture locations with other systems so that either conflicting items are relocated or fixture locations are adjusted to suit.
- D. **Offsets:** Provide offsets in piping to fixtures to accommodate building systems. Such offsets shall include off-setting waste piping into cabinet bases (in kick space where possible) to accommodate beams located directly below walls behind fixtures.
- E. **Carriers:** All off-the-floor (i.e. wall) mounted fixtures shall be installed with supporting carriers and additional anchors, bracing and supports to transmit fixture loads to the floor and building structure without exceeding the maximum specified fixture movement. Prior to concealing carrier and associated supports review adequacy of support system with Architect/Engineer.
- F. **Fixture Sealant:** Where fixtures abut to walls, floors, and cabinets seal all joints with a uniform fillet bead of sealant. Provide at other locations as recommended by fixture manufacturer.
- G. **Protection:** Protect fixtures against use and damage until project substantial completion; provide guards and/or boxing to protect.

### 3.2 INSTALLATION OF SPECIALTIES

- A. **Escutcheons:** Provide escutcheons at each point where an exposed pipe or other fitting passes through walls, floors, backs of cabinets, or ceilings.
- B. **Stops:** Provide stops in water connections to all fixtures/equipment, except where a stop valve is integral to the fixture (e.g. flush valves) and in water connections to all items not served by another valve.
- C. **Hot Water Temperature Limiting Valve:** Install on all lavatories, bathtubs, showers, whirlpools, bidets and as fixtures required by Code (reference UPC Chapter 4); set for 115 deg F maximum delivery temperature. Test and adjust for proper operation and submit written report documenting work performed.

### 3.3 INSTALLATION OF EQUIPMENT SPECIFIED ELSEWHERE

- A. General: Refer to the drawing schedules, architectural specifications and related information in the Contract Documents. Under this section of the specifications provide and install and/or connect all plumbing services indicated to be by Mechanical (M), Plumbing (P), or by Divisions 22 or 23.
- B. Installation: Comply with installation requirements for fixtures and specialties per this specification Section.
- C. Complete Connections: Provide all water supply stops and appurtenances necessary to make a complete installation of items. All lines between the stops and fixtures/equipment shall be hard piped, chrome plated and sized as indicated (or, where not sized, size per the UPC or manufacturer).
- D. Exposed: All waste, drain, indirect drain, and traps exposed to view shall be chrome plated or sleeved with chromed sleeves.

#### 3.4 ADJUSTMENT AND CLEANING

- A. Cleaning: After completion of installation remove all labels and thoroughly clean all fixtures, trim and fittings.
- B. Adjustment: Adjust all flush valves, fixture stops, faucets, valves, and associated plumbing items as necessary for the proper operation of all fixtures and equipment.

#### 3.5 COMMISSIONING

- A. The Products referenced in this section are to be commissioned per Section 220800 Commissioning. The Contractor has specific responsibilities for scheduling, coordination, startup, test, development, testing and documentation. At a minimum, the Contractor shall provide a documented and signed record to verify that all equipment and systems installed under this contract have been inspected and functionally tested to verify full compliance with the contract specifications. In many cases, this shall require the Contractor to create or otherwise provide procedures and checklists for approval by the Commissioning Consultant prior to the start of functional testing. Reference Section 01810 and coordinate all commissioning activities with the Commissioning Consultant.

END OF SECTION

**DIVISION 23**  
**HEATING, VENTILATING, AND**  
**AIR CONDITIONING (HVAC)**



## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Building Outdoor Air Flush Out.
- B. Documentation.

## PART 2 PRODUCTS

NOT USED

## PART 3 EXECUTION

### 3.1 GENERAL

- A. Coordinate with the overall project schedule to insure that the initial building flush out occurs prior to substantial completion.
- B. Air quality assurance flush-out periods shall appear as milestones on Contractor's CPM schedule.
- C. Notify Owner at least 14 days in advance of proposed flush-out periods.
- D. Adjust all outdoor air dampers, return air dampers, exhaust air dampers, fans, controls, system components, and building features (doors, door openers, windows, vents, etc.) so as to allow the use of 100% outdoor air without causing harmful pressure gradients, damage due to low or high temperatures, damage due to rate of change of temperature/pressures, or other similar problems in the building. If the outdoor air temperature is such that freezing of coils or other items is possible, adjust the outdoor air dampers to increase temperatures to prevent such problems. Coordinate such concerns and revisions with the Architect/Engineer. Heating and cooling systems shall be operable during flushout periods.

### 3.2 FLUSH OUT PERIODS

- A. Initial Building Flush Out: Prior to any furniture being placed in the building, but after completion of all interior construction finishes (trim, carpeting, painting, etc.) operate the building's HVAC systems on 100% outdoor air for a period of 7 days to completely flush the building's air. Systems shall operate 24 hours/day, with thermostats set to maintain space temperatures between 60 and 80 degrees F. Promptly change out all system filters after this flush out period, and reset all adjusted items for normal operation.

- B. Final Building Flush Out: After all furniture has been installed (unpacked and located), operate the building's HVAC systems on 100% outdoor air for an additional period of 7 days. Systems shall operate 16 hours/day (evening to morning hours), with thermostats set to maintain space temperatures between 60 and 80 degrees F. Adjust system for normal, specified operation for 8 hours (normal, daytime, occupied hours). Promptly change out all system filters after this flush out period, and reset all adjusted items for normal operation.

### 3.3 DOCUMENTATION

- A. Provide written records documenting the dates and times when the flush out periods occurred, equipment that was operated, any significant system adjustments made to allow the flush out, general weather conditions and indoor conditions observed during the flush out periods. Provide a signed copy (by the individual responsible for overseeing the Project with the General Contractor) of such documentation to the Architect/Engineer, Owner, and a copy in the O&M Manual.

### 3.4 COMMISSIONING

- A. The Products referenced in this section are to be commissioned per Division 01 and Section 230800. The Contractor has specific responsibilities for scheduling, coordination, startup, test, development, testing and documentation. At a minimum, the Contractor shall provide a documented and signed record to verify that all equipment and systems installed under this contract have been inspected and functionally tested to verify full compliance with the contract specifications. In many cases, this shall require the Contractor to create or otherwise provide procedures and checklists for approval by the Commissioning Consultant prior to the start of functional testing.

END OF SECTION

## PART 1 GENERAL

### 1.1 SUMMARY

- A. The purpose of this section is to describe the commissioning process specific for those sections found in Division 23 and 25.

### 1.2 ADMINISTRATIVE REQUIREMENTS

- A. GENERAL RESPONSIBILITIES: The Contractor's commissioning responsibilities applicable to the mechanical contractor are as follows:

- 1. In each purchase order or subcontract written, include requirements for submittal data, commissioning documentation, O&M data and training.
- 2. Attend a commissioning kick-off meeting and other meetings necessary to facilitate the Commissioning process.
- 3. Contractors shall assist in clarifying the installation, operation, maintenance, and control of commissioned equipment if requested by the Commissioning Authority.

- B. COORDINATION

- 1. Refer to Section 01 91 00 for a listing of all sections where commissioning requirements are found, for systems to be commissioned and for Pre-verification testing requirements.
- 2. Assist and cooperate with the Controls and TAB contractor and Commissioning Authority by:
  - a. Putting all HVAC components and systems into operation and continuing the operation during each working day of TAB and commissioning, as required.
  - b. Including cost of sheaves and belts that may be required by TAB.
  - c. Providing temperature and pressure taps according to the Construction Documents for TAB and commissioning testing.
  - d. Install a P/T plug at each water sensor that is an input point to the control system.
  - e. List and clearly identify on the as-built drawings the locations of all instrumentation.
- 2. Provide to the Commissioning Authority a written sequence of operation for packaged controlled components demonstrating compliance with the sequence of operation found in Division 23 and 25. (Equipment manufacturers' stock sequences may be included but will generally require additional narrative).
- 3. TAB Contractor. The duties of the TAB contractor, in addition to those listed in (A) are:
  - a. Prior to starting TAB, submit to the Contractor the qualifications of the site technician for the project, including the name of the contractors and facility managers of recent projects the technician on which was lead. The Commissioning Authority will approve the site technician's qualifications for this project.
  - b. Provide formal progress reports and deficiency reports weekly to the Commissioning Authority.

- c. Communicate in writing to the controls contractor all set-point and parameter changes made or problems and discrepancies identified during TAB that affect the control system setup and operation.
- d. Provide a draft TAB report within two weeks of completion. A copy will be provided to the Commissioning Authority. The report will contain a full explanation of the methodology, assumptions and the results in a clear format with designations of all uncommon abbreviations and column headings.
  - 1) Provide a list of all components and systems that perform out of specified parameters.
  - 2) Provide the Commissioning Authority with any requested data, gathered, but not shown on the draft reports.
- e. Provide a final TAB report for the Owner's Representative and Commissioning Authority with details, as in the draft.
- f. Participate with the Commissioning Authority in checking performance on the original TAB.

### 1.3 SUBMITTALS

- A. General Submittals: Contractor shall provide to the Commissioning Authority, through established channels, normal cut sheets and shop drawing submittals, and detailed manufacturer's installation and start-up checklists, for all commissioned equipment.
  1. Provide additional documentation to the Commissioning Authority.
    - a. Detailed operating, troubleshooting and maintenance procedures, fan and pump curves, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified.
    - b. The installation, start-up and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians to the Commissioning Authority.
  2. The Commissioning Authority may request further documentation necessary for the commissioning process. This data request may be made prior to normal submittals.
  3. Provide assistance to the CA in preparation of the specific functional performance test procedures specified in Section 019100. Subcontractors shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
- B. Mechanical Contractor Submittals: Prepare a preliminary schedule for pipe and duct system testing, flushing and cleaning, component start-up and completion for use by the Contractor in developing the startup plan. Update the schedule as appropriate.
- C. TAB Contractor: Submit the outline of the TAB plan and approach for each system and component to the Owner's Representative, Commissioning Authority, and the Controls contractor six weeks prior to starting the TAB. This plan will be developed after the TAB has some familiarity with the control system.
  1. The submitted plan will include:
    - a. Certification that the TAB contractor has reviewed the construction documents and the systems with the design engineers and contractors to sufficiently understand the design intent for each system.



- b. An explanation of the intended use of the DDC. The controls contractor will comment on feasibility of the plan.
- c. All field checkout sheets and logs to be used that list each component to be tested, adjusted and balanced with the data cells to be gathered for each.
- d. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
- e. Final test report forms to be used.
- f. Detailed step-by-step procedures for TAB work for each system and issue: terminal flow calibration (for each terminal type), diffuser proportioning, branch / sub-main proportioning, total flow calculations, rechecking, diversity issues, expected problems and solutions, etc. Criteria for using air flow straighteners or relocating flow stations and sensors will be discussed. Provide the analogous explanations for the waterside.
- g. List of all airflow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
- h. Details of how *total* flow will be determined (Air: sum of terminal flows via DDC calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations. Water: pump curves, circuit setter, flow station, ultrasonic, etc.).
- i. The identification and types of measurement instruments to be used and their most recent calibration date.
- j. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and provide methods to verify this.
- k. Confirmation that TAB understands the outside air ventilation criteria under all conditions.
- l. Details of whether and how minimum outside air cfm will be verified and set, and for what level (total building, zone, etc.).
- m. Details of how building static and exhaust fan / relief damper capacity will be checked.
- n. Proposed selection points for sound measurements and sound measurement methods.
- o. Details of methods for making any specified coil or other system plant capacity measurements.
- p. Details of any TAB work to be done in phases (by floor, etc.), or of areas to be built out later.
- q. Details regarding specified deferred or seasonal TAB work.
- r. Details of any specified false loading of systems to complete TAB work.
- s. Details of all exhaust fan balancing and capacity verifications, including any required room pressure differentials.
- t. Details of any required interstitial cavity differential pressure measurements and calculations.

## PART 2 PRODUCTS

Not Used

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Installation Checklists: The Contractor shall complete the checklist(s) provided with the Facility Grid app.
1. The completion of these checklists does not limit the Contractor's responsibilities for quality control and scheduling as indicated elsewhere in the documents, nor does this checklist include all submittal, inspection, or quality assurance requirements for the work of this Section.
  2. Complete the installation checklists for each component and each system to be commissioned with the Facility Grid app and updated at a minimum of once per week.
    - a. The field technician or installer should complete the updates that will be logged by Facility Grid.
    - b. The installer should be aware of the importance of proper installation and that verification of the installation of components will be on going through out construction by the Commissioning Authority.
    - c. The checklists are available for review by the Construction team and Commissioning Authority at any time by logging in to Facility Grid.

### 3.2 Start Up Activities

- A. General Requirements: Develop a project start-up plan using manufacturer's start-up procedures and the installation checklists for all commissioned components. Submit to Commissioning Authority for review and approval 14 days prior to startup. Refer to Division 01 91 00 for further details on the start-up plan.
1. Notify the Owner's Representative and Commissioning Authority, when pipe and duct system testing, flushing, cleaning, startup of each component and TAB will occur. Be responsible to notify the Owner's Representative and Commissioning Authority, ahead of time, when commissioning activities not yet performed or not yet scheduled will delay construction.
- B. Mechanical Contractor: Provide startup for all HVAC components, except for the building automation control system.
1. The HVAC mechanical and controls contractors shall follow the start-up plan. Division 23 and 25 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the Commissioning Authority or Owner.
  2. During the startup and initial checkout process, execute the mechanical-related portions of the installation checklists for all commissioned components.
  3. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the Architect and Commissioning Authority.
  4. Provide skilled technicians to execute starting of components. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem solving.
- C. TAB Contractor: Coordinate with the mechanical and controls contractors for components and systems that have completed startup.

3.3 Pre-Verification Testing (PVT): The Contractor will perform the Pre-verification tests as provided with the Facility Grid app. The PVT's will be done on all equipment and systems outlined in Division 01 91 00. When all pre-verification testing has been completed, the CA will schedule Functional Performance testing and substantial completion may be issued.

### 3.4 CLOSEOUT ACTIVITIES

- A. Functional Performance Testing (FPT): The CA shall verify that the PVT's were done and complete by running the FPT's in the Facility Grid app.
- B. Functional Performance testing is intended to begin upon completion of a system and after Pre-verification testing, is complete. Functional Performance testing may proceed prior to the completion of systems or sub-systems at the discretion of the Owner's Representative and Commissioning Authority. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all construction checklists and Pre-verification tests as soon as possible.
- C. Mechanical Contractor: Provide skilled technicians to assist with functional performance testing under the direction of the Contractor for specified components in Division 01 91 00.
- D. TAB Contractor: The CA may verify the accuracy of the TAB work prior to commencing Functional Performance testing activities that may be adversely affected by improper balancing.
  - 1. Test, Adjust, and Balance (TAB) Reports: After TAB activities are completed; submit report to the Commissioning Authority and the Architect's consultant.
    - a. Identify the following:
      - 1) Systems or subsystems for which final balancing is complete.
      - 2) Status of deficiencies and balancing issues encountered, including corrective actions taken.
      - 3) Plan & Schedule for completion of unfinished work.
- B. Operation and Maintenance Manuals: The approved complete manuals must be on site prior to training.
  - 1. Requirements for Operations and Maintenance Manuals is found in Division 1.
  - 2. TAB Contractor: The TAB will compile and submit the following with other documentation that may be specified elsewhere in the Specifications.
  - 3. Final report containing an explanation of the methodology, assumptions, test conditions and the results in a clear format with designations of all uncommon abbreviations and column headings.
  - 4. The TAB shall mark on the drawings where all traverse and other critical measurements were taken and cross reference the location in the TAB report.
- C. Training: The Owner personnel shall be trained on procedures related to the list in 1.1A above.
  - 1. Requirements for Training are listed in Division 1.
  - 2. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
  - 3. Mechanical Contractor. The mechanical contractor shall have the following training responsibilities:
    - a. Provide the Owner's Representative and Commissioning Authority with a training plan and training checklists two weeks before the planned training for approval.

- b. Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of all HVAC components.
- c. The appropriate trade or manufacturer's representative shall provide the instructions on each major component. This person may be the start-up technician for the component, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific component is required. More than one party may be required to execute the training. Training cannot coincide with startup or other contract requirements.
- d. The mechanical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not *controlled* by the central control system.
- 4. Duration of Training: The appropriate contractor shall provide training on each component as required in this Division and the main specifications in Division 1.

D. TAB Contractor: The TAB contractor shall have the following training responsibilities:

- a. TAB shall meet with Owner's personnel after completion of TAB and instruct them on the following:
  - 1) Go over the final TAB report, explaining the layout and meanings of each data type.
  - 2) Discuss any outstanding deficient items in control, ducting or design that may affect the proper delivery of air or water.
  - 3) Identify and discuss any terminal units, duct runs, diffusers, coils, fans and pumps that are close to or are not meeting their design capacity.
  - 4) Discuss any temporary settings and steps to finalize them for any areas that are not finished.
  - 5) Other salient information that may be useful for facility operations, relative to TAB.

### 3.3 DOCUMENTS REQUIRED

A. The General Contractor will provide the following documentation before Final Acceptance:

- 1. Completed Inspection Forms with approval signatures of all Authority Having Jurisdiction.
- 2. Approval Signature of Engineer of Record
- 3. Training Attendance Sheets with Agenda

END OF SECTION

## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Thermowells.
- B. Control Tubing.
- C. Control Damper Installation.
- D. Control Valve Installation.

### 1.3 SUBMITTALS

- A. General: Comply with Section 220500.
- B. Product Data: Submit product data for all items to be used.

### 1.4 GENERAL REQUIREMENTS

- A. General: The control system is specified in Division 25. The Division 23 contractor is required to coordinate the work with the control systems work to allow installation of items required for the HVAC control system, and to install the control items indicated.
- B. Control Dampers: Furnished under Division 25 and installed under this specification section.
- C. HVAC Control Valves: Furnished under Division 25 and installed under this specification section.

### 1.5 REFERENCES

- A. ASTM B88: Standard Specification for Seamless Copper Water Tube.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Products shall comply with Section 220500, Paragraph 2.1, Acceptable Manufacturers.
- B. Thermowells: Trerice, Ashcroft, IPS, RTD, Texas Thermowell, Thermometrics.

### 2.2 THERMOWELLS

- A. Series 300 stainless steel or brass construction, with 2 inch lagging neck and extension type well. Diameter and insertion length to suit application.

## 2.3 TUBING

- A. Soft Copper tubing, per ASTM B 88; with soldered or flared/screwed type fittings.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. General: Install items in accordance with manufacturer's instructions and control system requirements. Coordinate all work requirements with Division 25.
- B. Thermowells: Provide all HVAC system piping thermowells required for Division 23 work and by the control system. Install thermowells in accessible locations, to allow for visual observation of control devices, and to allow for proper control system operation.
- C. Tubing: Provide all control tubing necessary to properly connect all control devices (e.g. differential pressure sensors, gauges, etc.).
- D. Control Dampers: Install all control dampers furnished by Division 25 and as necessary for proper functioning HVAC systems. Verify damper sizes, locations, orientation, accessibility, and other installation requirements.
- E. Control Valves: Install all control valves furnished by Division 25 and as necessary for proper functioning HVAC systems. Verify valve sizes, locations, porting arrangements, and other installation requirements. Provide unions at connections to valves (except not required on flanged valves).

END OF SECTION

## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Hot Water Heating Piping.
- B. Chilled Water Piping.
- C. Valves.
- D. Balancing Valves.
- E. Combination Valves.
- F. Coil Connection Kits.
- G. Expansion Tanks.
- H. Air Separator.
- I. Chemical Addition Tank.
- J. Air Vents.
- K. Flow Measuring Devices.
- L. Unit Heaters.
- M. Flushing and Initial Testing.
- N. Chemical Cleaning, Treatment and Final Testing.

### 1.3 SUBMITTALS

- A. General: Comply with Section 220500.
- B. Product Data: Submit product information data for all items.
- C. Shop Drawings: Submit shop drawings of underground piping system.
- D. System Flushing, Cleaning and Testing: Submit documentation of work performed.
- E. Water Treatment:

1. Submit name and qualifications of Water Treatment Specialist and chemical product data.
  2. MSDS sheets for all chemicals.
  3. Submit Water Treatment Specialist report.
- F. Operation and Maintenance: Submit operation and maintenance data, submittal data, and Water Treatment Specialist report for inclusion in project O&M Manuals.

#### 1.4 QUALITY ASSURANCE

- A. Water Treatment Specialists (WTS): Shall be a company regularly engaging in this work, having local representation and staff with at least 5 years experience, separate and independent from the system installers. WTS shall have staff trained and experienced in hydronic system chemistry and water treatment. WTS shall have water treatment research and laboratory services available for analyzing hydronic water systems and prescribing proven treatment systems.

#### 1.5 REFERENCES

- A. ASME B16.3: Malleable Iron Threaded Fittings.
- B. ASME B16.15: Cast Bronze Threaded Fittings: Classes 125 and 250.
- C. ASME B16.18: Cast Copper Alloy Solder Joint Pressure Fittings.
- D. ASME B18.22: Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- E. ASME B18.24: Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 400, 600, 900, 1500, and 2500.
- F. ASTM A 53: Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless.
- G. ASTM A 530: General Requirements for Specialized Carbon and Alloy Steel Pipe.
- H. ASTM B 16.18: Seamless Copper Water Tube.
- I. ASTM B 32: Solder Metal.
- J. ASTM E 84: Standard Test Method for Surface Burning Characteristics of Building Materials.
- K. AWS A5.8: Filler Metals for Brazing and Braze Welding.

### PART 2 PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Products shall comply with Section 220500, Paragraph 2.1, Acceptable Manufacturers.
- B. Pipe and Fittings: US Steel, Anvil International, Wheatland Tube, Weldbend, Exltube, Elkhart, CTS, Mueller, Cerro, Cambridge-Lee.



- C. Valves: Milwaukee, Nibco, Watts, Conbraco/Apollo, Stockham, Kitz, Red-White.
- D. Balancing Valves: Bell & Gossett, Armstrong, Taco, Nibco, Red-White.
- E. Combination Valves: Griswold, Bell & Gossett, HCl.
- F. Coil Connection Hoses: HCl, Metraflex, Pro Hydronics.
- G. Air Vents – Manual: Same as listed for valves.
- H. Air Vents – Automatic: Bell & Gossett.
- I. Expansion Tanks: Amtrol, Bell & Gossett, Armstrong, Taco.
- J. Air Separator: Bell & Gossett, Armstrong, Taco, Spirotherm.
- K. Chemical Addition Tanks: J.L. Wingert, Vector Industries, Neptune.
- L. Unit Heaters: Sterling, Modine, Trane, Carrier.
- M. Flow Measuring Devices: Bell & Gossett.
- N. Chemicals: Hydrochem, Dow Chemical, Hercules Chemical Company, Rhomar Water Management.

## 2.2 PIPE AND FITTINGS – MATERIALS

- A. Steel Pipe and Fittings:
  - 1. Pipe: Black steel pipe, per ASTM A 53, Type E or S, Grade A or B, Schedule 40 unless indicated otherwise.
  - 2. Fittings:
    - a. Threaded: Malleable iron fittings per ASME B16.3 or threaded cast iron fittings per ASME B16.1 or ASME B16.4.
    - b. Welded: Steel weld fittings per ASTM A 234; butt weld type per ASME B16.9; socket weld type per ASME B16.11.
    - c. Flanged: Fittings, bolts, nuts, and bolt patterns per ASME B16.5, Class 150. Flanges shall comply with ASTM A105. Bolts shall be high strength or intermediate strength, with material conforming to ASTM A193.
  - 3. Threads: Shall conform to ASME B1.20.1
  - 4. Coupled Piping Systems: See Section 232115.
- B. Copper Pipe and Fittings:
  - 1. Pipe: Seamless copper water tube, hard temper (unless noted otherwise), type K or L as indicated, per ASTM B88.
  - 2. Fittings:
    - a. Solder Joint: Wrought copper and bronze fittings per ASME B16.22 and cast copper alloy fittings per ASME B16.18, cast bronze threaded fittings per ASME B16.15.
    - b. Flanged: Cast bronze fittings per ASME B16.24.
    - c. Solder Material: 95/5 tin-antimony solder per ASTM B32 or “Silvabrite 100” (95.5 tin/4 copper/0.5 silver) solder; lead free.
    - d. Brazing Material: AWS A5.8, BCuP-5.

3. Coupled Piping Systems: See Section 232115.

C. HDPE Pipe and Fittings:

1. Type: High Density Polyethylene (HDPE) piping designed and intended for underground water use, with materials conforming to the Plastic Pipe Institute standards for such pipe. All pipe and fitting materials shall be the product of a single manufacturer.
2. Materials: Materials used for the manufacturer of pipe and fittings shall be PE 4710 high density polyethylene conforming to ASTM D3350, cell classification 445574C and shall be listed in the PPI TR-4 having a hydraulic design basis (HDB) of 1600 psi at 73 deg F.
3. Sizes: Pipe and fittings shall be fabricated in SDR wall thicknesses in standard IPS sizes. Pipe sizes up to 3-inch shall conform to ASTM D3005, larger sizes shall conform to ASTM F714. Where pipe size shown on plans is not available, provide next larger pipe size.
4. Pressure Rating: Minimum rating of 160 psi at 73 deg F.
5. Joints: Joints shall be butt fusion type except for aboveground end fittings which shall be flanged for transitioning to aboveground piping. Provide flanges fittings with back-up rings, with back-up ring bore radiused or chamfered to provide clearance to the flange adapter radius.
6. Fittings and Custom Fabrications: Shall be of same materials as pipe with dimensions to match pipe joined to and have same (or higher) pressure rating. May be molded or fabricated type. Molded fittings shall be manufactured in accordance with ASTM D3261. Fabricated fittings shall be made by heat fusion joining of specially machined shapes from standard polyethylene materials; fabricated fittings may only be used with prior approval of the Engineer and shall be tested per AWWA C906.
7. Identification: Piping shall be marked and identified in accordance with ASTM F714, including pressure rating (or class) and dimensions.
8. Design Drawings: Submit complete plans showing all pipe routings, dimensions of each section, fitting locations, joint locations, and details of end connections to building piping systems.

2.3 PIPE AND FITTINGS – APPLICATIONS

- A. Hot Water Heating - Aboveground: Steel with threaded fittings on pipe 2 inch and smaller, flanged or welded on larger pipe sizes; or type L copper with soldered or brazed joints.
- B. Chilled Water - Aboveground: Steel with threaded fittings on pipe 2 inch and smaller, flanged or welded on larger pipe sizes; or type L copper with soldered or brazed joints.
- C. Chilled Water - Underground: HDPE.
- D. Automatic Air Vent Drain Piping and Miscellaneous Drain Piping: Type L copper with soldered or brazed joints.

2.4 VALVES

- A. Ball Valves:
  1. 2 Inches and Smaller: 125 psi-swp bronze body, full port, 2 piece construction, anti-blowout stem, reinforced TFE seats, stainless steel or chrome plated brass ball, extended stem, cadmium plated steel lever handle with vinyl covering, solder or

- threaded connections as required. Provide with extension stem for handle where valve is installed in systems with insulation thickness greater than 0.5 inch. Nibco S-585, T-585 (or approved).
2. 2-1/2 Inches and Larger:
    - a. Stainless: Class 150 stainless steel body, split-body full bore design, anti-blowout stem, carbon filled TFE seats, stainless steel ball, stainless steel trim. Nibco F-515-S6-F-66-FS (or approved).
    - b. Cast Iron: Class 125 cast iron body, split-body full port, anti-blowout stem, PTFE seats, stainless steel ball. Conbraco/Apollo IBV-125 Series (or approved).
- B. Butterfly Valves:
1. 2 Inches and Smaller: 125 psi-swp bronze body, stainless steel disc and extended stem, with solder or threaded connections as required. Milwaukee "Butterball" Model No. BB2 (or approved).
  2. 2-1/2 Inches and Larger: 200 psi non-shock cold water, ductile iron body, extended neck, molded-in seat EPDM liner, stainless steel stem, and aluminum bronze disc. Provided with lugs for dead-end service. Nibco LD-2000, WD-2000 (or approved).
- C. Check Valves:
1. 2 Inches and Smaller:
    - a. Horizontal: 125 psi-swp bronze body horizontal swing check valve, regarding type, y-pattern, renewable seat and disc, solder or threaded connection. Nibco S-413 or T-413 (or approved).
    - b. Vertical: 125 psi-swp bronze body vertical inline check valve, stainless steel or bronze disk holder, Buna-N disk, stainless steel spring actuated, solder or threaded connection. Nibco S-480 or T-480 (or approved).
  2. 2-1/2 Inches and Larger:
    - a. Horizontal: 125 psi-swp iron body vertical inline "silent" check valve, wafer or flanged style, renewable seat and disk, stainless spring actuated, bronze disk. Nibco W-910 (or approved).
    - b. Vertical: 125 psi-swp iron body vertical inline "silent" check valve, wafer or flanged style, renewable seat and disk, stainless spring actuated, bronze disk. Nibco W-910, F-910 (or approved).
- D. Drain Valves: Bronze ball valve, minimum 125 psi-swp, anti-blowout stem, stainless steel or chrome plated brass ball, reinforced TFE seat, solder or threaded inlet connection, male 3/4-inch hose thread outlet connection, with brass cap and chain. Nibco S-585-70-HC, T-585-70-HC (or approved).
- E. Pressure Reducing Valves: Bronze body construction, renewable nickel alloy or stainless steel seat, lead free, with integral strainer and union inlet connections. Adjustable range 25 to 75 lbs, suitable for inlet pressures up to 300 psi. Watts Series U5-Z3 (or approved).
- F. Triple Duty Valve: Single valve providing isolation, balancing, and check valve functions in one valve; designed for application on discharge of pumps. Rated for 175 psig working pressure at 250 deg. F. Cast iron body or ductile iron body with bronze or brass disc, stainless steel valve stem and spring. Check valve shall be spring loaded to prevent valve chatter with pump cycling. Valve shall have brass taps with integral check valves (and gasketed caps) for reading pressure drop across the valve, calibrated flow chart, position indicator to allow determination of flow through valve, and square (or hex) head valve stem allowing adjustment of valve position.

## 2.5 BALANCING VALVES

- A. General: Valve shall have, as an integral factory manufactured part of the valve, ports which allow measurement of the pressure drop across the valve to determine the flow rate using factory calibrated pressure drop versus flow charts. Valve shall have a means to adjust the flow rate through the valve and shall have a numerical readout indicating valve position. Valve shall have a concealed locking memory stop feature which prevents opening the valve beyond its balanced setting. Locking position may be unlocked by use of a standard size allen wrench.
- B. Construction: Rated 300 psig at 250 degrees F, Y-pattern, globe type, constructed of brass copper alloy or ASTM A536 ductile iron, with EPDM O-ring seals. Handwheel controlling valve position shall be of plastic construction, containing readout of valve position.
- C. Connections: Valves 2-1/2 inch and smaller shall have solder or threaded end connections; larger valves shall have flanged or grooved ends.
- D. Sizing: Valve shall be same size as pipe installed in, except where required for proper flow measuring, valve may be one pipe size smaller.

## 2.6 COIL CONNECTION HOSES

- A. Construction: Flexible braided stainless steel over a synthetic polymer liner, with brass threaded end connectors, stainless steel ferrules, and swivel end connections at coil connection ends.
- B. Length: Minimum 18 inches.
- C. Pressure Temperature Rating: Minimum 150 psi at 230 degrees F, all sizes.
- D. Fire Hazard Rating: Shall not exceed 25 for flame spread and 50 for smoke development, as tested by ASTM E 84.
- E. Insulation: Hoses carrying chilled water shall be factory insulated with minimum 1/2-inch thick polyethylene or cellular elastomeric insulation.

## 2.7 AIR VENTS

- A. Automatic Air Vent - - High Capacity: Float type, with stainless steel float and float mechanism, cast iron body, rated for 250 psig maximum operating pressure, 300 degrees F. maximum temperature and 10 cfm capacity at 100 psig water pressure. Hoffman No. 792 (or approved).
- B. Automatic Air Vent: Float type, with stainless steel float and float mechanism, semi-steel or cast brass body, ball check preventing re-entry of air, rated for 150 psig maximum pressure and 250 degrees F. maximum temperature. Hoffman No. 78 (or approved).
- C. Manual Air Vent – Unfinished Areas: 1/4-inch, 125 psi bronze ball valve (Nibco S-589, T-580 or equal), with nipple connecting to pipe and discharge nipple and 1/4-inch diameter soft copper tubing, 24-inch long, provided.
- D. Manual Air Vent – Finished Areas: 1/4 inch, 125 psi bronze ball valve (Nibco S-589, T-580

or equal), with nipple connecting to pipe and discharge nipple with 1/4-inch male threaded outlet adaptor and cap.

## 2.8 EXPANSION TANKS

- A. Type: Pre-pressurized, ASME labeled diaphragm expansion tanks.
- B. Capacity: Tank volume shall be as indicated on the drawings, factory pressurized to the pressure indicated, and shall be rated for 125 psig maximum working pressure and 240 degrees F. maximum temperature and shall be constructed in accordance with ASME code.
- C. Data Sheet: Furnish each expansion tank with manufacturer's Data Report for Pressure Vessels, per ASME Boiler and Pressure Vessel Code.

## 2.9 AIR SEPARATOR

- A. Type: Coalescing type combination air eliminator and dirt separator. Spirotherm "Spirovent" VHN (or approved).
- B. Construction: Shall be of cast iron or welded steel construction, with copper or stainless steel coalescing medium, brass air venting components, bottom connection for blowdown. Rated for 150 psig (minimum) at 270 degrees F (minimum) in accordance with the ASME Boiler and Pressure Vessel Code. Unit shall have a removable lower head for internal inspection.
- C. Size and Capacity: Air separator shall have flanged connections, size to match connecting piping as shown on plans, and be rated for the gpm shown on the drawings (i.e., the gpm for the pump(s) which flow through the unit) with 100% free air elimination, 99.6% dissolved air removal, and dirt separation efficiency of 80% (of all particles 30 microns and smaller). Pressure drop shall be no greater than 4 feet of water.

## 2.10 CHEMICAL ADDITION TANK

- A. Type: Welded steel or cast iron construction, with side top and side bottom threaded connections (minimum 3/4 inch), bottom drain 3/4 inch threaded connection, top fill opening with cap (minimum 3-1/2 inch diameter), dished out bottom, and vertical support legs. Fill cap shall be of steel or ductile iron construction, with Buna-N O-ring seal.
- B. Capacity: As indicated on the drawings (where not indicated shall be 5 gallon capacity). Tank shall be suitable for up to 300 psig working pressure, at 200 deg F.

## 2.11 CHEMICALS

- A. General: Chemicals shall be compatible with system materials and suitable for system operating conditions. Chemical shall be acceptable by local utility for discharge to sanitary sewer. Chemicals shall be delivered to the site in manufacturer's original sealed and labeled containers.
- B. Cleaner: Single liquid chemical product formulated for use as a cleaner in hot water heating and chilled water piping systems. Product shall have detergents, dispersants, alkaline emulsifiers, and additional agents to effectively remove grease, oil, dirt, mill scale and other contaminants from the piping systems. Cleaner shall be biodegradable. Rhomar "Hydro-Solv 9100" (or approved).

- C. Biocide: Broad spectrum microbiocide for use in hydronic piping systems.
- D. Corrosion Inhibitor: Nitrate/borate or molybdate based inhibitor, single liquid chemical product formulated for use in hot water heating and chilled water cooling systems to provide protection from corrosion. Product shall be compatible with antifreeze, and all materials in the hydronic system that the product may come in contact with. Product shall be formulated from a combination of sodium nitrate, sodium borate, and other ingredients.

## 2.12 UNIT HEATERS

- A. Type: Horizontal discharge, hot water coil, propeller fan type unit heater.
- B. Casing: Shall be constructed of minimum 20 gauge steel, with horizontal adjustable angle louvers and with baked-on enamel finish. Finished color shall be beige.
- C. Coils: Seamless copper tubing with aluminum fins mechanically bonded to tubes. Aluminum fins shall have integral collars for improved heat transfer. Coils shall be tested at minimum 225 psig air under water and shall be suitable for 150 psig hot water working pressure.
- D. Fan and Motor: Propeller type fan with aluminum blades and steel hub. Motor shall be totally enclosed type, with built-in thermal overload protection.
- E. Capacity: Unit shall have minimum heating capacity as scheduled at conditions shown.

## PART 3 EXECUTION

### 3.1 GENERAL

- A. Installation: Installation of all items shall comply with code, best professional practices, and manufacturers written installation instructions.
- B. Complete System: Provide all piping as indicated and as required to allow complete supply and return connections to each item requiring hydronic service. Provide piping connections to equipment furnished by others in accordance with Section 220500.
- C. Coordination: Coordinate installation of items with all trades that are affected by the work to avoid conflicts. Review all drawings for location of pipe spaces, ducts, electrical equipment, ceiling heights, door openings, window openings, and other details and report discrepancies or possible conflicts to Architect/Engineer before installing pipe.

### 3.2 PIPE AND FITTINGS

- A. General:
  - 1. All piping in finished areas shall be installed concealed unless specifically noted otherwise.
  - 2. Install piping at such heights and in such a manner so as not to obstruct any portion of windows doorways, passageways, or access to any items requiring routine service, maintenance, or inspection. Offset of reroute piping as required to clear any interferences which may occur.

3. Install all piping parallel to the closest wall and in a neat, workmanlike manner. Horizontal exposed straight runs of piping shall not deviate from straight by more than 1/4-inch in ten feet. Vertical piping shall not deviate from plumb by more than 1/8-inch in ten feet.
  4. Use eccentric reducers for changes in pipe sizing, keeping the top of pipes in line.
- B. Insulation: Allow sufficient clearances for installation of pipe insulation in thickness specified. If interferences occur, reroute piping to accommodate insulation.
- C. Escutcheons: Provide escutcheons where exposed pipe passes through walls, floors, or ceilings.
- D. Electrical Items: Do not run any piping above electrical panels (and similar electrical equipment). Provide offsets around such panels as necessary. Such offsets are typically not shown on the plans, and are required per this paragraph.
- E. Joints: Prior to the joining of any section of pipe to a pipe run, the section shall be thoroughly cleaned inside and out, the ends shall be reamed to remove any cutting burrs and piping prepared as recommended by pipe and fitting manufacturer.
- F. Threaded Connections: Cut piping carefully, ream, thread and work into place without springing. Use TFE tape or lead and graphite lubricant (on male threads only).
- G. Soldered and Brazed Connections: Polish contact surfaces of fittings and pipes with emery cloth before fluxing male and female surfaces of joints. Steel wool and sandpaper not permitted for polishing.
- H. Welding: Shall conform to ASME B31.1 and ASME B31.9. Welders and welding operators shall be qualified as required by ASME B31.1, ASME B31.9, and governing code. Welded joints on piping system shall be continuous, without backing rings, and pipe ends beveled for butt weld connections. Gas cuts shall be square and free from burned material. Before welding, surfaces shall be thoroughly cleaned. Piping shall be carefully aligned, with no weld material projecting inside the pipe.
- I. Unions: Install unions in pipe connections to valves, coils, and any other equipment where it may be necessary to disconnect the equipment or piping for repairs or maintenance; and as indicated. Where flanged connections occur at equipment additional unions are not required unless indicated otherwise.
- J. Insulating Unions: Install dielectric insulating unions or insulating type flexible connectors between all connections of copper piping and steel piping of steel equipment. Where flanged connections occur use insulating type flanges.
- K. Automatic Air Vents:
1. Provide automatic air vents installed at each high point in the system, where air may become trapped, and where system is separated from other air vents by vertical drops or rises. Provide added automatic air vents where shown on drawings.
  2. All automatic air vents shall be connected to the system through a ball valve.
  3. All automatic air vents shall be provided with drain piping to the nearest funnel or floor drain. Multiple vents may be plumbed to a common drain line which then runs to the nearest funnel or floor drain. Such a drain system is not shown on the drawings (due to

its incidental nature) but is a project requirement. Such drain line shall pitch toward nearest drain at a minimum 1% slope down and shall be the same size as the air vent connection size where serving 1 AAV, minimum 1/2-inch for serving up to 4 AAV's, 3/4-inch for serving up to 12 AAV's, and 1-inch where more are served.

- L. Manual Air Vents: Provide manual air vents where shown on the drawings and at each coil, except that automatic air vents shall be used where specifically called for on the drawings or where it is a high point in the system or where air may become trapped.
- M. Drains: Install drain valves at the low points in the piping system and at the base of each system riser. Provide additional drains as required to allow for complete draining of the system. These drain valves shall take off of the bottom of any horizontal pipe that they are connected to. Identify system drains on record drawings.
- N. Accessories: Install flow measuring devices, balancing valves, and related items per manufacturer's instructions; with the proper distances upstream and downstream to any pipe fittings.
- O. Coil Connections: Piping to coils may utilize "Combination Valves" in lieu of individual components shown on the plans. Coil connection hoses may be used in lieu of rigid pipe for piping from valves to coils.

### 3.3 VALVES

- A. General: Provide isolation valves as shown on the drawings. In addition to those shown, provide added valves to allow for the isolation of all individual equipment items.
- B. Type: Valves 2 inches and less shall be the ball or butterfly type; larger valves may be ball or butterfly type at Contractor's option; except that valves indicated to be a specific type shall be the type as noted.
- C. Installation: Install valves so as to be easily accessible and oriented to permit ease of operation. Valve stem shall be directed toward operator in either the vertical or horizontal direction. Provide access doors for valves not otherwise accessible.
- D. Pressure Reducing Valves: Provide pressure reducing valves as shown on drawings, complete with by-pass line, isolation valves, unions, and pressure gauges. Set initial pressure and adjust as required so that system receives adequate fill and has sufficient pressure at the top of the system to vent system of air.
- E. Balancing Valves: Provide balancing valves in piping where indicated and where required to allow for equal distribution of water flows. Install in full open position unless noted otherwise.
- F. Check Valves: Check valves used on the discharge of pumps shall be the non-slam type (except for pumps 3/4 hp and less).

### 3.4 FLUSHING AND INITIAL TESTING

- A. General:
  - 1. All hydronic piping systems shall be flushed and tested.



2. The activities specified herein represent the minimum work required; Contractor shall provide additional work as necessary to suit unique aspects of the project (e.g. phased construction, long pipe runs, etc.) and as recommended by the Water Treatment Specialist (WTS) in order to provide clean, pressure tested, and chemically treated hydronic systems ready for service.
  3. System shall not be allowed to remain in a condition that is deleterious or aggravates corrosion. After being filled with water systems may not remain without chemical treatment for more than 48 hours; after having been filled and drained, systems may not remain empty for more than 24 hours. Provide added chemical treatment cycles during initial fill periods as needed to suit project phasing or extended testing/flushing periods.
- B. Witnessing: Notify in writing the Architect/Engineer in advance (minimum three days notice) of when flushing, strainer blow-down and final testing will occur. Flushing and testing work may be witnessed by the Architect/Engineer and Owner's representative (at their option). If the strainer blow-down is not witnessed by the Architect/Engineer then it is considered to not have occurred. Failure to provide proper notification and allowing an opportunity for witnessing may require the work to be repeated so that witnessing can occur.
- C. Sequence: Work shall occur in the following order:
1. Prepare system for work.
  2. Initial fill and leak testing.
  3. Initial flushing (includes initial strainer blow-down).
  4. Post flush testing.
  5. Chemical cleaning (includes second strainer blow-down and cleaning).
  6. Final testing.
  7. Chemical treatment.
- D. Preparation: Prepare system for flushing and testing. Isolate from the piping any parts of the system or equipment that may be damaged by the test pressure or entrapment of debris during the flushing process. Install any required (or recommended) start-up strainer screens or related items to protect components or to aid in the flushing process. The system may be isolated into various smaller sub-systems to allow easier flushing, testing and locating of leaks.
- E. Initial Fill and Leak Test: Fill system with clean water. Open system air vents and valves to allow complete filling of system. Check system for leaks during filling. Pressurize system to at least 20% above what system will experience during flushing process. System shall hold the test pressure for at least 2 hours with no drop in pressure. Any leaks shall be repaired and the system re-tested until system proves tight.
- F. Initial Flushing: Prior to additional testing and chemical cleaning, the system shall be flushed with clean water to remove all large debris. Circulate system water for at least 24 hours. Open system valves and other components to ensure full flushing. Blow-down and clean all system strainers. Provide temporary fill and drain piping as necessary. System normal circulating pumps may be used for the circulation. Flush system until water runs clear. Provide sufficient number of drain points to ensure that all parts of the system are flushed.
- G. Post Flush Testing: After initial flushing and draining, the system shall be refilled and a hydrostatic test applied. Test pressure shall be 125 psig on new systems and 75 psig on existing systems. System shall hold the test pressure for a minimum of 2 hours with no drop

in pressure. Any leaks shall be repaired and the system re-tested until system proves tight.

- H. Gauges: Contractor shall ensure that clear, accurate, and readable pressure gauges are used to ensure accurate testing and allow for witnessing by others. Contractor shall make a written record of the gauge readings, time, date, and where connected to the system and mark this information on the site as-builts.
- I. Documentation: Document all flushing, testing, and strainer cleaning. Documentation shall indicate when these tasks were conducted, description of the extent/scope of work, who did the work, and be signed by the person performing the work or the person supervising the work.

### 3.5 CHEMICAL CLEANING, TREATMENT AND FINAL TESTING

- A. General: The interior surfaces of all hydronic piping shall be chemically cleaned and the system chemically treated. The Contractor is responsible to calculate all system volumes and chemical requirements.
- B. Witnessing: Notify in writing the Architect/Engineer minimum three days in advance as to when system cleaning, strainer blow-down, and chemical treatment will occur. Cleaning and strainer blow-down shall be witnessed by the Architect/Engineer and Owner's representative. If the strainer blow-down is not witnessed by the Architect/Engineer then it is considered to have not occurred. System chemical treatment may be witnessed by the Architect/Engineer and Owner's representative (at their option). Failure to provide proper notification and allowing an opportunity for witnessing may require the work to be repeated so that witnessing can occur.
- C. Sequence: See paragraph titled "Flushing and Initial Testing".
- D. Supervision: All work shall be performed under the direct supervision of the Water Treatment Specialist (WTS) subject to approval by the Architect/Engineer.
- E. Preparation: Prepare system for chemical cleaning and treatment. Confirm system construction materials and requirements to ensure proper chemicals and methods are utilized. Isolate from the piping any parts of the system or equipment that may be damaged by the cleaning chemicals, entrapment of dirt, or in any way be damaged or have their performance hindered by the cleaning process. Provide temporary bypass piping, drain piping, pumps, and apparatus as required.
- F. System Cleaning:
  - 1. Chemical cleaning solution shall be added via a bypass feeder or pump to concentration recommended by the chemical manufacturer (or by the WTS).
  - 2. The solution shall be circulated as recommended by the chemical manufacturer and WTS (approximately 12 hours for non-aluminum systems, approximately 8 hours for systems with aluminum components). Circulation rate shall be equivalent to that provided by the system pumps. During this time, partially close and re-open valves, air vents, and other system components to ensure full filling and cleaning of the entire system. Provide temporary fill piping, drain piping, as necessary. System normal circulating pumps may be used for system circulation.
  - 3. Blow-down and thoroughly clean all system strainers.

4. At the end of the cleaning period, a running flush shall be started and continued until the system water runs clear, all cleaning chemicals have been removed and is near the normal pH of the fill water. Provide sufficient number of drain points to ensure that all parts of the system are flushed of all debris and cleaning chemicals.
  5. After flushing is completed, chemically test system as recommended by the WTS to confirm proper system cleaning and stability; test as a minimum for total dissolved solids, pH, soluble iron, and soluble copper. Re-clean and fill system as needed to meet conditions recommended by the WTS.
- G. Final Testing: After chemical testing confirms complete cleaning and flushing, remove any temporary piping or other items installed to allow for system cleaning. Prepare system for normal operation, with equipment connected (except parts of system or equipment that would be damaged by the final test pressure), system fully filled with water, and a final hydrostatic test applied. Test pressure shall be 125 psig on new systems and 75 psig on existing systems. System shall hold the test pressure for a minimum of 2 hours with no drop in pressure. Any leaks shall be repaired and the system re-tested until system proves tight. After successfully proven free of leaks, system shall be chemically treated.
- H. Chemical Treatment:
1. Corrosion Inhibitor: Add to concentration of 100-150 ppm for molybdate inhibitors and 800-1200 ppm for nitrite inhibitors (or as recommended by WTS).
  2. Spare Chemicals: Provide additional chemicals for Owners future use; amount shall be one-fourth of volume originally installed in system by Contractor.
- I. Final Chemical Testing: Chemically test system as recommended by the WTS to confirm proper system cleaning and stability. Test as a minimum for: total dissolved solids, pH, soluble iron, soluble copper, antifreeze percentage (as applicable), and concentration of corrosion inhibitor. Re-clean and fill system as needed to meet conditions recommended by the WTS.
- J. Report: The WTS shall submit a report describing the cleaning operation, system testing, chemical treatment provided, final chemical test results, and the final condition of the system. Report shall include when work was performed, who did the work, and be signed by the person performing the work or the person supervising the work.

END OF SECTION



## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Mechanically Coupled Pipe.
- B. Mechanically Coupled Pipe Fittings.
- C. Mechanical Couplings.
- D. Mechanically Coupled Valves.
- E. Mechanically Coupled Piping Specialties.

### 1.3 SUBMITTALS

- A. General: Submittals shall comply with Section 220500.
- B. Product Data: Submit product information on all pipe, pipe fittings, valves, and specialty products proposed to be used. Indicate gasket materials and coupling types to be used for each system and pressure/temperature limitations of all products.
- C. System Expansion/Contraction: Submit information indicating how system expansion/contraction will be accommodated. Provide plans with locations and details of all expansion joints, loops, anchors, guides, and other system features.

### 1.4 GENERAL REQUIREMENTS

- A. Contractor Option: The Contractor, at his option, may use mechanically coupled pipe, pipe fittings, valves and piping specialties in lieu of those materials otherwise specified. Only the valve and specialty items specifically called out in this specification section may be used.
- B. Systems: Mechanically coupled piping products are approved for use on the following only:
  - 1. Hot Water Heating Piping System: Located in Mechanical Rooms and where fittings are accessible.
  - 2. Chilled Water Piping System: Located in Mechanical Rooms, at chiller, and where fittings are accessible.
- C. Standardization: All mechanically coupled piping products shall be of one manufacturer.
- D. Quality: All mechanically coupled piping products shall be equal to or superior than the otherwise specified product (i.e. if standard threaded, welded or flanged items were used). Mechanically coupled piping products shall only be used where the operating conditions do

not exceed the design parameters of the gasket and product, and where system operation/performance is not adversely affected. The use of mechanically coupled piping products does not eliminate the requirement to provide other components indicated on the plans (i.e. flex connectors, expansion devices, etc.). Product manufacturer shall be ISO-9001 certified.

- E. Costs: Contractor shall bear all added costs of using mechanically coupled piping products in lieu of otherwise specified products.
- F. Tools: Tools used in grooving pipes and in assembling mechanically coupled system components shall be approved for such use by the mechanical coupled product manufacturer.

## 1.5 QUALITY ASSURANCE

- A. Domestic Manufacturing: Major components (piping, fittings, couplings, and valves, exclusive of minor hardware) shall be made in the United States of America, and shall permanently be marked as such.

## 1.6 REFERENCES

- A. ASTM A53: Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- B. ASTM A183: Carbon Steel Track Bolts and Nuts.
- C. ASTM A234: Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel.
- D. ASTM A449: Quenched and Tempered Steel Bolts and Studs.
- E. ASTM A536: Ductile Iron Castings.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Products shall comply with Section 220500, Paragraph 2.1, Acceptable Manufacturers.
- B. Pipe: See system specification sections.
- C. Mechanically Coupled Piping Products: Victaulic Company of America.

### 2.2 PIPE AND FITTINGS

- A. Pipe: See system specification sections.
  - 1. Pipe shall be roll/cut grooved in accordance with the latest manufacturer's recommendations.
  - 2. Pipe ends shall be free from indentations, projections, and roll marks.
- B. Fittings:

1. General: Fittings shall be full flow type, with grooves, shoulders and other provisions for use with mechanical couplings by the same manufacturer as the fitting. Shall be products as indicated in the manufacturer's latest catalog literature.
2. Steel Piping Systems: Fittings shall be constructed of malleable iron conforming to ASTM A47, ductile iron conforming to ASTM A536, segmentally welded schedule 40 steel pipe conforming to ASTM A53 (type F, E or S, Grade B), or forged steel conforming to ASTM A234, (Grade WPB). Fittings shall be factory coated with an orange colored alkyd enamel paint; except where piping system is galvanized the fitting shall be hot dipped galvanized (conforming to ASTM A153).
3. Copper Piping Systems: Fittings shall be constructed of copper, conforming to ASTM B-75 alloy C12200 or ASTM B-152 alloy C11000, up through 4-inch size; or conforming to ASTM B-584, copper alloy CDA 836, 5 inch and larger. Fittings shall be factory coated with a copper colored alkyd enamel paint.

## 2.3 MECHANICAL COUPLINGS

### A. Coupling Components:

1. Coupling housings shall be malleable iron conforming to ASTM A47 or ductile iron conforming to ASTM A536; hot dip galvanized per ASTM A153 where the connecting piping or fittings are galvanized.
2. Couplings shall be factory coated with an alkyd enamel paint; copper colored for fittings used on copper piping systems and orange colored for other systems.
3. Bolts shall be carbon steel track type conforming to ASTM A183 Grade 2, or ASTM A449; minimum tensile 110,000 psi. Nuts shall be hex style, conforming to ASTM A183 Grade 2, or ASTM A563 Grade A. Bolts and nuts shall be zinc electroplated to ASTM B633.
4. Gaskets shall be grade "E" EPDM conforming to ASTM D2000 Grade 2, with temperature range from -30 degrees F to +230 degrees F. Gasket selection for each system shall be in accordance with latest manufacturer's recommendations and so as to suit system pressures, temperatures and chemicals.

### B. Couplings:

1. Steel Piping Systems: Couplings shall be equal to those manufactured by Victaulic, Styles 77, 177, 72, 750, and 107, or approved.
  - a. Victaulic Style 77, 177, 72, W77 and 750 coupling (or approved) shall be used to provide allowance for controlled pipe movement expansion/contraction/deflection to absorb movement for thermal changes, settling or seismic action.
  - b. Victaulic Style 107 "Zero Flex" W07 rigid coupling (or approved) with angular bolt pads shall be used for all pipe joint connections where joint flexibility is not desired.
2. Copper Piping Systems: Couplings shall be equal to those manufactured by Victaulic, Style 607. Coupling housings shall be cast with angular bolt pads.

## 2.4 VALVES

### A. Butterfly Valves:

1. Shall have housing cast of ductile iron conforming to ASTM A-536, or malleable iron conforming to ASTM A-47, with grooved ends and shall be coated with a black alkyd enamel or epoxy coating or polyphenylene sulfide (PPS). Disc shall be of ductile iron construction, conforming to ASTM A-536, with electroless nickel coating conforming to ASTM B-733, or with grade "E" EPDM coating. Disc seat shall be pressure

- responsive elastomer, "E" EPDM. Stem shall be Type 416 stainless steel. Valve shall be rated for bubble-tight shut-off service up to 300 psi; vacuum service up to 29.9 inches of mercury; and for dead-end service. Provide valves with extended necks where used on insulated piping to allow for insulation without inhibiting valve operation. Victaulic "Vic-300, MasterSeal-W761" (or approved).
2. Operator: Manual lever lock/ininitely variable handle with memory stop. Shall be fabricated of ductile iron, with painted enamel finish, and steel zinc plated fasteners. On valves 5-inch and larger, provide with manual gear operator with round handwheel.
  3. Alternative Valves: Other valves having equal pressure capabilities and of like construction to the above may be used with the Engineer's approval prior to bidding.
- B. Check Valves: Body shall be constructed of ductile iron conforming to ASTM A-536 and ASTM A-395, with grooved ends. Disc shall be aluminum bronze conforming to ASTM B-148 or ductile iron conforming to A-536, or Type 304 stainless steel; with spring assist. Body shall be coated with a black alkyd enamel or epoxy coating or polyphenylene sulfide (PPS). Spring shall be constructed of Type 316 stainless steel. Seal shall be grade "E" EPDM with temperature range -30 degrees F to +230 degrees F continuous service, and be rated for up to 300 psi working pressure. Valve shall be operational when installed in horizontal or vertical positions, and shall close off tight with as low as 5' of head on discharge side. Victaulic Series 716/779 W716 (or approved).
- C. Balancing Valves:
1. General: Valve shall have, as an integral factory manufactured part of the valve, ports which allow measurement of the pressure drop across the valve to determine the flow rate using factory calibrated pressure drop versus flow charts. Valve shall have a means to adjust the flow rate through the valve and shall have a numerical readout indicating valve position. Valve shall have a concealed locking memory stop feature which prevents opening the valve beyond its balanced setting. Locking position may be unlocked by use of a standard size Allen wrench. Victaulic/TA Hydronics Series 786, 787, 788, or 789 (or approved).
  2. Construction: Rated 300 psig at 250 deg F, Y-pattern, globe type, constructed of brass copper alloy or ASTM A536 ductile iron, with EPDM O-ring seals. Handwheel controlling valve position shall be of plastic construction, containing readout of valve position.
  3. Connections: Valves 2-1/2 inches and smaller shall have solder or threaded end connections; larger valves shall have flanged or grooved ends.
  4. Sizing: Valve shall be same size as pipe installed in, except where required for proper flow measuring, valve may be one pipe size smaller.

## 2.5 PIPING SPECIALTIES

- A. Suction Diffuser: Body shall be constructed of ductile iron conforming to ASTM A536 or malleable iron conforming to ASTM A47. The combination diffuser-strainer-orifice cylinder shall be of Type 304 stainless steel with 5/32-inch or 3/16-inch diameter holes. Start-up pre-filter shall be stainless steel (or bronze), 20 or 16 mesh screen. Rated for 300 psi working pressure at 250 deg F. Provide with 1-1/4-inch pipe support boss, bottom drain plug and side gauge tap. Victaulic 731-D/W731 (or approved).
- B. Strainer: "T" or "Y" type configuration. Body shall be constructed of ductile iron conforming to ASTM A536 and ASTM A395 or malleable iron conforming to ASTM A47. Body shall be coated with an alkyd enamel or epoxy coating or polyphenylene sulfide (PPS).



Screen shall be removable by removing end cap coupling. Screen shall be basket type, constructed of Type 304 stainless steel, 6 mesh. End cap shall have NPT blow-down connection, minimum 1/2-inch, and utilize manufacturers standard coupling style and gasket matching other couplings used in the system. Strainer Cv shall be no less than the nominal strainer diameter squared times 26. Rated for 300 psi working pressure at 250 deg F. Victaulic style 730/W730 (or approved).

- C. Branch Outlets: Victaulic Style 923 "Vic-Let", Style 924 "Vic-O-Well", Victaulic Style 920 and 920N "Mechanical-T" outlets (or approved); rated for 300 psi working pressure at 230 deg F.
- D. Dielectric Connection: Victaulic Style 47 "Clearflow Dielectric Waterway" fitting (or approved). Constructed of steel or ductile iron pipe, with zinc electroplating and internal thermoplastic lining. Rated for 300 psi working pressure at 230 deg F.
- E. Adapter Connection: Conversion of flanged outlets to mechanically coupled system connection shall be accomplished by Victaulic Styles 741 Flange Adapter (or approved), conforming to ANSI Class 125/150 bolt pattern, or Style 743 Flange Adapter (or approved), conforming to ANSI Class 250/300 bolt pattern.
- F. Flanged Adapter Nipples: Victaulic Style 41, 45, 46 (or approved) for connecting ANSI class 125, 150, and 300 flanged components to mechanically coupled piping system connection. Nipples shall be constructed of carbon steel pipe (same schedule as the piping system being connected); flanges of cast iron or carbon steel construction.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. General: Install all components according to the manufacturer's written installation instructions and applicable codes and standards. See piping system specification section for piping and system installation requirements.
- B. Pipe Preparation: Piping shall be prepared in strict accordance with the coupling manufacturer's instructions and ANSI/AWWA C-606.
- C. Coupling Fasteners: Torque as required by manufacturer. Demonstrate equipment used upon Engineer's request.
- D. Dielectric Connection: Provide dielectric at all piping connections between dissimilar metals and equipment to protect from local cell corrosion.
- E. Coupling Types: Couplings that allow for system flexibility and expansion/contraction shall be used except where a rigid coupled system is specifically required. Couplings shall provide a rigid system equivalent to threaded or welded systems, except where indicated otherwise (or where system flexibility is required to accommodate system expansion/contraction, movement, vibration, or similar requirements). Three (3) Victaulic 177 or 77 Flexible Couplings in close proximity to pump or equipment connection may be used in lieu of flex connectors.

- F. Manufacturer's Review: Coupling manufacturer's factory representative shall periodically visit the project site and review the mechanical coupled products and installation and confirm compliance with the manufacturer's installation instructions. Manufacturer's representative shall submit a written report of such visits to the Engineer, noting work progress, areas and items reviewed, and an evaluation of the installation. The Contractor shall pay all costs for manufacturer's review and report. The Contractor shall remove and replace any work deemed improper by the manufacturer's representative or by the Engineer.
- G. System Expansion/Contraction:
  - 1. "Flexible" Coupled Systems: Install piping ends with proper clearances ("pre-gap") to allow for system expansion (or contraction), as appropriate to temperatures at the time of installation and system operating temperatures and pressures. Provide pipe anchors at the end of pipe runs and intermediate guides to allow the gap between piping ends to take up piping expansion/contraction. Provide additional couplings (or expansion joints) to accommodate all pipe movement without excessive pipe stress or angular deflection in piping mains and branch connections.
  - 2. "Rigid" Coupled Systems: Provide expansions joints and expansion loops (or changes in piping direction) to accommodate system expansion and contraction. Provide pipe anchors at the end of pipe runs and intermediate guides to allow piping to expand/contract into the installed expansion device/system.
  - 3. The system features to accommodate all system expansion and contraction shall be Contractor selected, subject to review by the Engineer. Contractor's methods shall be based on guidance from the coupling manufacturer and engineering principles.

END OF SECTION

## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. In-Line Pumps.
- B. End Suction Pumps.

### 1.3 SUBMITTALS

- A. Product Data: Provide product information and performance data for all pumps. Performance data shall include pump curves, showing pump performance as head vs. GPM, BHP and NPSH vs. GPM, with system operating point clearly marked. (NPSH vs. GPM not required for pumps 1 HP and less.)
- B. Installation: Submit manufacturers installation instructions for pumps.

### 1.4 QUALITY ASSURANCE

- A. Factory Testing: All pumps shall be factory tested per the Hydraulic Institute Standards and be thoroughly cleaned.
- B. Electrical: Coordinate pump electrical voltage/phase with Division 26 prior to ordering.

### 1.5 GENERAL REQUIREMENTS

- A. Spare Parts:
  - 1. Seals: Provide a complete set of factory replacement seals for all pumps provided by this section.
  - 2. Couplers: Provide a spare motor-to-pump coupler for each unique non-direct coupled pump.

### 1.6 REFERENCES

- A. Hydraulic Institute Standards: ANSI/HI Pump Standards, Version 3.1.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Products shall comply with Section 220500. See Section 220500, paragraph 2.1 for Acceptable Manufacturer requirements.

- B. In-Line Pumps: Bell & Gossett, Armstrong, Grundfos, Taco.
- C. End Suction Pumps: Bell & Gossett, Armstrong, Grundfos, Taco.
- D. Split Case Pumps: Bell & Gossett, Grundfos, Peerless, Ingersoll-Rand.

## 2.2 GENERAL

- A. Balancing: All rotating parts shall have been statically and dynamically balanced at the factory.
- B. Alignment: Pump and motors shall be factory aligned, and have alignment checked and reset once installed in place.
- C. RPM: Pumps and motors shall operate at 1750 rpm unless indicated otherwise.
- D. Pump Capacity: Shall be no less than the values listed on the Mechanical Equipment Schedule on the drawings.
- E. Pump Types: The type of each pump is indicated on the Mechanical Equipment Schedule under the "Type" column, and corresponds to the types specified herein.
- F. Motors: Shall comply with Section 220500. Motors shall be of sufficient size so as to be non-overloading at any point on the operating curve and shall be no smaller than the size shown on the drawings. Motors shall be of drip-proof construction (unless indicated otherwise), resilient mounted with oil lubricated journal or ball bearings, and have built-in thermal overload protectors. Motors shall be for use with the voltage and phase as indicated on the drawings.
- G. Finish: Pumps shall have minimum one coat high grade machinery enamel finish, factory applied, manufacturer's standard color.
- H. Nameplate: Pumps shall have nameplates identifying: manufacturer, model number, capacity (gpm and head), and date of manufacturer.
- I. Variable Speed Application: Pumps used with variable speed drives shall have motors that are compatible with the variable frequency drive unit and shall have suitable couplings and accessories to suit variable speed duty.
- J. Coupling Guards: Provide pumps with coupling guards complying with OSHA requirements.
- K. Pump Seal Replacement: If pumps are used for any Hydronic System Flushing or Cleaning (see hydronic piping system specifications), Contractor shall replace pump seals when flushing/cleaning is complete.

## 2.3 HORIZONTAL IN-LINE PUMPS

- A. Type: Centrifugal, single stage, close coupled, in-line pump with horizontal shaft. Bell & Gossett Series 60 (or approved).
- B. Operating Range: Pump shall be rated for continuous operation at a minimum 175 psi and 225 deg F.

- C. Volute: Cast iron or ductile iron or cast bronze construction; except where used on domestic water systems or indicated to be “all bronze” shall be of cast bronze construction, with plugged gauge tappings at inlet and outlet, and plugged vent and drain tappings at top and bottom.
- D. Impeller: Brass or cast bronze, fully enclosed, keyed to shaft and secured with stainless steel locknut.
- E. Shaft: Stainless steel or alloy steel with copper or stainless steel shaft sleeves, supported by permanently lubricated and sealed ball bearings.
- F. Seal: Internally self-flushing mechanical seal, with carbon seal ring and ceramic or tungsten carbide seat, Buna N seals, stainless steel spring, and stainless steel or brass metal parts.
- G. Motor: Drip-proof construction, permanently lubricated bearings, with a flexible type coupling to pump shaft.
- H. Service: Pump internals, shall be capable of being serviced without disturbing piping connections.

#### 2.4 END SUCTION PUMPS

- A. Type: Centrifugal, single stage, vertical split, end suction base mounted pump. Bell & Gossett Series 1510 (or approved).
- B. Operating Range: Pump shall be rated for continuous operation at a minimum of 175 psi and 250 deg F.
- C. Volute: Cast iron or ductile iron construction (except shall be of bronze construction where pump is noted as “all bronze”), with plugged gauge tappings at inlet and outlet, and an integrally cast support foot centered beneath volute. Shall have flanged suction and discharge connections, pressure class to match piping system connected to.
- D. Impeller: Cast bronze or stainless steel, fully enclosed, keyed to shaft and secured with stainless steel locking cap screw.
- E. Shaft: High strength steel, with bronze or stainless steel replaceable shaft sleeves. Where “all bronze” pump is noted, shaft shall be Type 416 stainless steel. Shaft shall be coupled to motor with a flexible, center drop-out type coupler, with coupling guard. Shaft support bearings shall be re-greasable roller or ball bearings.
- F. Seal: Internally self-flushing mechanical seal; with EPR or EPDM or Viton elastomer, carbon rotating face, tungsten carbide (or silicon carbide) stationary face, stainless steel spring, and metal parts of stainless steel or brass construction.
- G. Base: Pump and motor shall be mounted on a heavy structural steel baseplate, with welded cross members, fully enclosed sides and ends, and open grouting area.
- H. Service: Entire rotating assembly shall be removable for service (back pull-out arrangement) without disturbing pump piping or motor.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. General: Comply with Section 220500. Install in accordance with manufacturer's written installation instructions, code, applicable standards and best construction practices. Install pumps at locations indicated and in accordance with Contract Documents. Set base mounted pumps on concrete housekeeping pads; provide vibration isolation bases as indicated.
- B. Piping: Decrease from line size to pump inlet size with long radius reducing elbows and minimum 5-pipe diameter straight pipe into pump (except where suction diffusers are used) and out of pump. Where reducers in the horizontal are used on pumps, they shall be the eccentric type installed with taper on the bottom.
- C. Suction Diffusers: Provide suction diffusers at entrance to base mounted pumps and where indicated.
- D. Flexible Connectors: Provide flexible connectors in piping to base mounted pumps and where indicated.
- E. Alignment: Check motor alignment after pump installation; re-align as necessary.
- F. Grouted Base: Grout in base of base mounted pumps after pumps have been set.
- G. Operation and Maintenance:
  - 1. General: Operation and Maintenance shall be in accordance with manufacturer's written procedures and recognized best maintenance practices. Keep records of maintenance and (upon request) forward to the Architect/Engineer prior to project final acceptance.
  - 2. Stored Products: Provide maintenance (i.e. equipment rotation, lubrication, flush, cleaning, etc.) and inspection on products while stored to maintain new condition.
  - 3. Installed Products: Provide maintenance and inspection of products and operate mechanical systems until substantial completion or specified Owner Instruction has been provided (whichever is later). Maintenance shall include all manufacturer's recommended maintenance (i.e. strainer cleaning, filter changes, bearing lubrication, belt tensioning, etc.). In addition to scheduled maintenance, review all equipment periodically to allow detection of improper operation or any special maintenance needs; review shall be consistent with best practices for the product but in no case less than every two weeks.
  - 4. Units shall not be operated until all construction activities that generate dust, dirt, fumes, or odors are complete. Units shall not be placed into service until start-up has been completed.
- H. Owner Instruction: Instruct Owner on equipment operation, including: system start-up, shut-down, emergency shut-down, normal control operation, safety aspects, maintenance and repair instructions. Comply with Section 220500.

### 3.2 START-UP

- A. Pre Start-Up Inspection: Inspect equipment and connecting systems to confirm equipment and connecting systems, and to confirm equipment has been installed properly and is ready for start-up. As a minimum, check for: proper voltage and phases, correct electrical

connections, correct pump rotation, and other items as listed by the manufacturer are properly provided/connected and operating to ensure safe and proper start-up. Install in accordance with manufacturer's written instructions, code, applicable standards and best construction practices. Care shall be taken when moving and setting units not to damage roof, curb, units, or other items.

- B. Start-Up: Perform start-up in accordance with manufacturers written start-up procedures. Arrange other trades needed to be present (i.e. balancer, control technician, etc.). Check pump operation to ensure that specified flows are provided, without motor unloading or pump cavitation. Notify the Architect/Engineer of any unusual conditions or performance other than as specified.
- C. Adjustments: Adjust and set unit components to allow for proper operation (i.e. adjust fan sheaves, adjust fan speeds, unit settings, etc.). Observe unit to detect any unusual vibration, leakage, loose wiring, or other situations that could affect unit operation.

### 3.3 COMMISSIONING

- A. General: The Products referenced in this section are to be commissioned. The Contractor has specific responsibilities for scheduling, coordination, testing, and documentation of the commissioning. The Contractor shall provide a documented and signed record to verify that all equipment and systems installed under this contract have been inspected and functionally tested to verify full compliance with the contract specifications. See Section 230800.

END OF SECTION





## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Cooling Coil Condensate Drains.
- B. Overflow, Miscellaneous Drains.
- C. Fabricated P-traps.
- D. Condensate Pumps.
- E. Testing and Inspection.

### 1.3 SUBMITTALS

- A. Submittals shall comply with Section 220500.
- B. Submit product information on all items to be used.

### 1.4 REFERENCES

- A. ASME B 16.15: Cast Bronze Threaded Fitting Classes 125 and 250.
- B. ASME B 16.18: Cast Copper Alloy Solder Joint Pressure Fittings.
- C. ASME B 16.22: Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- D. ASME B 16.23: Cast Copper Alloy Solder Drainage Fittings.
- E. ASME B 16.29: Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings (DWV).
- F. ASTM B 32: Solder Metal.
- G. ASTM B 88: Seamless Copper Water Tube.
- H. ASTM B 306: Copper Drainage Tube (DWV).
- I. ASTM D 1785: Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- J. ASTM D 2466: Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

- K. ASTM D 2564: Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
- L. ASTM D 2665: Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Products shall comply with Section 220500, 2.1, Acceptable Manufacturers.
- B. Pipe and Fittings: Mueller, Cerro, Tyler, US Pipe, Charlotte Pipe and Foundry, Pacific States Pipe, Atlantic States, Spears Manufacturing, Cresline Northwest.
- C. Fabricated P-Trap: Rectorseal.
- D. Condensate Pumps: Little Giant.

### 2.2 PIPE AND FITTINGS - MATERIALS

- A. Copper DWV Pipe and Fittings: Copper drainage tube per ASTM B 306. Wrought copper and wrought copper alloy solder joint fittings per ASME B 16.29; or cast copper alloy solder joint fittings per ASME B 16.23.
- B. Copper Pipe and Fittings: Seamless copper water tube, tube L or M, per ASTM B 88. Solder joint wrought copper and bronze fittings per ASME B 16.22 cast copper alloy fittings per ASME B 16.18, and cast bronze threaded fittings per ASME B 16.15 with 95/5 tin-antimony solder per ASTM B 32.
- C. PVC DWV Pipe and Fittings: Polyvinyl chloride drain waste and vent pipe and fittings per ASTM D 2665, with solvent cement joints. Solvent cement shall comply with ASTM D 2564.
- D. PVC Pipe and Fittings: Polyvinyl chloride pipe, schedule 40, per ASTM D 1785. Solvent cement socket type fittings per ASTM D 2466. Solvent cement shall comply with ASTM D 2564.

### 2.3 PIPE AND FITTINGS - APPLICATION

- A. Cooling Condensate Drains: Copper DWV, copper, PVC DWV, or PVC.
- B. Miscellaneous Drains: Copper DWV, copper, PVC DWV, or PVC. Except that handling acidic or corrosive fluids shall be PVC.

### 2.4 FABRICATED P-TRAPS

- A. Type: Factory fabricated p-trap with dual cleanouts and clear trap, for cooling coil condensate. Rectorseal "EZ Trap" (or approved).
- B. Construction: Fabricated of schedule 40 PVC, with transparent plastic trap portion. Portion connection to HVAC unit (or coil) drain shall consist of a PVC cross, with top and side

cleanouts having caps with integral retaining strap and ring. Outlet portion shall consist of PVC tee fitting, with top portion able to serve as vent.

- C. Size: 3/4-inch unless indicated otherwise. Trap heights shall be sized to suit HVAC unit static pressures, unit configuration (i.e. blow through or draw through), and be consistent with HVAC unit manufacturers installation recommendations.
- D. Cleaning Brush: Provide with bristled flexible shaft cleaning brush, sized for cleaning of p-trap.

## 2.5 CONDENSATE PUMP

- A. Type: Automatic condensate pump with integral tank; for pumping cooling coil condensate, combustion condensate and similar fluids. Little Giant VCMA, VCMX or VCL series (or approved).
- B. Capacity: Pump shall be rated to pump minimum of 1.4 gallons per hour per ton of unit cooling capacity served (e.g. 10 ton unit shall have a  $1.4 \times 10 = 14$  gph capacity) at 15 feet of head (unless a different capacity is indicated). Pumps serving combustion condensate shall have a capacity of 25 gph per 1000 MBH of equipment capacity at 15 feet of head (unless a different capacity is indicated). Tank shall be 1/2 gallon capacity (unless indicated otherwise). Unit shall be rated for continuous operation.
- C. Construction: Tank body and pump shall be constructed of oil resistant polypropylene or ABS, with discharge check valve, and float for pump on/off control, factory wired.
- D. Accessories: Provide with overflow safety switch for wiring to low voltage controls to stop HVAC unit on high condensate (or to indicate an alarm).
- E. Electrical: Provide with integral electric motor, having thermal overload protection, for use with 115 volt or 230 volt (as required to suit available power) AC single phase power, with minimum 6-foot 3-prong grounded plug.

## PART 3 EXECUTION

### 3.1 GENERAL

- A. Installation of all items shall comply with code, best professional practices, and manufacturers written installation instructions.
- B. Provide all piping as indicated and as required for all drip pans, unit condensate drains, unit p-traps, and miscellaneous drains and vent connections to all items requiring such drains (i.e. HVAC units, furnaces, boilers, AC units, etc.).
- C. Coordinate installation of items with all trades that are affected by the work to avoid conflicts.
- D. Consult manufacturers data and drawings for information on equipment before beginning drain rough-in.

- E. Verify points of connection, elevations, and grade requirements before beginning installation or ordering materials.
- F. Trap all equipment items as required by code; provide proper venting for each trap as indicated and as required by code.
- G. Run piping to nearest point of drainage, or as shown on drawings. Where routing is not shown, route to nearest point of proper drainage.

### 3.2 PIPE AND FITTINGS

- A. All piping in finished areas shall be installed concealed unless specifically noted otherwise.
- B. Install piping so as not to obstruct access to any items requiring routine service, maintenance, or inspection. Offset or reroute piping as required to clear any interferences which may occur. Prior to running any exposed piping, confirm with Architect/Engineer (unless is clearly noted to be ran exposed). Install exposed piping so as not to obstruct any portion of windows, doors, doorways, passageways, or items requiring service or access.
- C. Consult all drawings for location or pipe spaces, ducts, electrical equipment, structural elements, ceiling heights, door items requiring access, openings, window openings, and other details and report discrepancies or possible conflicts to Architect/Engineer before installing pipe.
- D. Install all drain lines with a slope of 1/4-inch per foot unless noted otherwise. Coordinate with AHJ if written approval is required for exceptions to 1/4-inch per foot slope.
- E. Provide escutcheons where exposed pipe passes through walls, floors, or ceilings.
- F. Install all piping parallel to equipment and nearby walls and in a neat, workmanlike manner. Horizontal straight runs of piping shall not deviate from straight by more than 1/4-inch in ten feet. Vertical piping shall not deviate from plumb by more than 1/8-inch in ten feet.
- G. Do not run any piping above electrical panels (and similar electrical equipment). Provide offsets around such panels as necessary. Such offsets are typically not shown on the plans, but are required per this paragraph.
- H. Prior to the joining of any section of pipe to a pipe run, the section shall be thoroughly cleaned inside and out, the ends shall be reamed to remove any cutting burrs and piping prepared as recommended by piping and fitting manufacturer.
- I. Threaded Connections: Cut piping carefully, ream, thread and work into place without springing. Use TFE tape or lead and graphite lubricant (on male threads only).
- J. Soldered Connections: Polish contact surfaces of fittings and pipes with emery cloth before fluxing male and female surfaces of joints. Steel wool and sandpaper not permitted for polishing.
- K. PVC Pipe:
  - 1. Solvent Joints: The outside of the PVC pipe shall be chamfered to a minimum of 1/16 inch at approximately 22 degrees. Chemicals used must penetrate the surface of both

pipe and fitting which will result in complete fusion at the joint. Use solvent and cement only as recommended by the pipe manufacturer.

2. Plastic to Metal Connections: Work the metal connection first. Use a non-hardening compound on threaded connections. Use only light wrench pressure. Connections between metal and plastic are to be threaded utilizing female threaded adapters only, not male adapters.

### 3.3 TESTING AND INSPECTION

- A. All piping shall be inspected and approved prior to being concealed or covered.
- B. Provide testing as required by code. Testing shall be by water and shall comply with governing code. Testing shall be witnessed by the plumbing inspector and the Engineer's representative (at his option).
- C. All leaks shall be eliminated and the system re-tested before proceeding with additional work or concealing pipe.
- D. All repairs to piping shall be with new pipe and fitting material's; no caulking of screwed joints or holes is allowed.

END OF SECTION



## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Combustion Condensate Drains.
- B. Testing and Inspection.

### 1.3 SUBMITTALS

- A. Submittals shall comply with Section 220500.
- B. Submit product information on all items to be used.

### 1.4 REFERENCES

- A. ASTM A312: Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
- B. ASTM A403: Wrought Austenitic Stainless Steel Piping Fittings.
- C. ASTM A530: General Requirements for Specialized Carbon and Alloy Steel Pipe.
- D. ASTM A774: As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
- E. ASTM A 778: Welded, Un-annealed Austenitic Stainless Steel Tubular Products.
- F. ASTM D1785: Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- G. ASTM D2466: Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
- H. ASTM D2564: Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
- I. ASTM D2665: Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
- J. ASTM F437: Threaded Chlorinated Poly (Vinyl Chloride) CPVC Plastic Pipe Fittings, Schedule 80.
- K. ASTM F439: Socket-Type Chlorinated Poly (Vinyl Chloride) CPVC Plastic Pipe Fitting.
- L. ASTM F441: Chlorinated Poly (Vinyl Chloride) CPVC Plastic Pipe.
- M. ASTM F493: Solvent Cement for Chlorinated Poly (Vinyl Chloride) CPVC Pipe and

Fittings.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Products shall comply with Section 220500, 2.1, Acceptable Manufacturers.
- B. Pipe and Fittings: Pacific Plastics, Charlotte Pipe, Spears Manufacturing, Cresline Northwest, Mueller, Cambridge-Lee, US Steel, Anvil International, Wheatland Tube, Weldbend, Exltube.

### 2.2 PIPE AND FITTINGS - MATERIALS

- A. CPVC Pipe and Fittings: Chlorinated poly vinyl chloride pipe, schedule 80, per ASTM F441. Socket-type fittings per ASTM F439 or threaded fittings per ASTM F437 Solvent cement shall comply with ASTM F493.
- B. PVC DWV Pipe and Fittings: Polyvinyl chloride drain waste and vent pipe and fittings per ASTM D2665 or ASTM F891, with solvent cement joints. Solvent cement shall comply with ASTM D2564.
- C. PVC Pipe and Fittings: Polyvinyl chloride pipe, schedule 40, per ASTM D1785. Solvent cement socket type fittings per ASTM D2466. Solvent cement shall comply with ASTM D2564.
- D. Flexible PVC Tubing: Clear flexible polyvinyl chloride tubing, tensile strength 1980 psi, conforming to USP Class VI requirements. Fittings shall be plastic multi-barbed type fabricated of natural nylon or polypropylene, suitable for temperatures equal to tubing rating; with stainless steel worm gear clams, 5/16 inches wide, having 1/4-inch hex head slotted stainless steel screw.
- E. Stainless Steel Pipe and Fittings:
  - 1. Pipe: Seamless or welded stainless steel per ASTM A778 or A312, type 304L or 316L, tolerances per ASTM A530. Schedule 40 unless indicated otherwise.
  - 2. Fittings: Threaded, constructed of same material as piping, per ASTM A774 or A403, suitable for 150 psi swp.

## PART 3 EXECUTION

### 3.1 GENERAL

- A. Installation of all items shall comply with code, best professional practices, and manufacturers written installation instructions.
- B. Provide all piping as indicated and as required for combustion equipment condensate drainage; including accessory items (i.e. flues, heat exchangers, etc.). Provide p-traps and vents as required by code, recommended by equipment manufacturer, and where required for proper operation.



- C. Coordinate installation of items with all trades that are affected by the work to avoid conflicts.
- D. Consult manufacturers data and drawings for information on equipment before beginning drain rough-in. Verify points of connection, elevations, and grade requirements before beginning installation or ordering materials.
- E. Route combustion condensate drains through acid neutralizer and to nearest point of drainage, or as shown on drawings.
- F. Fill equipment and drain p-traps with water and condensate neutralizers with neutralizing chemical (type and quantity as recommended by manufacturer) before operating systems.

### 3.2 PIPE AND FITTINGS

- A. Piping shall be stainless steel except where other materials are specifically approved by boiler manufacturer. Use flexible pipe only at connections to acid neutralizer where needed to allow for unit removal and where recommended by unit manufacturer.
- B. Install piping so as not to obstruct access to any items requiring routine service, maintenance, or inspection. Offset or reroute piping as required to clear any interferences which may occur.
- C. Install all drain lines with minimum slope of 1/4-inch per foot unless noted otherwise. Coordinate with AHJ if written approval is required for exceptions to 1/4-inch per foot slope.
- D. Install all piping parallel to equipment or nearby walls and in a neat, workmanlike manner.
- E. Prior to the joining of any section of pipe to a pipe run, the section shall be thoroughly cleaned inside and out, the ends shall be reamed to remove any cutting burrs and piping prepared as recommended by piping and fitting manufacturer.
- F. Threaded Connections: Cut piping carefully, ream, thread and work into place without springing. Use TFE tape or lead and graphite lubricant (on male threads only).
- G. Solvent Joints: The outside of the PVC pipe shall be chamfered to a minimum of 1/16 inch at approximately 22 degrees. Chemicals used must penetrate the surface of both pipe and fitting which will result in complete fusion at the joint. Use solvent and cement only as recommended by the pipe manufacturer.
- H. Plastic to Metal Connections: Work the metal connection first. Use a non-hardening compound on threaded connections. Use only light wrench pressure. Connections between metal and plastic are to be threaded utilizing female threaded adapters only, not male adapters.

### 3.3 TESTING AND INSPECTION

- A. All piping shall be inspected and approved prior to being concealed or being placed in service.
- B. Provide testing as required by code. Testing shall be by water and shall comply with governing code. Testing shall be witnessed by the plumbing inspector (if required) and the

Engineer's representative (at his option).

- C. All leaks shall be eliminated and the system re-tested before proceeding with additional work or concealing pipe.
- D. All repairs to piping shall be with new pipe and fitting material's; no caulking of screwed joints or holes is allowed.

END OF SECTION

## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Environmental Ductwork Systems.
- B. Flexible Duct.
- C. Acoustical Duct Lining.
- D. Preparation of Duct for Service.
- E. Duct Pressure Testing.

### 1.3 DEFINITIONS

- A. Duct Sizes: All duct dimensions shown are inside clear dimensions. Where inside duct lining is specified or indicated, duct dimensions are to the inside face of lining.
- B. Environmental Ductwork Systems: Ductwork systems that are not covered by Section 233500 - Special Exhaust Systems.

### 1.4 QUALITY ASSURANCE

- A. All work and materials shall comply with SMACNA-DCS, NAIMA-DLS, ASHRAE-F, IBC, IMC, NFPA-90A, NFPA-90B, and code. The most restrictive criteria governs.
- B. Leakage Criteria: Duct system shall be constructed and sealed so that leakage does not exceed the following:
  - 1. Variable-Air-Volume (VAV) Systems - Supply Duct: Fan to VAV boxes 3% of system maximum airflow; VAV box to connection to air outlets 5% of VAV maximum airflow.
  - 2. Other Systems - Supply Duct: From fan to connection to air outlet 5%.
  - 3. All Systems - Return Duct: 5%.
  - 4. All Systems - Exhaust Duct: 5%.
- C. Fabrication Proximity: The Contractor performing the work of this section shall have fabricating facilities located within 100 miles of the project site.
- D. Drawing Review: Prior to beginning any work review all drawings, duct routing, duct connections, equipment configuration, equipment connection locations, and other work details to discover conflicts in anticipated duct arrangement and improper or incomplete connections. Review shall include the following: supply ducts not connected into return (or

exhaust) ducts, ducts not crossed and improperly connected in shafts, air outlets/inlets connected to ducts, unit configuration compatible with planned duct connections, louver locations match architectural plans. Submit resolutions of such possible conflicts as submittals with shop drawings of proposed solutions; written description in lieu of shop drawings is acceptable for minor issues.

## 1.5 SUBMITTALS

- A. General: Comply with Section 220500.
- B. Product Data: Submit product data for duct lining, flexible duct, and factory fabricated items.
- C. Shop Drawings: Submit shop drawings for all HVAC ductwork which is to be installed differently than as shown on the drawings.
- D. Conflict Resolution: Submit additional shop drawings showing proposed resolution of conflicts after review of documents and again after review of actual field conditions.

## 1.6 DUCT PRESSURE CLASS

- A. Constant Volume Systems: Ductwork shall be constructed to the pressure class corresponding to 1.2 times the static pressure indicated for the fan which serves the duct system (plus or minus as appropriate); unless noted otherwise. (For example, a fan designed to operate at 1-inch wc static pressure would require 2-inch pressure class duct construction as  $1\text{-inch} \times 1.2 = 1.2\text{-inch}$ ; 2-inch is therefore the required pressure class.)
- B. Variable-Air-Volume (VAV) System:
  - 1. Ductwork upstream of VAV boxes shall be constructed to the pressure class corresponding to 1.5 times the static pressure indicated for the fan which serves the duct system (plus or minus as appropriate); unless noted otherwise. (For example, a fan designed to operate at 3-inch wc static pressure would require 6-inch pressure class duct construction as  $3\text{-inch} \times 1.5 = 4.5\text{-inch}$ ; 6-inch is therefore the required pressure class.)
  - 2. Ductwork downstream of VAV boxes shall be constructed to 1-inch pressure class standards.

## 1.7 REFERENCES

- A. ADC-FLEX: Air Diffusion Council Flexible Duct Performance and Installation Standards.
- B. ASHRAE-F: ASHRAE Handbook of Fundamentals.
- C. ASTM A 653: Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process
- D. ASTM A 924: General Requirements for Steel Sheet Metallic-Coated by the Hot-Dip Process.
- E. ASTM E 84: Standard Test Method for Surface Burning Characteristics of Building Materials.
- F. IMC: International Mechanical Code.

- G. NAIMA-DLS: North American Insulation Manufacturers Association Fibrous Duct Liner Standards, 1st Edition.
- H. NFPA 90A: Standard for the Installation of Air Conditioning and Ventilating Systems.
- I. NFPA 90B: Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
- J. SMACNA-DCS: SMACNA HVAC Duct Construction Standards.
- K. UL 181: Underwriter Laboratories Factory-Made Air Ducts and Air Connectors.
- L. UL 181A: Underwriter Laboratories Closure Systems for Use with Rigid Air Ducts.
- M. UL 181B: Underwriter Laboratories Closure Systems for Use with Flexible Air Ducts and Air Connectors.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Products shall comply with Section 220500, Paragraph 2.1, Acceptable Manufacturers.
- B. Sheet Metal: All domestic manufacturers.
- C. Spin-in Fittings and ATTO: Sheet Metal Connectors Inc., United McGill, Royal Metal Products, Airflow Products Inc.
- D. Gasketing: Preson, Insulfab, Duraco.
- E. Duct Sealant and Tape: Carlisle (Hardcast), Ductmate, Benjamin Foster, Grace Construction Products, United McGill, Polymer Adhesives Sealant Systems, RCD Corporation, Nashua, 3M.
- F. Flexible Duct: Flexible Technology Inc., JP Lamborn Co.; Hart & Cooley, Thermaflex.
- G. Acoustical Duct Lining: Johns-Manville.

### 2.2 GENERAL MATERIALS

- A. Ducts: Construct of galvanized sheet steel, suitable for lock forming without flaking or cracking, conforming to ASTM A653 and A924, having a zinc coating of 0.90 ounces total per square foot for both sides of a sheet, corresponding to coating G90.
- B. Fasteners: Steel construction, electroplated zinc coated, having strength properties adequate for the application, compatible with materials being joined, and in accordance with SMACNA-DCS. Where exposed to corrosive conditions shall be of Type 304 or 316 stainless steel. Type to meet duct pressure class and duct leakage requirements. Where used for the support and anchorage of ducts shall comply with Section 220529, with independent test reports regarding strength.

- C. Spin-in Fittings: Factory fabricated of galvanized steel with die-formed mounting groove and damper with raised damper quadrant where ducts are to be insulated. Collar length for flexible duct attachment shall be at least 2" long.
- D. Air-Tight Take-Off Fittings (ATTO): Factory fabricated branch duct connector, of galvanized steel. Flange shall be 1-1/2" wide with 1/8" self-adhesive gasket and pre-drilled fastener holes. Collar length for flexible duct attachment shall be at least 2" long. Where used on round duct mains, shall be saddle type appropriately sized for main duct diameter.
- E. Draw Bands:
  - 1. Metal: Worm gear type clamp, constructed of galvanized steel, stainless steel, or aluminum; minimum 1/2-inch wide band; suitable for 200 pound loading.
  - 2. Non-Metal: Nylon "zip-tie" with self-locking ability, designed for flexible duct usage, minimum 1/4 inch wide, rated for 175 pound load, suitable for temperatures from 0 to 185 deg F; listed per UL181B and labeled "UL181B-C".
- F. Gasketing: Vinyl nitrile, vinyl neoprene, or neoprene nitrile PVC blend; designed for HVAC use with size to suit the application having minimum 1.5-inch width at equipment roof curb applications. Fire hazard rating not to exceed 25 for flame spread and 50 for smoke development per ASTM E 84.
- G. Duct Sealant/Mastic: Water based duct sealant, listed per UL 181B-M and UL 181A-M, suitable for indoor and outdoor use. Fire resistant with a flame spread rating of 5 or less, and a smoke developed rating of 0. Sealant shall be resistant to ultraviolet radiation and ozone. Fiberglass mesh shall be minimum 0.006-inches thick, with minimum 9 x 9 weaves per inch, and 2-inch width; for use with mastic in sealing ductwork. Sealant system shall be suitable for duct system pressure class and materials used with. Carlisle Hardcast "Versa-Grip 181".
- H. Foil Tape: Foil back adhesive tape, listed per UL181A-P and UL181B-FX, with listing labeled on tape outer foil face. Minimum 3-inch width for metal-to-metal applications; minimum 2-inch width for flexible duct applications. 3M No. 3340 or Nashua No. 324A.

## 2.3 DUCT FABRICATION

- A. Duct Gauge and Reinforcement: Shall be as shown in SMACNA-DCS according to the pressure classification of the system and the duct dimensions; with heavier gauge duct used as required to minimize duct reinforcement to suit space available and other project constraints.
- B. Joints and Seams: Construct in accordance with SMACNA-DCS, code requirements, and these specifications (more stringent governs). Ducts shall be constructed and sealed so that the leakage criteria is not exceeded. Round ducts shall be the spiral seam type; except that branch ducts to individual air inlets/outlets less than 16" diameter may be of other types as allowed by SMACNA-DCS. Coordinate joint spacing with duct reinforcement requirements so that transverse joints having the required stiffness may be incorporated in the reinforcement spacing schedule. Round duct transverse joints shall be made with beaded sleeve joints or flanged connections in accordance with SMACNA-DCS; except that branch ducts to individual air inlets/outlets less than 16" diameter may use other joining methods as allowed by SMACNA-DCS.
- C. Elbows and Tees: Shall be long-radius type with a center-line radius not less than 1-1/2

times the width or diameter of the duct. Where space does not permit the use of long-radius elbows, short-radius or square elbows with turning vanes may be used. Elbows in round duct systems with duct pressure class above 2-inches shall be stamped type, welded segmented type, or standing seam segmented type.

- D. Transitions: Increase duct sizes gradually. Transitions for diverging air flow shall be made with each side pitched out not more than 22.5 degrees. Transitions for converging air flow shall be made with each side pitched in not more than 30 degrees. Except that eccentric transitions for round to flat oval may have up to a 45 degree pitch.
- E. Branch Connections: Shall comply with SMACNA-DCS, and as required herein.
  - 1. Rectangular-to-Rectangular: Rectangular take-off with 45 degree angle on "inside" of take-off, minimum 4" length. Reference SMANCA-DCS Figure 4-6. Close corner openings.
  - 2. Rectangular-to-Round:
    - a. Serving Individual Air Inlet/Outlet: Spin-in type connector or air-tight take-off (unless a different fitting type is specifically noted).
    - b. Serving Branch Duct: Rectangular to round transition, with maximum degree pitch as specified for transitions. Rectangular end size shall have free area no less than round end. Rectangular connection to rectangular main shall be made as specified for "Rectangular-to-Rectangular" connections.
    - c. Serving Individual VAV Terminal Unit: Conical type connector, with connector 2" larger on one end and maximum 15 degree pitch on sides.
  - 3. Round-to-Round:
    - a. Serving Individual VAV Terminal Unit: Conical type connector (or conical tee fitting), with connection at the main duct 2" larger than the end serving the VAV terminal unit, and a maximum 15 degree pitch on sides; or "Lo-Loss" tee fitting, equivalent to that manufactured by United McGill.
    - b. Other Connections: Air-tight take-off or constructed in accordance with SMACNA-DCS and recognized professional practices.
  - 4. Other Connections: In accordance with SMACNA-DCS and recognized professional practices.
- F. Ductmate Systems:
  - 1. Rectangular Duct: Transverse duct joints may be made with Ductmate System, or approved equal. System shall consist of companion flanges of 20 gauge galvanized steel with an integral polymer mastic seal; corner pieces of 12 gauge G90 galvanized steel; 20 gauge G90 galvanized cleats; closed cell, high density gasket type; and galvanized carriage bolts with hex nuts. The flanges shall be securely fastened to the duct walls using self-drilling screws, rivets or spot welding. Fastener spacing shall be as recommended by the manufacturer for the size of duct and the pressure class. The raw duct ends shall be properly seated in the integral mastic seal. A continuous strip of gasket tape, size 1/4" x 3/4", shall be installed between the mating flanges of the companion angles at each transverse joint; and the joint shall be made up using 3/8-inch diameter x 1-inch long plated bolts and nuts. Galvanized drive-on or snap-on cleats shall be used at spacing recommended by the manufacturer.
  - 2. Round Duct: Transverse duct joints may be made with Ductmate "Spiralmate" system, or approved equal. System shall consist of galvanized steel round connector flanges (fitting inside each duct section to be joined) and an exterior galvanized steel closure ring with tightening bolt to form an airtight duct connection and join flanges together.

Duct connector flanges shall have non-hardening integral mastic to seal between flanges and duct, and a neoprene gasket to seal flange faces.

G. Lined Ductwork:

1. Rectangular Ducts: Contractor Fabricated ductwork with interior duct lining. Duct fabrication and liner installation shall comply with NAIMA-DLS. Lining material shall comply with paragraph titled "Duct Lining" in this specification section.
2. Round and Oval Ducts: Shall consist of acoustic insulation in between a perforated interior duct liner and solid exterior duct. Acoustic insulation shall be 1-inch thick, except where noted to be greater. Duct sections shall connect by mechanical means to maintain positive concentricity of liner with duct. All fittings and transitions shall have perforated inner liner (except where noted otherwise). Lining material shall comply with paragraph titled "Duct Lining" in this specification section. United McGill "Acousti-k27" (or approved).

2.5 FLEXIBLE DUCT

- A. Type: Factory insulated fully lined flexible duct.
- B. Construction: Double-ply neoprene coated polyester fabric hose, reinforced with a steel wire helix. Black color. Fire hazard rating not to exceed 25 for flame spread and 50 for smoke development, as tested by ASTM E84.
- C. Thermal Characteristics: Certified thermal resistance "R" of 4.2 Hr-SF-deg F/Btu, rated in accordance with ADC-FLEX. Except where duct is installed in an unconditioned area (and where required by code) provide certified thermal resistance "R" of 8 Hr-SF-deg F/Btu, rated in accordance with ADC-FLEX.
- D. Working Pressure: As required to suit maximum pressure to be encountered on system, but no less than 4-inch wc positive, 0.5-inch wc negative.
- E. Length: Shall not exceed 8 feet where used on duct systems with a pressure class of 2-inches and less; maximum 5 feet length on higher pressure class systems.
- F. Code Compliance: Comply with code and applicable standards; including NFPA 90A, NFPA 90. Shall be UL listed and labeled as a Class 1 connector per UL 181.

2.6 DUCT LINING

- A. Material: Flexible, inorganic glass fiber material, bonded with thermosetting resin, maximum thermal conductivity of 0.24 Btu-inch/hr-sq. ft.-degree F at 75 degrees F, coated to prevent erosion, conforming to NAIMA-DLS and exceeding that standard as specified herein. Suitable for air temperatures to 250 degrees F, and duct velocities to 6000 feet per minute. Surface shall be coated with an acrylic coating having anti-microbial agents and factory applied edge coating. Johns-Manville "Permacote Linacoustic" (or approved).
- B. Thickness: Lining shall be 1-inch thick except where noted otherwise.
- C. Adhesives and Fasteners: Shall conform to NAIMA-DLS, and as suitable for the duct liner material and ductwork.
- D. Fungi and Bacteria Resistance: Conform to ASTM C 1338 and ASTM G21 for fungi



resistance and ASTM G 22 for bacteria resistance.

### PART 3 EXECUTION

#### 3.1 DUCTWORK INSTALLATION

- A. General: Install all ductwork with all accessories and connections to provide complete and operable duct systems, in accordance with plans and specifications. See Section 220529 for hangers and supports. Provide quality assurance review of all drawings prior to beginning work (see paragraph titled Quality Assurance, this specification Section and see Section 220500). Provide duct and plenum sizes and locations as shown on the drawings; except as adjusted for field conditions and work of other trades, and with prior approval of the Engineer. See Section 220500 for offsets and transitions to be included in project.
- B. Coordination: The Contractor shall fully coordinate the work of all trades to avoid interferences and conflicts. Due to the extremely tight spaces in portions of the building, the Contractor shall coordinate duct reinforcement spacing and supports with other trades as necessary to avoid interferences. In addition, the Contractor shall select duct gauge and reinforcement types to avoid interferences. Changes required due to lack of coordination between trades, improper spacing or selection of hangers, or improper duct gauge and reinforcement selection, shall be done at no additional cost to the owner.
- C. Field Measurements: Prior to fabricating any duct materials, the Contractor shall field measure all areas where ducts will be installed to verify room available and all offsets and fittings required. Field verify connection sizes and locations to equipment, louvers, and similar items.
- D. Workmanship: All work shall comply with code, SMACNA-DCS, and other applicable standards. Ducts shall be installed level (unless noted otherwise) and in neat lines with the building construction using best professional practices.
- E. Exposed Ducts:
  - 1. All ducts are to be installed concealed unless indicated otherwise. Ducts that are exposed shall be carefully fabricated, stored, and installed for best appearance. All dents, dings, scratches and other damage shall be repaired for a high quality finished look; all dirt, debris, labels, stickers, lettering, and marks removed; and the duct completely cleaned. Any sealant shall be cleaned to form a straight and even seam adjacent to joints, have no overlap onto duct areas not needing sealant, and have all excess sealant removed (mask off adjacent areas as necessary).
  - 2. Outdoor exposed ducts shall have "hat" type channels installed over all joints (top and sides) to prevent entry of water.
- F. Flexible Duct: May only be used where specifically shown on the plans. Attach flexible duct inner core to sheet metal duct (or connector) with draw band. For insulated type, pull insulation and outer jacket completely over the inner core (at the connection to the sheet metal duct) with outer jacket covering the inner core and tucked back at its end to provide a continuous vapor barrier cover; install draw band to secure the outer jacket and insulation. Use metal type draw bands on duct systems where duct pressure class exceeds 3-inches or where temperature or other conditions do not allow the non-metal type and where indicated; use type of metal suitable for the conditions without corrosion or other deterioration. Install

flexible duct with a centerline turning radius not less than one duct diameter. Where this turning radius cannot be maintained with the flexible duct use sheet metal elbows or (at air inlets/outlets) provide a plenum having a side connection.

- G. Spin-in Fittings/ATTO's: May be used for branch ducts to individual outlets only. Apply a bead of duct sealant to all spin-in fittings where fitting seals against sheet metal duct.
- H. Sealing:
  - 1. General: Use materials listed and approved for the specific application. Foil tape may only be used at duct connections to air inlets/outlets (unless specifically noted otherwise). Clean surfaces to be sealed of moisture and all contaminants. Seal joints in accordance with SMACNA-DCS, sealant manufacturer's instructions, and UL 181.
  - 2. Ductwork: Seal to meet duct leakage criteria as follows:
    - a. Ducts upstream of VAV terminal units: Seal Class A.
    - b. Ducts downstream of VAV terminal units: Seal Class C.
    - c. Ducts with pressure Class 3" and greater: Seal Class A.
    - d. Ducts with pressure Class 2": Seal Class B.
    - e. Ducts with pressure Class 1" and less: Seal Class C.
  - 3. Flexible Duct: Coat connection of flexible duct to metal duct with duct sealant prior to installing the flexible duct.
  - 4. Air Inlets/Outlets: Seal duct connections (including "cans" or plenums) at air inlets and air outlets with duct sealant or foil tape; except at louvers and exposed ducts only sealant shall be used.
  - 5. Exterior Ductwork: Special attention and effort shall be applied to the sealing of exterior ductwork to prevent any entry of water. Sealant shall be applied to all seams and joints prior to assembly in order to provide a layer of sealant which is continuous through the joint or seam. Additional sealant shall then be applied to the exterior of the joint or seam to ensure a weathertight closure. Any leakage or damage from water leakage into duct or building shall be repaired at no additional cost to the Owner.
- I. Ductmate: All "Ductmate" and similar systems shall be installed in strict accordance with manufacturer's instructions.
- J. Underground Ductwork: Shall be fiberglass reinforced duct or minimum 20 gauge galvanized steel encased in 4 inch thick concrete. Fiberglass duct installation shall be in strict accordance with manufacturer's instructions, including but not limited to, the following: duct to be installed in a trench with provision for good drainage and an allowance for a minimum of 4-inch pea gravel or dry sand to completely encase the duct. The top of the duct shall be at least 6 inches below the bottom of the concrete slab. Field joints to be watertight. Galvanized sheetmetal may be used for custom transitions, fittings, and where indicated; and shall be encased in a minimum of 4-inch thick concrete.
- K. Protective Caps: Provide temporary sheetmetal caps or heavy visqueen covers over all open portions of ductwork to prevent debris, dirt, and dust from entering the ductwork. Such covers shall be installed at the end of each work shift, and shall remain in place until all work activities or events that may cause duct contamination will no longer occur.

### 3.2 ACOUSTICAL DUCT LINING INSTALLATION

- A. General: Install acoustical duct lining in ducts to extent shown on drawings, covering all interior surfaces. Round ducts shall use factory fabricated double-wall ducts as specified.

- B. Installation: Installation shall comply with NAIMA-DLS and these specifications. The liner shall be cut to assure tightly butted joints.
- C. Liner Attachments: The duct liner shall be applied with a 100% coverage of adhesive. Mechanical Fasteners shall be installed flush with the liner surface, and shall be spaced in accordance NAIMA-DLS.
- D. Horizontal Duct Runs: Tops of ducts over 12" wide and sides of duct over 16" high shall have liner additionally secured with mechanical fasteners.
- E. Vertical Duct Runs: Any side of duct over 12" in size shall have liner additionally secured with mechanical fasteners.
- F. Exposed Edges: All joints, exposed edges and any damaged areas of the liner, shall be heavily coated with fire resistant adhesive/mastic.
- G. Metal Nosing: Install metal nosings on the leading edges of the liner in ducts where the velocity exceeds 4000 feet per minute.

### 3.3 PREPARATION FOR SERVICE

- A. Cleaning: All ducts shall be wiped or blown clean of all dust and debris prior to the installation of grilles or diffusers. Notify the Engineer to allow for an inspection prior to installing grilles or diffusers.
- B. Contaminated Ducts: Where ducts have been contaminated by dirt or debris during the construction process, the affected duct systems shall be cleaned by an independent firm specializing in the vacuum cleaning of ductwork. All costs associated with such cleaning shall be the responsibility of the Contractor.

### 3.4 DUCT PRESSURE TESTING

- A. Tested Systems: All supply air duct systems shall be tested.
- B. Duct Pressure Class > 2-inches:
  - 1. Cap all outlets temporarily to isolate the portion of the system being tested.
  - 2. Use portable blower with volume adjustment and a calibrated orifice for determining cfm of air being added to ductwork. Maintain duct system rated pressure in duct; examine each section at this pressure, and seal all observable leaks so that leakage during final testing will be at or below maximum permissible leakage.
  - 3. Maximum Permissible Leakage: See "Quality Assurance" paragraph, Part 1 of this specification section.
  - 4. Final test of each section shall be witnessed by the Architect/Engineer or Owner's representative. Give Architect/Engineer at least 7 days prior notice before such test.
  - 5. Test Data: Record data of test results of final test only, including sketch or diagram of tested section, computation of total system cfm, allowable leakage and actual leakage found during test. Submit two copies to Architect/Engineer.
- C. Duct Pressure Class  $\leq$  2-inches: Air balancers readings will be used to determine percent leakage of ductwork. Where leakage exceeds allowable by 25% or less, sealing shall be provided at all potential leak spots. Where leakage exceeds allowable by more than 25%, the system shall be re-sealed and the Sheetmetal Contractor shall pay the Balancer to re-measure

and determine the new leakage rate.

### 3.5 COMMISSIONING

- A. The Products referenced in this section are to be commissioned per Division 01 and Section 230800 - Commissioning. The Contractor has specific responsibilities for scheduling, coordination, startup, test, development, testing and documentation. At a minimum, the Contractor shall provide a documented and signed record to verify that all equipment and systems installed under this contract have been inspected and functionally tested to verify full compliance with the contract specifications. In many cases, this shall require the Contractor to create or otherwise provide procedures and checklists for approval by the Commissioning Consultant prior to the start of functional testing. Reference Division 01 and Section 230800 and coordinate all commissioning activities with the Commissioning Consultant.

END OF SECTION

## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 200500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Manual Dampers.
- B. Fire Dampers.
- C. Combination Fire/Smoke Dampers.
- D. Smoke Dampers.
- E. Backdraft Dampers.
- F. Turning Vanes.
- G. Flexible Connectors.
- H. Duct Access Doors.
- I. Air Measuring Units.
- J. Duct Thermometers.

### 1.3 QUALITY ASSURANCE

- A. General: Comply with Section 200500.
- B. Workmanship: Construction and installation of all duct accessories shall comply with applicable SMACNA-DCS, and exceed those standards as noted.
- C. Fire dampers, combination fire/smoke dampers, and smoke dampers shall be UL listed.

### 1.4 SUBMITTALS

- A. General: Submittals shall comply with Section 200500.
- B. Product Data: Submit product information on all items to be used.
- C. Sound Attenuators: Submit dynamic insertion loss and pressure drop data for all sound attenuators. Submit listing of all sound attenuators by unit served, airflow application, cfm, size, velocity, and pressure drop.

## 1.5 REFERENCES

- A. AMCA 500D: Laboratory Methods for Testing Dampers for Rating.
- B. SMACNA-DCS: SMACNA HVAC Duct Construction Standards, 3rd Edition.
- C. UL 555S: Smoke Dampers.
- D. UL 555: Fire Dampers.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Products shall comply with Section 200500, Paragraph 2.1, Acceptable Manufacturers.
- B. Manual Damper Hardware: Duro-Dyne, Young Regulator Co., Ventfabrics, Krueger, Rossi.
- C. Fire Dampers, Combination Fire/Smoke Dampers and Smoke Dampers: Ruskin, National Controlled Air, Air Balance, Greenheck.
- D. Backdraft Dampers: Air Balance, Ruskin, Greenheck.
- E. Turning Vanes: Duro-Dyne, Aero-Dyne, Oil Capital Sheet Metal, Airsan.
- F. Flexible Connections: Ventfabrics, Duro-Dyne Elgen.
- G. Duct Access Doors: National Controlled Air, Ventfabrics, United-McGill, Kees, Ruskin, Vent Products, Duro-Dyne.
- H. Air Measuring Units: Cambridge Filter Corp., Monitor Corp.
- I. Building Access Doors: J.R. Smith, Zurn, Acudor, Elmdoor, Kees, J.C. Industries, Milcor.
- J. Duct Thermometers: Weksler, Weiss.

### 2.2 MANUAL DAMPERS

- A. Type: Manually adjustable volume dampers.
- B. Blades: Damper blades shall be fabricated of galvanized steel or stainless steel (unless a specific material is indicated), two gages heavier than duct in which installed, and in accordance with SMACNA-DCS. Maximum blade width 12 inches; fabricate multi-blade dampers with opposed blade pattern for ducts larger than 12" x 48".
- C. Regulators: Damper regulator sets shall have quadrant dial regulator with locking nut, square end bearing one side, and spring round end bearing other side (small sizes) or open end square bearing (larger sizes), axis of blade the long dimension. Multiple blade dampers shall have individual quadrants for each blade or one quadrant with interconnected blades. Regulator sets shall be Duro-Dyne model numbers (or approved equal) as follows:

Max. Blade		
<u>Dimension</u>	<u>Duro-Dyne Regulator Set</u>	<u>Shaft Size</u>
10" and less	KS-145, 145L	1/4"
11" to 14"	KSR-195, 195L	3/8"
15" to 23"	SRS-388, SB-138, KP105	3/8"
24" and larger	SRS-128, SB-112, KP105	1/2"

- D. Concealed Regulator: For remote damper adjustment with finished ceiling appearance. Shall consist of self-locking regulator of cast alloy construction (with serrated core, spring washer, housing, indicator, lock nut) cast into a cylindrical housing for flush ceiling installation. Housing cover shall be of steel construction, shall telescope into the regulator housing to be flush with the finished ceiling, and be secured to the housing with two screws. Provide with extension rods, linkages, miter gears, and all accessories as needed for proper damper operation. Plain Finish. Ventfabrics No. 666, 667 or Young Regulator Co. No. 301 (or approved equal).
- E. Extractor Fittings: Galvanized steel construction, 24 gauge steel blades on 2 inch centers, with worm gear operator for adjustment through face of grille. Krueger EX-88 (or approved equal).

### 2.3 MANUAL DAMPERS – CABLE OPERATED

- A. General: Cable operated system of dampers and rack and pinion type controller, made for use to allow remote damper adjustment.
- B. Round Dampers: Constructed of heavy duty galvanized steel duct with rolled-in stiffening beads for rigidity. Damper minimum 20 gauge galvanized steel blade secured with 1/2" diameter steel shaft and high strength Teflon bushings requiring no lubrication. Damper shall include all necessary hardware to ensure compatibility with remote cable control system. Young Regulator Model 5020-CC (or approved).
- C. Rectangular Dampers: Opposed blade type constructed of 0.050 minimum heavy duty extruded aluminum frames and blades. Damper blades to include individual blade bushings; damper blades shall rotate between a matched pair of formed and punched 306 stainless steel connecting slide rails that facilitate smooth blade movement and ensure alignment. All necessary hardware to ensure compatibility with remote cable control system shall be included. Young Regulator Model 830A-CC series (or approved).
- D. Cable Control: Cable to consist of 0.054" stainless steel cable encapsulated in 1/16" flexible galvanized spiral wire sheath. Control hardware shall be designed for use with damper to be controlled with wall mounted. Control hardware shall include 14 gauge steel rack and pinion gear drive, controls shaft shall be flatted 1/4" diameter with 265-degree rotation provided linear travel capability. Where ceiling access is indicated provide with concealed regulator assembly; wall mounted shall have exposed knob control, with position indicator. Young Regulator Model 270-275 or 270-301 or 270-700 to suit application (or approved).

### 2.4 FIRE DAMPERS

- A. Type: Dynamic rated fire dampers, UL labeled, conforming to UL 555 and NFPA 90A.
- B. Fire Resistance: Dampers shall have a 1-1/2 hour fire rating (unless a longer rating is

indicated or required by code).

- C. Construction: Shall be factory-fabricated of galvanized steel, or stainless steel (unless a specific material is indicated). Dampers shall be equipped with a steel sleeve or steel frame, arranged for installation such that disruption of the attaching ductwork will not impair damper operation.
- D. Configuration: Shall be folding blade curtain type, with blades stacked outside of the airstream so as not to reduce the net free area of the duct. Except that fire dampers required to be provided in multiple sections due to large sizes (larger than 30" x 30"), may have the damper and associated frame located in the airstream. Damper assembly shall be complete with sleeve length, sleeve gauge, retaining plates/angles, duct connection transitions, and accessories to suit the application, operate properly, and conform to damper UL listing and code. Shall be for horizontal or vertical installation to suit application required.
- E. Fusible link: Shall be UL listed and set for 50 degrees above maximum temperature expected in duct, but in no case less than 165 degrees F.
- F. Operation: Shall be automatic operating type, with, dampers weighted or spring operated to close when released by fusible link.
- G. Dynamic Rating: Shall suit maximum velocity and pressure differential to which dampers will be subjected.

## 2.5 COMBINATION FIRE/SMOKE DAMPERS

- A. Type: Combination fire smoke dampers, UL labeled, conforming to UL 555, UL 555S, NFPA 90A, NFPA 92A, NFPA 92B.
- B. Leakage Rating: Class I. Dampers shall be classified as Leakage Rated Dampers for use in Smoke Control Systems per UL 555S.
- C. Fire Resistance: Dampers shall have a 1-1/2 hour fire rating (unless a longer rating is indicated or required by code).
- D. Operational Temperature: Assembly shall be qualified by UL 555S to operate at 250 degrees F.
- E. Construction: Frame shall be of minimum 5" x 1" 16 gauge galvanized steel channel, with 4" to 7" wide blades constructed of 16 gauge galvanized steel. Blade edge seals shall be silicone type; jamb seals shall be stainless steel compression type. Axles shall be 1/2" plated steel hex, with stainless steel bearings pressed into frame. Provide with factory steel sleeve or steel frame, arranged for installation such that disruption of the attaching ductwork will not impair damper operation.
- F. Configuration: Actuator exterior of damper sleeve assembly, except where damper occurs immediately behind an air inlet/outlet, and where the actuator would not otherwise be accessible, configuration shall allow through grille (or through duct access door) access to damper and actuator. Damper assembly shall be complete with sleeve length, sleeve gauge, retaining plates/angles, duct connection transitions, actuators, and accessories to suit the application and conform to damper UL listing and code.



- G. Operation: Dampers shall be automatic operating and shall be spring operated to close when released by resettable link or by loss of power to actuator. Closure shall be controlled type to prevent duct damage from instantaneous closure. Momentary contact test switch shall allow for testing of damper closure.
- H. Resettable Link: Electric, manually resettable type with bimetal heat responsive device to activate damper at set temperature. Set to operate for 50 degrees above maximum temperature expected in duct but in no case less than 165 degrees F. Provide with momentary contact reset switch, factory wired to actuator, in accessible location at damper.
- I. Test Switch: Momentary contact test switch, in accessible location at damper, to allow test of damper closure by pressing switch, factory wired to actuator, in accessible location at damper.
- J. Actuator: Shall be for use with 120 volt 60 Hz AC power, two position spring return type to close damper upon loss of power (except where indicated to be a different arrangement or are part of an engineered smoke control system requiring modulating operation). Actuators shall be rated for continuous energized hold open position. Actuator shall be in a NEMA rated enclosure suitable for the conditions the actuator will be exposed to.
- K. Operational Rating: Damper shall be rated for use with the maximum velocities and pressure differentials to which they will be exposed; but no less than 2000 fpm and 4 in w.g. differential pressure.
- L. Smoke Detector: UL listed duct smoke detector with air sampling tube. Factory mounted and wired to damper assembly to activate damper in the event of detection of smoke. For use with 120 volt 60 Hz AC power. Provide with clear cover. Detector shall have auxiliary contacts which close on an alarmed condition for use by other building systems.

## 2.6 SMOKE DAMPERS

- A. Type: Smoke dampers, UL labeled, conforming to UL 555S, NFPA 90A, NFPA 92A, NFPA 92B.
- B. Leakage Rating: Class I. Dampers shall be classified as Leakage Rated Dampers for use in Smoke Control Systems per UL 555S.
- C. Operational Temperature: Assembly shall be qualified by UL 555S to operate at 250 degrees F.
- D. Construction: Frame shall be of minimum 5" x 1" 16 gauge galvanized steel channel, with 4" to 7" wide blades constructed of 16 gauge galvanized steel. Blade edge seals shall be silicone type; jamb seals shall be stainless steel compression type. Axles shall be 1/2" plated steel hex, with stainless steel bearings pressed into frame. Provide with factory steel sleeve or steel frame, arranged for installation such that disruption of the attaching ductwork will not impair damper operation.
- E. Configuration: Actuator exterior of damper sleeve assembly, except where damper occurs immediately behind an air inlet/outlet, and where the actuator would not otherwise be accessible configuration shall allow through grille (or through duct access door) access to damper and actuator. Damper assembly shall be complete with sleeve length, sleeve gauge, retaining plates/angles, duct connection transitions, actuators, and accessories to suit the

application and conform to damper UL listing and code.

- F. Operation: Dampers shall be automatic operating and shall be spring operated to close upon loss of power to actuator. Closure shall be controlled type to prevent duct damage from instantaneous closure. Momentary contact test switch shall allow for testing of damper closure.
- G. Test Switch: Momentary contact test switch, in accessible location at damper, to allow for testing damper operation when pressed.
- H. Actuator: Shall be for use with 120 volt 60 Hz AC power, two position spring return type to close damper upon loss of power (except where indicated to be a different arrangement or are part of an engineered smoke control system requiring modulating operation). Actuators shall be rated for continuous energized hold open position. Actuator shall be in a NEMA rated enclosure suitable for the conditions the actuator will be exposed to.
- I. Operational Rating: Damper shall be rated for use with the maximum velocities and pressure differentials to which they will be exposed; but no less than 2000 fpm and 4 in w.g. differential pressure.
- J. Smoke Detector: UL listed duct smoke detector with air sampling tube. Factory mounted and wired to damper assembly to activate damper in the event of detection of smoke. For use with 120 volt 60 Hz AC power. Provide with clear cover. Detector shall have auxiliary contacts which close on an alarmed condition for use by other building systems.

## 2.7 BACKDRAFT DAMPERS

- A. Type: Airflow and gravity operated backdraft dampers. Greenheck WD-100, WD-300, WD-400 (or approved equal).
- B. Frame: Shall be constructed of minimum 18 gauge galvanized steel or stainless steel or minimum 0.063 thick 6063T5 extruded aluminum (unless a specific material is indicated).
- C. Blades: Shall be constructed of minimum 0.025" thick formed aluminum, or stainless steel (unless a specific material is indicated), with extruded vinyl edge seals. Seals shall prevent any noise due to damper opening/closing. Bearings shall be synthetic polycarbonate or acetal type. Damper linkage shall be with aluminum or galvanized steel tiebar. Dampers with vertical airflow shall be spring assist type.
- D. Configuration: For horizontal or vertical airflow as indicated on plans.
- E. Performance:
  - 1. General: Dampers shall be tested in accordance with AMCA standards.
  - 2. Pressure Drop: Not to exceed 0.05 inch w.g. at 250 fpm with vertical airflow; and not to exceed 0.07 inch w.g. pressure drop for horizontal airflow.
  - 3. Leakage: Dampers used to prevent the entry of outdoor air shall have air leakage no greater than 20 cfm/sf at 1-in w.g. where not less than 24-inches in any dimension, and no greater than 40 cfm/sf where less than 24 inches in any dimension; when tested in accordance with AMCA 500D.
  - 4. Pressure and Velocity Ratings: Shall suit maximum velocity and pressure differential to which dampers will be subjected; but no less than 1500 fpm and 1.0-in w.g. differential pressure.

## 2.8 COUNTERBALANCED BACKDRAFT DAMPERS - LOW PRESSURE DROP

- A. Type: Airflow and gravity operated backdraft dampers with adjustable counterbalance weight. Ruskin CBD6.
- B. Frame: Shall be constructed of minimum 18 gauge galvanized steel or stainless steel or minimum 0.125-inch thick 6063T5 extruded aluminum (unless a specific material is indicated).
- C. Blades: Shall be constructed of minimum 0.07-inch thick extruded aluminum, or formed stainless steel (unless a specific material is indicated), with extruded vinyl edge seals. Seals shall prevent any noise due to damper opening/closing. Bearings shall be synthetic polycarbonate or acetal or zytel type. Damper linkage shall be with aluminum or galvanized steel tiebar. Counterbalance weights shall be attached to blades, be of galvanized steel construction, and be adjustable.
- D. Configuration: Horizontal or vertical airflow as indicated on plans.
- E. Performance:
  - 1. General: Dampers shall be tested in accordance with AMCA standards.
  - 2. Temperature Rating: -40 to 200 degrees F.
  - 3. Closed Position: Withstand maximum back pressure of 16 inches w.g.
  - 4. Open Position: Withstand maximum air velocity of 2,500 feet per minute.
  - 5. Operation of Blades: Start to open at 0.02 inch w.g.; fully open at 0.05 inch w.g.
  - 6. Pressure Drop: Maximum 0.025 inch w.g. at 700 feet per minute, maximum 0.15 inch w.g. at 1,500 feet per minute.
  - 7. Dampers used to prevent the entry of outdoor air shall have air leakage no greater than 20 cfm/sf at 1-in w.g. where not less than 24-inches in any dimension, and no greater than 40 cfm/sf where less than 24 inches in any dimension; as tested in accordance with AMCA 500D.
- F. Depth of Operation: Depth required to operate shall not exceed 10-inches.

## 2.9 TURNING VANES

- A. Type: Galvanized steel turning vanes to guide airflow through duct elbows to minimize pressure drop.
- B. Construction: Turning vanes shall comply with SMACNA-DCS. Vanes shall be fabricated of minimum 26 gauge galvanized steel; rails shall be fabricated of minimum 24 gauge galvanized steel. For duct widths less than 12 inches, vanes may be single wall construction; for widths 12" and greater, vanes shall be double wall "airfoil" type.
- C. Spacing: Turning vanes shall be equally spaced in accordance with SMACNA-DCS, parallel to each other, and securely attached to runners.
- D. Unequal Elbows: For elbows where the inlet and outlet dimensions are not the same, modify vane shape or angle to provide optimum turning.

## 2.10 ACOUSTICAL TURNING VANES

- A. Type: Double-wall perforated acoustical turning vanes. Airsan "Acoustiturn" (or approved

equal).

- B. Construction: Shall comply with SMACNA-DCS. Vanes shall be airfoil shape, double-wall factory fabricated of 14 gauge aluminum, with inner wall perforated metal, and filled with fiberglass media. Rails shall be fabricated of minimum 24 gauge galvanized steel construction.
- C. Spacing: Turning vanes shall be equally spaced in accordance with SMACNA-DCS, parallel to each other, and securely attached to runners.
- D. Unequal Elbows: For elbows where the inlet and outlet dimensions are not the same, modify vane shape or angle to provide optimum turning.

## 2.11 FLEXIBLE CONNECTORS

- A. Type: Flexible fabric type connectors, to provide vibration isolation at equipment duct connections and to allow for movement in duct systems.
- B. Fabric:
  - 1. Width: Minimum 3" wide except at equipment 3 hp or larger with external vibration isolators fabric shall be minimum 6" wide.
  - 2. Indoor Applications: Flexible woven glass fiber fabric with neoprene coating, minimum 22 oz/sq. yard, 500 lbs x 450 lbs tensile strength. Suitable for temperatures from -40 to 200 deg F.
  - 3. Outdoor Applications and Where Exposed to Chemicals: Flexible woven glass fiber fabric with hypalon coating, ozone resistant, 24 oz/sq. yard, 225 lbs x 300 lbs tensile strength. Suitable for temperatures from -40 to 250 deg F.
  - 4. High Temperature Applications: Fiberglass/satin weave with Teflon coating; temperature rating of minimum 500 deg F and to suit application, 400 lbs x 300 lbs tensile strength.
- C. Metal Collars: Minimum 24 gauge galvanized steel 3" wide metal edge connectors, each side of fabric, connected to fabric by folded over metal seam. Fabricate of same material as ducts connected to.
- D. Fire/Smoke Rating: Flame spread rating not over 25, and smoke developed rating not higher than 50; complying with IMC requirements and NFPA standards.

## 2.12 DUCT ACCESS DOORS

- A. Construction: Access doors shall be of double wall construction, made with minimum 24 gage galvanized steel, tight fitting, with sealing gasket, and cam locks (or may be hinged type with latches).
- B. Size:
  - 1. General: Access doors shall be of sufficient size so that items concealed in duct can be serviced and inspected, and shall be adequately sized to allow complete removal of the item being served (where removal cannot be made without disturbing fixed ductwork).
  - 2. Minimum size: Doors shall be minimum 14" x 14". Where duct size will not accommodate this size door, the doors shall be made as large as practicable.
  - 3. Large Sizes: Doors larger than 14" x 14" shall have a minimum of 4 cam locks (or where hinged type is used, have a minimum of two (2) latches).

- C. Insulation: Doors in insulated ducts shall be insulated type, with minimum 1 inch thick fiberglass insulation.
- D. Round Ducts: Access doors on round ducts shall use either lined rectangular tap off with rectangular access door or curved insulated access door (for insulated duct); or curved type un-insulated access door (for un-insulated duct).

## 2.13 BUILDING ACCESS DOORS

- A. Type: Hinged lockable steel access doors, for wall or ceiling installation.
- B. Construction: Minimum 16 gauge frame and 14 gauge door, concealed hinge, cam and cylinder lock, anchoring provisions, and 1" wide frame to conceal rough building opening. Provide of 18-8 stainless steel construction with No. 4 finish where used in restrooms, locker rooms, kitchens, and similar "wet" areas. Provide of steel construction with prime coated finish in other areas.
- C. Size: Size shall be 12" x 12" (unless indicated otherwise) but shall be large enough to allow necessary access to item being served and sized to allow removal of the item (where access door is the only means of removal without disturbing fixed construction).
- D. Fire Rating: Door shall maintain fire rating of element installed in; reference drawings for required rating.
- E. Keys: Access doors shall all be keyed alike. Provide two (2) keys for each door.

## 2.14 AIR MEASURING UNITS

- A. Type: Multiple pitot tube type for measuring velocity pressure and corresponding airflow.
- B. Construction: Units shall have 16 gauge (minimum) galvanized steel casing; copper or aluminum pressure sensing tubing; and 4 inches minimum depth aluminum air-straightening grid.
- C. Airflow Sensing: Air flow sensing shall be by pitot tube; maximum of 144 square inches per static pressure sensor; maximum of 36 square inches per total air pressure sensor; sensors shall measure equal areas; sensors in circular ducts shall measure equal annular areas; sensors shall be interconnected to give average reading; output shall be suitable for control purposes as required.
- D. Air Flow Meters: Diaphragm actuated differential pressure gauge, mounted on metal panel, calibrated to read cfm and fpm. Gauge shall be labeled indicating the fan or system being measured, and the design cfm.
- E. Free Area: Units shall have free area at least 97% of connecting duct size area.

## 2.15 DUCT THERMOMETERS

- A. Type: Dial bi-metal.
- B. Construction: Minimum 3-inch diameter corrosion protected case, remote or direct type bulb as required, plus or minus 1% (of scale range) accuracy, white face with black digits

graduated in 2 degrees F increments. Thermometer wells of the separable socket-type shall be provided for each thermometer with direct-type bulb.

- C. Ranges:
  - 1. Sensing Outdoor Air: -20 to 120 degrees F.
  - 2. Sensing Supply Air: 30 to 130 degrees F.
  - 3. Sensing Return Air: 30 to 130 degrees F.

## 2.16 SOUND ATTENUATION MATERIALS

- A. Sound Barrier Wrapping Materials: Peabody Kinetics Model KNM-100F1 (1 lb./SF) loaded vinyl limp mass barrier material, with a STC of 27 or better.
- B. Damping Compound: Peabody Kinetics Type KDC-E-162 viscoelastic emulsion damping material.

## 2.17 DUCT SMOKE DETECTORS

- A. Supplied by Division 26.

# PART 3 EXECUTION

## 3.1 MANUAL DAMPERS

- A. General: Dampers shall be fabricated and installed in accordance with SMACNA-DCS requirements for volume dampers.
- B. Locations: Install dampers at locations shown on the drawings in branch ducts to all air inlets/outlets, and at all other locations as required by the Balancer to allow for the balancing of the system. Locate dampers at a point where the damper is most accessible; orient damper regulator for best access.
- C. Non Accessible Dampers: Provide flush-mounted concealed type damper quadrants for ducts concealed in walls or non-removable ceilings and where a remote damper operator has been indicated.
- D. Initial Setting: Set and lock all dampers in the full open position prior to balancing.
- E. Extractor Fittings: Provide where indicated on the plans and at wall type inlets/outlets where such outlets cannot be served by a manual damper in the branch duct.
- F. Identification: Provide orange surveyor's tape, approximately 18" long tied to each damper regulator (except not required on dampers in ducts exposed to view in finished areas).

## 3.2 FIRE DAMPERS, COMBINATION FIRE/SMOKE DAMPERS, SMOKE DAMPERS

- A. General: Install dampers with all necessary retaining angles, sleeves, breakaway connections and other materials as required to provide an installation equivalent to that utilized by the manufacturers when dampers were tested at UL and as required by code.
- B. Sleeves: Dampers shall be installed in a sleeve or casing which shall extend through the

building element that the damper is installed in. Sleeve shall connect to duct in accordance with manufacturers approved installation requirements and code.

- C. Sleeve Anchoring: Sleeve shall be anchored to wall or slab with minimum 1-1/2" x 1-1/2" x 14 gage angles on all four sides; angles shall be bolted, tack welded, or screwed to sleeve; angles shall overlap wall a minimum of one inch on all four sides.
- D. Damper Anchoring: Damper shall be bolted, tack welded or screwed to sleeve on all four sides.
- E. Wiring: Wiring to damper actuator shall be the responsibility of Division 26, unless indicated otherwise.
- F. Access Doors: Provide access doors to all dampers, locate on corridor or mechanical room side where possible. Label doors with pre-printed label "FIRE DAMPER ACCESS", (or "FIRE/SMOKE DAMPER ACCESS", "SMOKE DAMPER ACCESS") minimum 1" high letters, color in sharp contrast to background.
- G. Combination Fire/Smoke Damper Testing: Test operation of all fire/smoke and smoke dampers. Dampers shall operate (close) upon a smoke detector alarm (or building fire alarm system alarm), unit shall restore to its normal position upon restoration of the alarm to normal. The Contractor installing the dampers shall verify proper operation of each damper with the Division 26 Contractor present and submit signed documentation showing each individual damper has been satisfactorily tested.

### 3.3 BACKDRAFT DAMPERS

- A. General: Install in accordance with manufacturer's instructions.
- B. Application: Use counterbalanced type at all non-fan powered building exhausts and reliefs; all others shall be the standard type.
- C. Adjustments: Adjust counterbalanced backdraft dampers to be open at 0.07" building pressure (unless noted otherwise), or as necessary for proper space pressurization and building air balance. Coordinate work and settings with air balancer.
- D. Access Doors: Provide access doors to backdraft dampers, except that where damper is installed immediately behind a ceiling or wall grille, and is accessible by removing this grille, an access door is not required.

### 3.4 TURNING VANES

- A. General: Install turning vanes in all duct elbows and "T" fittings, and at locations shown on the drawings.
- B. Attachment: Securely attach turning vane runners to ductwork.

### 3.5 FLEXIBLE CONNECTORS

- A. General: Provide flexible connectors at all duct connections to all equipment, where ducts of dissimilar metals are connected, and where shown on the drawings. Except that flexible connectors are not required on internally spring isolated fans where the fan is located in a

separate mechanical room and a flexible connector has not been shown.

- B. Round: For round ducts, the flexible material may be secured by zinc-coated, iron clinch type draw bands directly to adjoining duct; or with normal duct joining methods and using metal collars furnished with flexible connectors.
- C. Slack: Install flexible connections with sufficient slack to permit 1 inch of horizontal or vertical movement of ducts or equipment at flexible connection point without stretching the flexible material. At building expansion joints install sufficient flexible material to allow for 2 inch movement in any direction; provide two flexible connectors separated by a 12 inch section of duct.
- D. Outdoors: Where installed exposed to outside weather, provide a galvanized "hat" channel protecting top and vertical stretches of flexible connector from sunlight and weather.

### 3.6 DUCT ACCESS DOORS

- A. General: Provide duct access doors at all automatic control dampers, fire dampers, fire/smoke dampers, smoke dampers, backdraft dampers, all duct coils, thermostats, filters, control devices, and any other components in the duct system that require service or inspection. Coordinate with Division 25 to confirm quantity and location of control devices.
- B. Return and Exhaust Ducts: Provide access doors every 20 feet in return and exhaust air ductwork as required by NFPA 90.
- C. Size and Location: Access doors shall be of sufficient size and so located so that the concealed items may be serviced and inspected or completely removed and replaced.

### 3.7 BUILDING ACCESS DOORS

- A. General: Provide access doors in walls, floors, ceilings, etc. as indicated on the drawings and where needed to provide service access or maintenance to duct access doors, backdraft dampers, damper actuators, automatic dampers, coils, control devices, fans, HVAC equipment and similar items.
- B. Coordination: Consult architectural drawings and coordinate location and installation of access doors with trades which are affected by the installation.

### 3.8 THERMOMETERS

- A. Thermometers shall be provided in the main supply, return, and outside air ducts to and from each air handling unit and where indicated or specified and shall be so located as to be easily read from the operating floor. Thermometers shall be duct-mounting or remote type.
- B. On thermally insulated ducts, casings, equipment, or piping, stand-off mounting brackets, bases, adapters, or extended tubes shall be provided. These items shall provide clearance not less than the thickness of the insulation. Stand-off mounting items shall be integral with the thermometer or standard accessories of the thermometer manufacturer.
- C. Remote-type thermometers shall have sensing elements or thermal elements with capillaries.

### 3.9 DUCT SMOKE DETECTORS



- A. Division 23 Contractor shall install the portions of duct smoke detectors that are installed in the ductwork. Installation shall comply with manufacturer's instructions; coordinate work and location with Division 26.

END OF SECTION



## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Ceiling Exhaust Fans.
- B. Rooftop Exhaust Fans.
- C. Rooftop Kitchen Upblast Fans.
- D. In-Line Exhaust Fans.
- E. Fan Accessories.

### 1.3 SUBMITTALS

- A. General: Comply with Section 220500.
- B. Product Data: Submit manufacturer's product data for all items to be used. Submit fan curves showing SP vs. CFM and BHP vs. CFM with system operating point clearly marked.
- C. Sound Power: Submit sound power level data showing sound power levels in decibels referenced to 10 watts for each of the eight octave bands (not required for fans under 2000 CFM). Submit sound power levels in sones for fans under 2000 CFM (or decibel values if available).

### 1.4 QUALITY ASSURANCE

- A. AMCA: Fans shall bear the AMCA certified seal unless indicated otherwise.

### 1.5 GENERAL REQUIREMENTS

- A. Spare Parts: Provide two complete sets of spare belts for all belt driven fans.

### 1.6 REFERENCES

- A. AMCA 210: Laboratory Methods of Testing Fans for Ratings.
- B. IMC: International Mechanical Code.
- C. UL 762: Power Ventilators for Restaurant Exhaust Appliances.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. General: Products shall comply with Section 220500. See Section 220500, paragraph 2.1 for Acceptable Manufacturer requirements.
- B. Exhaust Fans: Greenheck, Twin City, Penn Barry, Cook, Carnes.
- C. Accessories: Fan manufacturers listed, NCA, Ruskin, Thybar, RPS.

### 2.2 GENERAL

- A. Guards: All belt drives shall be equipped with belt guards, or enclosed within fan casing. Guards shall be factory fabricated and furnished with equipment, and comply with OSHA and WISHA regulations. Exposed openings into fan housings shall be protected with substantial metal screens or gratings.
- B. Drives: Shall be sized for not less than 150% of the rated motor horsepower.
- C. Adjustable Sheaves: All belt drive fans shall have adjustable sheaves and adjustable supports for adjusting belt tension. Sheaves shall be selected so that they are at their midpoint at design conditions.
- D. Motors:
  - 1. General: Comply with Section 220500. Motors on belt drive fans shall have adjustable supports for adjusting belt tension. Motor speed controllers shall be VFD type except where solid state speed controllers are provided or EC motors with integral speed controller. VFD's shall be as specified in Division 25.
  - 2. Fractional Horsepower Motors: Shall be the electronically commutated (EC) type with speed control where noted and where non-EC motors are not available which comply with code motor efficiency requirements. Unless noted otherwise, provide with manual speed control mounted at the motor for air balancers use. Motors shall be specifically designed for fan applications, have permanently lubricated ball bearings, speed controllable down to 20%, and have internal thermal overload protection.
  - 3. Belt Drive Fans: Motors shall have adjustable supports for adjusting belt tension.
  - 4. Performance: Fan capacity shall not be less than the values listed on the drawings. Fan performance shall be based on laboratory tests conducted in accordance with AMCA 210.
- E. Outlets and Inlets: Fans shall be furnished with attachment angles and/or flanges as required for attaching ductwork and/or flexible connections indicated.
- F. Fan Types: The type of each fan is indicated on the Fan Schedule, under the "Type" column, and corresponds to the types specified herein.
- G. Fan Arrangement and Drive: Shall be as indicated. Select motor and drive access side to allow best access and to suit available space.
- H. Electrical: Fan disconnects and motor starters shall comply with Division 26 specifications. Disconnects furnished with fan shall come factory wired to motor or shall be field wired by Division 23.

- I. Finish: All fans shall have factory applied enamel finish (manufacturer's standard color, unless noted otherwise) over a rust inhibiting primer base coat; except a painted finish is not required on rooftop type fans of aluminum or equivalent corrosion resistant construction.
- J. Fan Backdraft Dampers:
  - 1. General: Provide all exhaust fans with backdraft dampers. Backdraft dampers are not required for kitchen grease hood exhaust fans.
  - 2. Ceiling Exhaust Fans: Manufacturer's standard backdraft damper, factory installed integral with the fan, to close automatically to prevent airflow in the opposite direction than intended when fan is off; or type as specified for "Other Fans" below.
  - 3. Rooftop Fans: Multi-blade backdraft damper, to close automatically to prevent airflow in the opposite direction than intended when fan is off, aluminum or galvanized steel construction (except shall be of stainless steel construction where duct system served is constructed of stainless steel). Frame shall be minimum 0.090-inches thick, with minimum 0.050-inch thick blades, synthetic bearings, concealed linkage connecting all blades, vinyl or felt blade edge seals, rated for 2500 feet per minute velocity, counterbalanced with adjustable weights to allow for proper operation. Leakage less than 10 cfm at 0.5-inch w.g. pressure differential for a 36-inch square damper. Install in roof curb at fan.
  - 4. Other Fans: Multi-blade backdraft damper, to close automatically to prevent airflow in the opposite direction than intended, aluminum or galvanized steel construction, except shall be of stainless steel construction where duct system served is constructed of stainless steel. May be "butterfly" type where used on fans with round connections. Frame shall be minimum 0.125-inches thick, with minimum 0.070-inch thick blades, synthetic bearings, concealed linkage connecting all blades, vinyl or felt blade edge seals, and rated velocity of 2500 feet per minute or duct velocity at point of application (whichever is higher). Provide with counterbalanced and adjustable weights as required by the application in order to have proper damper operation. Leakage less than 12 cfm at 1-inch w.g. pressure differential for a 36-inch square damper.
- K. Weatherproof: Where installed exposed to weather, fans shall have weatherproof enclosure, preventing any wind driven water entry into unit or drive assembly.

## 2.3 CEILING EXHAUST FAN

- A. Type: Centrifugal exhaust fan with integral grille. Greenheck Model SP or approved.
- B. Housing: Shall be constructed of galvanized steel, with discharge backdraft damper, and 1/2" - 1-1/2 lb/cubic foot density fiberglass duct liner insulation. Fan shall have either top or horizontal discharge (as required). Housing shall have adjustable mounting brackets to match ceiling thickness.
- C. Grille: Shall be of aluminum or steel construction, with white baked-on enamel finish; except that fans with scheduled capacity less than 250 cfm capacity may have grilles constructed of high impact polystyrene.
- D. Fan Wheel: Shall be forward curved, centrifugal type.
- E. Drive: Fan shall be direct drive, with motor mounted on resilient elastic supports.
- F. Accessories: Provide, the following accessories where indicated on the Fan Schedule or

shown on the drawings:

1. Speed Control: Speed controller allowing speed reduction down to 50% of maximum.
2. Disconnect: Factory mounted on side of cabinet or within unit but so as to be accessible when unit is installed.

## 2.4 ROOFTOP FANS

- A. Type: Centrifugal fan, for rooftop curb mounting, with down-blast discharge. Greenheck G (or approved).
- B. Housing: Windband shall be constructed of minimum 16 gauge aluminum. Entire drive assembly and wheel, as a unit, shall be removable through the support structure without dismantling the housing. Provide birdscreen in fan discharge.
- C. Fan Wheels: Shall be aluminum, backward inclined, non-overloading centrifugal type; dynamically and statically balanced.
- D. Drive: Entire drive assembly shall be mounted on rubber vibration isolators. Motor and drives shall be isolated from the exhaust airstream. Air for motor cooling shall be taken into motor compartments by means of an air tube from an area free of contaminated exhaust fumes.
- E. Accessories: Provide the following accessories where indicated:
  1. Disconnect Switch: Factory mounted in motor compartment.
  2. Speed Controls: Speed controller, allowing speed reduction down to 50% of maximum. Controller shall be for mounting in a standard wall box. Where motor type is not available for use with a solid state speed controller, provide with variable frequency drive.

## 2.5 KITCHEN UPBLAST FAN

- A. Type: Centrifugal rooftop upblast vertical discharge fan, for commercial kitchen exhaust.
- B. Housing: Windband shall be constructed of minimum 16 gauge aluminum. Entire drive assembly and wheel, as a unit, shall be removable through the support structure without dismantling the housing. Provide birdscreen in fan discharge. Fan shall have heavy gauge steel curb cap, and drain tube with external grease trough for collection of liquid residue.
- C. Fan Wheels: Shall be aluminum, backward inclined, non-overloading centrifugal type; dynamically and statically balanced.
- D. Drive: Entire drive assembly shall be mounted on rubber vibration isolators. Motor and drives shall be isolated from the exhaust airstream. Air for motor cooling shall be taken into motor compartments by means of an air tube from an area free of contaminated exhaust fumes.
- E. Code Compliance: Fan shall be UL 762 listed for restaurant exhaust use and comply with IMC, NFPA 96, and code.
- F. Hinge Kit: Fan base shall be hinged to allow lifting of fan for access to ductwork; provide with restraint cables to limit range of motion to approximately 90 degrees.

- G. Accessories:
1. Disconnect Switch: Provide external junction box with disconnect, factory wired to motor.
  2. Roof Curbs: For roof top curb mounting type fans. Shall be constructed of minimum 18 gauge galvanized steel or 0.064-inch thick aluminum of all-welded construction, with top wooden nailer held in place by metal wrap-around, and internally insulated with minimum 1/2-inch thick rigid fiberglass. Size of curb shall match fan and/or extended base used with. Provide with built-in cant and step height (to allow for roof insulation), as required to match roof type. Provide with damper type as shown.

## 2.6 IN-LINE FANS

- A. Type: Square housed, in-line centrifugal fan. Greenheck SQ (or approved).
- B. Housing: Shall be constructed of galvanized steel, minimum 20 gauge for fans with up to 14" diameter fan wheels, minimum 18 gauge 14" to 29" fan wheels, and minimum 16 gauge for 30" diameter fan wheels and larger. Housing shall be of square shape, with inlet and outlet square duct mounting collars. Housing shall have removable or hingeable access covers providing complete access to fan internals. Housing shall be lined with minimum 1" thick 1-1/2 lb per cubic foot fiberglass duct liner.
- C. Fan Wheel: Shall be aluminum, backward inclined, non-overloading, centrifugal type; dynamically and statically balanced.
- D. Drive: Fan shall be direct or belt drive as indicated on the Fan Schedule.
1. Belt Drive: Fan bearing and drive components shall be isolated from the air stream. Motor shall be located outside the housing and cooled by ambient air. Provide motor position indicated on drawings. Wheel shaft shall be ground and polished and mounted in permanently lubricated, sealed ball bearing pillow blocks, with a minimum average bearing life over 200,000 hours.
  2. Direct Drive: Fan wheel shall be directly connected to motor.
- E. Supports: Fans shall be provided with supports for horizontal base mounted, horizontal ceiling suspended, or vertical mounting as shown on the drawings. Provide spring type vibration isolators for horizontal suspended fans and neoprene type for base mounted units. Vibration isolators shall be sized to match fan weight.
- F. Electrical Connections: Fans shall be factory wired to an external junction box and disconnect switch. Fan shall have flexible wiring for units where fan motor swings out of way for housing access.
- G. Accessories: Provide the following accessories where indicated on the Fan Schedule.
1. Inlet Vane Dampers: Shall be constructed of minimum 20 gauge steel, factory mounted in fan inlet, to provide automatic variable air volume operation. (Actuator and control specified in Division 25).
  2. Speed Controls: Solid state speed controller, allowing speed reduction down to 50% of maximum. Controller shall be for mounting in a standard wall box. Where motor type is not available for use with a solid state speed controller, provide with variable frequency drive.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. General: Comply with Section 220500. Install in accordance with manufacturer's written installation instructions, code, applicable standards and best construction practices.
- B. Locations: Install fans at locations indicated and in accordance with the Contract Documents.
- C. Speed Controls: Fans with speed controllers shall have the speed controller mounted on the fan housing unless another location is indicated on the drawings (for use by Balancer). Install VFD's at accessible locations near item served.
- D. Connections: Provide flexible connections in ductwork connections to all fans.
- E. Rooftop Type Fans: Rooftop type fans shall be mounted on roof curbs, secured to curb on all sides, and sealed watertight.
- F. Vibration Isolation: Install all fans with vibration isolators so that no sound or vibration is transmitted to the structure; except not required for rooftop type fans. See Section 220548 for vibration isolation specifications.
- G. Sheaves: Provide sheave changes for 50% of all belt driven fans. Sheave changes shall meet Balancer and Engineer requirements.
- H. Operation and Maintenance: See Section 220500.
- I. Owner Instruction: Instruct Owner on the operation of each fan, including: system start-up, shut-down, emergency shut-down, normal control operation, safety aspects, maintenance and repair instructions.
- J. Start-Up: Prior to start-up inspect fans and installation to confirm proper installation and system is ready for start-up. Arrange other trades to be present as needed (i.e. balancer, electrician, etc.). Check fans for correct rotation, tighten belts to proper tension, adjust fan speeds to provide required performance, verify proper electrical and control connections, check vibration isolation (as applicable) for correct operation, and lubricate bearings per manufacturer's recommendations.

END OF SECTION



## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Dryer Venting.
- B. Kitchen Hood Exhaust Ductwork.
- C. Kiln Exhaust System.

### 1.3 QUALITY ASSURANCE

- A. All hoods and ducts shall comply with NFPA, IMC and applicable ACGIH and SMACNA construction standards.

### 1.4 SUBMITTALS

- A. General: All submittals shall comply with Section 220500.
- B. Product Data: Submit manufacturer's product data for all items to be used.

### 1.5 REFERENCES

- A. ACGIH: American Conference of Governmental Industrial Hygienists, Industrial Ventilation - A Manual of Recommended Practice, 20th Edition.
- B. NFPA 96: Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment, 1986 Edition.
- C. SMACNA-DCS: HVAC Duct Construction Standards.
- D. UL 2518A: Clothes Dryer Transition Duct.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Products shall comply with Section 220500, Paragraph 2.1, Acceptable Manufacturers.

### 2.2 RANGE HOODS AND DUCTWORK

- A. Range Hood Type II: Factory fabricated Type II hood, size as shown on drawings,

constructed of minimum 18 gauge type 304 or 430 stainless steel, with all exposed surfaces having a number 4 polished finish. Hoods shall be fully welded, with turned in bottom lip, and all welds and sharp corners ground smooth. Designed for removal of heat and odor from over ovens or ranges. Provide hood with duct collar for connection of exhaust duct size as shown on plans. Provide hoods with LED lights (equivalent to 75 watt incandescent) vapor/grease proof type light(s), wired to a wall mounted light switch. Provide one light on hoods with less than 8 square foot inlet area, and two lights on larger hoods. Hood that have two lights shall have the lights evenly spaced. Furnish light on/off switch and separate fan on/off switch for field installation. Provide hood of adequate height to meet the following: Bottom of hood shall be at height as shown on Architectural elevations, or such that the vertical distance between bottom of hood and top surface of equipment does not exceed 4'-0". Top of hood shall extend minimum 3" above ceiling.

- B. Ductwork: Comply with Section 233100 for the applicable pressure/velocity class. Pressure class shall be 1-inch w.g., plus or minus as appropriate (unless noted otherwise).

### 2.3 DRYER VENT DUCTWORK

- A. Flexible Dryer Vent Duct:
  - 1. Type: UL listed dryer transition duct.
  - 2. Construction: Flexible aluminum, uninsulated, suitable for temperatures up to 400 deg F, with flame spread and smoke development ratings of 0 as tested by ASTM E84.
  - 3. Listing: UL listed per Standard 2158A.
  - 4. Connectors: Steel worm gear type clamps.
- B. Rigid Dryer Vent Duct: Minimum 24 gauge stainless steel or aluminum; with no fasteners protruding into the airstream more than allowed by code, rated for 1-inch wc pressure class (unless noted otherwise), constructed per SMACNA-DCS.

### 2.4 KITCHEN HOOD

- A. Hoods: See Division 11.
- B. Ductwork: Shall be constructed of minimum 16 gauge steel or stainless steel 0.044 inches thick with all seams and joints having a liquid-tight continuous exterior weld, and complying with IMC and NFPA standards. Pressure class shall be minus 3-inch w.g. (unless noted otherwise).

### 2.5 KILN EXHAUST SYSTEM

- A. Downdraft Kiln Exhaust: Exhaust fan and downdraft assembly for venting kiln to outside. Unit shall have stainless steel plenum, 18 inches long (minimum) stainless steel duct, exhaust fan, and related accessories for proper installation to kiln. Unit shall be sized by supplier to suit kiln being used with. Unit shall be for use with 115 volt/1 phase power. Skutt "Envirovent" (or approved).
- B. Kiln Ductwork: Same as specified in Section 233100; except that duct serving downdraft kiln exhaust shall be of stainless steel construction; either rigid or flexible. Provide wall cap vent, similar to dryer vent cap, at termination to outside.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. General: Installation shall comply with code, manufacturers written installation instructions, and best construction practices.
- B. Ductwork: Comply with cited standards and Section 233100.

END OF SECTION



## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Variable-Air-Volume Terminal (VAV) Air Terminal Units.
- B. Duct Coils.
- C. Radiant Heaters.

### 1.3 SUBMITTALS

- A. General: Comply with Section 220500.
- B. Product Data: Submit product information on all products being provided.
- C. Operation and Maintenance: Submit Operation and Maintenance data and submittal data for inclusion in project O&M Manuals.

### 1.4 REFERENCES

- A. AHRI 410: Forced-Circulation Air-Cooling and Air-Heating Coils.
- B. AHRI 880: Performance Rating of Air Terminals.
- C. UL 181: Air Ducts, Air Connectors, and Closure Systems.
- D. UL 1995: Heating and Cooling Equipment.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Products shall comply with Section 220500, 2.1, Acceptable manufacturers.
- B. Air Terminal Units: Titus, Carnes, Enviro-Tec, Price, Nailor, Krueger, Trane.
- C. Duct Coils: Trane, Temptrol, Heatcraft, American Coil, Colmac, Aerofin.
- D. Radiant Heaters: Markel, Berko, Q-Mark.

### 2.2 SHUT-OFF VAV AIR TERMINAL UNITS

- A. Type: Variable-Air-Volume, shut-off and shut-off reheat.
- B. Capacities: As indicated on plans, rated in accordance with AHRI Standards.
- C. Certification: Terminal units shall be certified under AHRI 880.
- D. Complete Assembly and Listing: Unit shall be factory tested as a single unit. Unit shall ship as a complete assembly requiring no field assembly (including accessories). All electrical components shall be UL listed and installed in accordance with UL 1995. Electrical connection shall be single point. All electrical components, including low voltage controls, shall be mounted in a NEMA 1 enclosure. The entire terminal shall be ETL or UL listed as a complete assembly.
- E. Casing: Shall be constructed of minimum 22 gauge galvanized steel, internally lined with glass fiber insulation complying with UL 181. All exposed insulation edges shall be coated with a liner sealant to prevent entrapment of fibers in the airstream. The terminal shall have a round duct collar for the primary air connection and a rectangular discharge suitable for flanged or slip drive duct connection. The casing shall be designed for hanging by sheetmetal straps or by hanger rods (one method or the other).
- F. Primary Air Damper: The primary air damper assembly shall be heavy gauge steel with solid shaft rotating in Delrin or bronze oilite self-lubricating bearings. Damper leakage shall not exceed 5% of the manufacturer's scheduled fan capacity at 1" w.g. inlet static pressure. Shaft shall be clearly and permanently marked on the end to indicate damper position. The damper shall incorporate a mechanical stop to prevent over-stroking and a synthetic seal to limit close-off leakage to the maximum values shown below.

Inlet Size	Maximum Damper Leakage, cfm		
	1.5" SP	3.0" SP	6.0" SP
6	4	5	7
8	4	5	7
10	4	5	7
12	4	5	7
14	4	6	8
16	5	7	9

- G. Airflow Sensor: Total pressure sensing flow ring with four average pressure points and static pressure point for measuring unit inlet velocity pressure to allow for pressure independent operation. Provide with tubing extended to point of connection to Division 25 controls.
- H. Sound Performance: Equivalent to manufacturer's model scheduled on the plans.
- I. Hot Water Heating Coil:
  - 1. General: Integral to air terminal unit, factory installed at unit outlet. Provide with rows, fin spacing, and circuiting to provide capacity indicated without exceeding water air pressure drops indicated.
  - 2. Casing: Shall be enclosed in galvanized steel casing with flanged or slip and drive construction for attachment to ductwork.
  - 3. Construction: Fins shall be heavy gauge aluminum, mechanically bonded to tubes. Tubes shall be copper with minimum wall thickness of .016-inch with male solder

header connections. Number of coil rows and circuits shall be selected to provide performance as indicated. Coil performance data shall be based on test run in accordance with AHRI 410.

4. Tests: Coils shall be factory leak tested to 300 psig.
- J. Controls: Electric heat units shall have terminals for Division 25 on/off (or staged as indicated) control of heater. Control of primary damper (and actuator) is by Division 25.

## 2.3 DUCT COILS

- A. Type: Hot water heating coil, for duct mounting. Trane, Type ST, TT, T, WC or approved.
- B. Capacity: As indicated on drawings at conditions shown. Rated in accordance with AHRI standards. Provide with fin spacing, number of rows, and circuiting to provide capacities scheduled without exceeding water and air pressure drops indicated.
- C. Construction: Shall be constructed of 5/8-inch or 1/2-inch OD seamless copper tube, aluminum fins (minimum 80 fins per foot), expanded into fin collar for permanent fin-tube bond. Casing of galvanized steel construction, with flanged or slip and drive ends for connection to ductwork. Coils shall be drainable.
- D. Tests: Coil shall be factory leak tested to 300 psig.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. General: Install items in accordance with manufacturers instructions, code requirements and applicable standards.
- B. Access: Verify access and clearance requirements before ordering and again before installing. Order with correct access orientation. Maintain code required clearances and maintenance access requirements.
- C. Air Terminal Units Inlets: Provide minimum length of straight duct to air terminal unit inlet as indicated on the plans; but no less than two feet.
- D. Transitions: Provide duct transitions as required to transition from items to duct sizes shown on plans. Transitions shall be lined. Where the connecting duct is indicated to be lined.
- E. Adjustments: Adjust air terminal units to provide air flow quantities indicated; coordinate settings with Balancer and Division 25.

END OF SECTION





## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. GRD Outlets.
- B. GRD Inlets.
- C. Wall Caps.
- D. Roof Vents.

### 1.3 DEFINITIONS

- A. GRD's: Grilles, Registers, and Diffusers.

### 1.4 REFERENCES

- A. AHRI 885: Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.
- B. AMCA 500: Laboratory Methods of Testing Louvers for Rating.
- C. ASHRAE 70: Method of Testing the Performance of Air Outlets and Air Inlets.
- D. ASHRAE-F: ASHRAE Handbook of Fundamentals.
- E. SMACNA-DCS: HVAC Duct Construction Standards, 3rd Edition.

### 1.5 SUBMITTALS

- A. General: Comply with Section 220500.
- B. Product Data: Submit product information for all items to be used.
- C. Operation and Maintenance: Submit operation and maintenance data and submittal data for inclusion in project O&M Manuals.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Products shall comply with Section 220500, Paragraph 2.1, Acceptable Manufacturers.
- B. Grilles, Registers and Diffusers: Titus, MetalAire, Krueger, Price, Tuttle & Bailey, Kees, Carnes.
- C. Grilles – Type A: Kees, AJ Manufacturing.
- D. Wall Caps: Greenheck, PennBarry, Nutone, Carnes.
- E. Dryer Vent Caps: Broan, Nutone, Greenheck, PennBarry, Cook, Carnes, Columbia.
- F. Roof Vents: PennBarry, Greenheck, Carnes, Cook “TRE” Series.

## 2.2 GENERAL REQUIREMENTS

- A. Type: Air outlets and inlets shall be of the size, type, and with number of throws as shown on the drawings; and shall match the appearance and performance of the manufacturers' models specified and scheduled on the drawings.
- B. Performance: Air outlet and outlet performance shall be based on tests conducted in accordance with ASHRAE 70.
- C. Sound Level: Air outlets and inlets shall not exceed a sound level of NC 30 for the size indicated and airflow rate application. Sound levels shall be determined in accordance with AHRI 885 and ASHRAE-F.
- D. Finish: Grilles, Registers and Diffusers shall have factory applied finish, color as selected by Architect/Engineer, except where indicated to have a brushed aluminum finish (or other finish type). Finish shall be an anodic acrylic paint, baked on, with a pencil hardness HB to H. Paint shall pass a 90 hour ASTM B117 salt spray test, 250 hour ASTM D870 water immersion test, and an ASTM D2794 reverse impact test with at least a 50 inch-pound force applied.
- E. Frame Style: Provide air outlets and inlets with frame style to match ceiling or wall construction installed in. Where supply air outlets or inlets are installed in T-bar ceiling systems, they shall be factory installed in 2' x 2' or 2' x 4' metal panel to match ceiling layout. Where installed against gypsum board surface, brick or similar hard surface, or where exposed, provide with 1-1/4-inch wide outer border. Where space does not permit installing 2' x 2' metal panel, provide outlets or inlets with 1-1/4-inch wide outer border. Where air outlets are installed adjacent to surface mounted light fixtures, outlets shall have 4-inch deep drop frames. (See reflected ceiling plan and/or electrical lighting plan for ceiling and lighting types).
- F. Transfer Grilles: Ceiling transfer grilles shall be same as ceiling exhaust grilles (CEG) unless noted otherwise; wall transfer grilles (WTG) shall be same as wall exhaust grilles (WEG) (unless noted otherwise).
- G. Construction: Air outlets and inlets shall be of steel or aluminum construction except that:
  - 1. Where noted to be constructed of a specific material, shall be as noted.
  - 2. In assemblies with a required fire rating and required to have fire dampers shall be of steel construction.

3. In wet areas or subject to condensation (i.e., locker rooms, restrooms, kitchens, exterior soffits, etc.), where not used in fire rated assemblies, shall be of aluminum construction.
4. Air outlets and inlets in the same room, area, or within common view shall be constructed of the same material.

## 2.3 SUPPLY AIR OUTLETS

- A. Ceiling Diffuser (CD): Aluminum or steel construction, modular core, with multiple curved (or angled) discharge blades, and square neck. Cores shall consist of four separate sections which can be repositioned to allow for one, two, three or four way discharges. Cores shall be easily removed with no tools required. Krueger 1240 Series, Titus MCD, MCD-AA Series (or approved equal).
- B. Wall Supply Grille (WSG): Aluminum or steel construction, double deflection type, with horizontal face bars and vertical rear bars. Unit shall have outer frame borders 1-1/4-inch wide, with mitered corners, and perimeter gasket to prevent air leakage. Frame shall be constructed of minimum 22 gauge steel or minimum 0.032-inch thick aluminum. Deflecting bars shall be rigid extruded aluminum of semi-air-foil design, on 3/4-inch centers. Vertical and horizontal bars shall have friction pivots at each end to allow for blade angle adjustment without blade loosening or rattling. Krueger 5880H, 880H Series; Titus 300FL, 300FS Series (or approved equal).
- C. Wall Supply Register (WSR): Same as WSG but with an opposed blade damper operable through the face of the grille.
- D. Wall Supply Grille-Type A (WSG-A): Steel construction, with 14 gauge horizontal bars at 0 degree on 1/2-inch centers, reinforced on 6-inch centers by vertical 14 gauge bars. Core shall be welded to 14 gauge frame. Provide with screw holes on maximum 8-inch centers. Kees GHD0 (or approved equal).
- E. Round Ceiling Diffuser (RCD): Aluminum construction, 4 cones, with inner cone assembly adjustable for three different discharge settings (from horizontal to vertical airflow). Inner 3 core assembly shall be positively latched in place, and be easily removed. Core shall be attached to diffuser body by a safety chain (or cable). Provide with radial opposed blade or butterfly type damper, operable from diffuser face.
- F. Linear Slot Diffuser (LSD): Linear slot diffuser with plenum for T-bar ceiling. Unit shall be of zinc coated steel construction, adjustable pattern diffuser providing up to 180 degree air diffusion, flat black enamel finish, insulated with 1/2-inch thick 1-1/2 pound/cubic foot fiberglass duct liner, and round inlet for flexible duct connection. Titus Series as scheduled.
- G. Perforated Supply Diffuser (PSD): Perforated ceiling grilles used for supply, of aluminum construction, with 0.055-inch thick aluminum plate, having 3/16-inch diameter perforations on 1/4-inch staggered centers to provide no less than 51% free area.

## 2.4 RETURN AIR INLETS

- A. Ceiling Return Grille (CRG): Aluminum construction, "cube-core" or "egg-crate" type, with 0.025-inch thick x 1/2-inch deep strips mechanically joined to form 1/2" x 1/2" x 1/2" cubes. Krueger Series EGC5. Titus Series 50F.

- B. Ceiling Return Register (CRR): Same as CRG but with opposed blade damper operable from face of register
- C. Wall Return Grille (WRG): Shall be of aluminum or steel construction, with 35 degree angular horizontal face bars. Unit shall have outer frame border, 1/4-inch wide, gasketed to prevent air leakage and minimize smudging. Deflecting bars shall be rigid extruded aluminum of semi-air-foil design, on 3/4-inch centers. Krueger Model No. S580H or S80H. Titus Series 350RL.
- D. Wall Return Grille--Type A (WRG-A): Shall be of aluminum or steel construction, with 14 gauge, 40 degree angular horizontal face bars, on 1/2" centers and reinforced on 6" centers by 14 gauge vertical bars. Core shall be welded to 14 gauge frame. Provide with screw holes on maximum 8" centers. Type to match WSG. Kees GHD40.

## 2.5 EXHAUST AIR INLETS

- A. Ceiling Exhaust Grille (CEG): Same as CRG.
- B. Ceiling Exhaust Register (CER): Same as CEG but with opposed blade damper operable from face of register.
- C. Bottom Exhaust Grille (BEG): Same as WRG.
- D. Wall Exhaust Grille (WEG): Same as WRG.
- E. Ceiling Exhaust Grille-Type A (CEG-A): Perforated ceiling grille of aluminum construction, with 0.055-inch thick aluminum plate, having 3/16-inch diameter perforations on 1/4-inch centers to provide approximately 60% free area, with collar for connection to ductwork. MetalAire Series 7000.

## 2.6 WALL CAPS

- A. Masonry Walls: Extruded aluminum brick vent, constructed of 6063T5 aluminum, minimum 4-inch depth, with minimum 0.1-inch thick angled blades, aluminum mesh insect screen, and internal bottom water stop. Provide with Baked Enamel Finish, color as selected by Architect. Provide with aluminum duct, minimum 0.063-inch thick, length to match wall thickness plus 2-inches. Size 15-5/8-inch x 7-3/4-inch, unless indicated otherwise. Ruskin BV100 (or approved equal).
- B. Non-Masonry Walls:
  - 1. For Airflows of 250 cfm and Less: Constructed of minimum 0.025-inch thick aluminum, hooded configuration, natural finish, with bird screen, built-in spring loaded backdraft damper, and round duct connection. Duct connection size to match connecting duct size (or equivalent free area). For air intake applications delete backdraft damper. Broan 641, 643, 610 (or approved equal).
  - 2. For Airflow of 251 cfm and Greater: Extruded aluminum brick vent, constructed of 6063T5 aluminum, minimum 4-inch depth, with minimum 0.1-inch thick angled blades, aluminum mesh insect screen, and internal bottom water stop. Provide with Baked Enamel Finish, color as selected by Architect. Provide with aluminum duct, minimum 0.063-inch thick, length to match wall thickness plus 2-inches. Size 15-5/8-inch x 7-3/4-inch, unless indicated otherwise. Ruskin BV100 (or approved equal).

- C. Dryer Vent Caps: Constructed of minimum 0.020-inch aluminum, hooded configuration, natural finish with integral backdraft damper. Inlet size to match connecting duct size. Provide painted finish to match adjacent surface area color. Artis DWVA, DWVSS (or approved equal).

## 2.7 ROOF VENTS

- A. Type: Penthouse louvered type. Greenheck Model WIH, WRH (or approved).
- B. Construction: Roof vents shall be constructed of galvanized steel, or aluminum and shall be designed for mounting on factory fabricated roof curbs. Roof vents shall have 1/2-inch mesh wire bird screen. Shall include mitered corners such that louver lines are continuous around vent.
- C. Size: Roof vents shall have throat size as indicated on the plans (or size to match the connecting duct sizes indicated).
- D. Roof Curb: Shall be constructed of minimum 18 gauge galvanized steel or 0.064-inch thick aluminum, of all-welded construction, with top wooden nailer held in place by metal wrap-around, and internally insulated with minimum 1/2-inch thick rigid fiberglass. Size of curb shall match roof vent. Provide curb type as required to match roof type (i.e., with built-in cant and step height to allow for roof insulation; sloped base; etc.). Greenheck Model GPR, GPS, GPF, or approved equal.
- E. Dampers:
  - 1. General: Provide all intake roof vents with motorized dampers; provide all relief (and exhaust) roof vents with motorized dampers and backdraft dampers. Backdraft dampers shall be the counter balanced type (unless noted otherwise). Size shall match roof vent throat size (unless noted otherwise).
  - 2. Gravity Type: Shall be as specified in Section 233300.
  - 3. Counter-balanced Type: Shall be as specified in Section 233300.
  - 4. Motorized Type: Shall be as specified in Division 25. Actuator shall be provided by Division 25.

## 2.8 MISCELLANEOUS

- A. Screen: 1/2-inch mesh, constructed of either 0.051-inch aluminum wire or 19 gauge galvanized steel wire.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. General: Install air outlets and inlets in locations indicated and so as to conform with building features and coordinated with other work.
- B. Connections: Furnish all necessary screws, clips, duct collars, and transitions required to allow for the installation and connection of ductwork to all air outlets/inlets.
- C. Location Verification: Verify all air inlet/outlet locations with building features and other trades prior to installing any duct systems that will connect to the air outlets/inlets. For

locations where air inlet/outlet location is noted to be verified, or location is not clear, develop shop drawings showing the proposed location, or the location that best suits field conditions, and submit for review.

- D. Painting:
  - 1. Paint ductwork and accessories which are visible behind air outlets and inlets flat black. Painting to include ductwork, duct liner, turning vanes, liner attachments, and all visible items (including fastening pins for duct lining).
  - 2. Coordinate with the Division 09 Contractor for any necessary painting of air outlets/inlets/louvers prior to installation.
- E. Weather Exposure: All outlets and inlets exposed to the weather shall be adequately flashed and installed in a manner to assure complete weatherproofness. Sealing and caulking of all outlets and inlets exposed to the weather shall conform to Division 07 and Section 220530.
- F. Provide screened openings (SO) on all duct openings where indicated and where openings do not have grilles or registers.
- G. Louver: Slope bottom of all ducts within 18 inches of connecting to louvers and wall caps at minimum 1% slope toward bottom of louver; seal bottom water tight.
- H. Louver Sizes: See architectural drawings for louver sizes. Verify planned openings and clearances required prior to ordering or fabricating louvers.

END OF SECTION

## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Boilers.
- B. Boiler Trim.
- C. Burners.
- D. Boiler Master Control System.
- E. Boiler Venting.
- F. Condensate Neutralizer.
- G. Boiler Flue.
- H. Combustion Air Duct.
- I. Start-up.
- J. Owner Instruction.
- K. Commissioning.

### 1.3 SUBMITTALS

- A. General: Comply with Section 220500.
- B. Product Data:
  - 1. Submit product information on boiler, including gas train details, wiring diagram (distinguishing field wiring from unit installed wiring) and point of connection of all utilities.
  - 2. Submit boiler installation instructions.
- C. Certification: Submit certification of boiler's compliance with ASME BPVC.
- D. Start-up Report: Submit completed boiler inspection and start-up report.
- E. Operation and Maintenance: Submit Operation and Maintenance data and submittal data for inclusion in project O&M Manuals.

## 1.4 REFERENCES

- A. ASME: American Society of Mechanical Engineers Codes and Standards.
- B. ASME BPVC: Boiler and Pressure Vessel Code (BPVC).
- C. ASME CSD-1: Controls and Safety Devices for Automatically Fired Boilers.
- D. UL 1738: Venting Systems for Gas-Burning Appliances, Categories II, III, and IV.

## 1.5 GENERAL REQUIREMENTS

- A. Special Warranty:
  - 1. General: The boilers and all accessories (burner, boiler trim, controls, etc.) shall be warranted to be free from defects in material and workmanship for a period of 2 years following date of substantial completion. Items which prove to be defective during this period shall be repaired or replaced by manufacturer's authorized personnel at no cost to the Owner.
  - 2. Heat Exchanger: Boiler heat exchanger shall be warranted against failure of any kind for 10 years from date of substantial completion [project final acceptance].
- B. Spare Parts:
  - 1. Provide a spare flame sensor.
  - 2. Provide additional acid neutralization media for Owner's future use; provide quantity equal to that provided in all condensate neutralizers.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. General: Comply with Section 220500, Paragraph 2.1, Acceptable Manufacturers.
- B. Boilers: Advanced Thermal Hydronics KN Series.
- C. Flue: Metalbestos, Metal-Fab, Lennox, Security Chimneys.
- D. Condensate Neutralizer: Hydrotherm, JJM.

### 2.2 BOILERS

- A. Type: Cast iron high efficiency, condensing type packaged hot water boiler, for firing natural gas. ATH "KN" series (or approved).
- B. General:
  - 1. Factory assembled, self-contained readily transported unit complete with all accessories and ready for automatic operation except for connection of water, fuel, electrical and vent services.
  - 2. AGA or CGA design certified as condensing boilers, with a thermal efficiency rating up to 99% at minimum input.
  - 3. Designed for a minimum 5:1 turn down with constant CO<sub>2</sub> discharge levels over the turndown range.



4. For use with maximum 14" W.C. and minimum 2" W.C. natural gas pressure.
  5. Boiler shall be able to vent a horizontal distance of 80 equivalent feet with a vent diameter equivalent to the combustion chamber outlet diameter.
  6. Controls shall be arranged so that any boiler may be made inoperative without interfering with the normal operation of other boiler(s).
- C. Capacity: No less than that indicated. Ratings shall be in accordance with AGA or CGA standards.
- D. Emissions: Shall comply with local requirements with NOx emissions less than 20 ppm at all firing rates.
- E. Construction:
1. ASME BPVC: Constructed and stamped in accordance with ASME BPVC, and Section IV of the ASME Code for low pressure heating boilers with a maximum water working pressure of 100 psi. Form H-3 Manufacturers' Data Report for Water Tube Boilers shall be provided.
  2. Combustion Chamber: Constructed of cast-iron having down-fired design with light weight refractory around the burner housing.
  3. Heat Exchanger: Constructed of cast iron sections, minimum thickness 1/4-inch, designed for maximum heat transfer and to prevent boiling. Sections shall be fully machined for metal to metal sealing of the gas side surfaces. Heat exchanger shall have no limitations on temperature rise or inlet temperature.
  4. Support: Boiler shall be mounted on a structural steel stand and fitted with drilled feet to facilitate bolt-down to the floor.
  5. Jacket: Stainless jacket, insulated with 2-inch thick insulation.
  6. Condensation: Flue gas condensation shall be collected in a corrosion resistant drain assembly with drain fitting for draining condensation from the products of combustion.
- F. Service Access: Provide with access covers for accessing all serviceable components. All accesses must seal completely as not to disrupt the sealed combustion process.
- G. Electrical: For use with power of voltage and phase as shown on the plans, and complete with wiring to all unit items requiring power. Wiring shall be color coded with terminals numbered, corresponding to unit wiring diagram furnished.

### 2.3 BOILER TRIM

- A. Relief Valve: ASME rated pressure relief valve, set at 100 psi, capacity to match boiler maximum output.
- B. Pressure/Temperature Indicator: Combination pressure/temperature gauge.
- C. Low Water Cut-Off: Manual reset low water cut-off, manufacturer's standard type, complying with ASME standards and acceptable to AHJ.
- D. High Temperature Cut-off: High temperature cut-out with manual reset to prevent unit operation if boiler water temperature rises to an unsafe level.
- E. Pressure Switch: Differential pressure switch to sense air flow to the burner and to prevent operation in case of inadequate combustion air flow.

- F. Gas Pressure Switches: Manual reset low gas pressure switch to prevent operation in case of low gas pressure; manual reset high gas pressure switch to prevent operation in case of high gas pressure.

## 2.4 BURNERS

- A. Type: Forced draft, pre-mix design, with horizontal burner flame, capable of 99% efficiency without exceeding a Nox reading above 11ppm.
- B. Construction: Metal fiber mesh construction, allowing high turndown of the fuel-air mixture, with equal distribution of heat throughout the entire heat exchanger. Forced draft fan shall utilize a variable speed drive to vary combustion.
- C. Gas Train:
  - 1. General: Comply with ASME CSD-1 and AHJ requirements.
  - 2. Main Regulator: AGA approved gas regulator, sized to suit boiler capacity and system gas pressures; with union connector and connecting piping.
  - 3. Pilot Fuel Assembly: Manual isolation valve, pilot pressure regulator, pilot solenoid valve, test port, inter-connecting piping, and components to comply with code.
  - 4. Main Fuel Assembly: Manual isolation valves, motorized gas valve, high and low gas pressure switches, test ports, downstream manual isolation valve, interconnecting piping, and components to comply with code.
- D. Burner Controls shall include:
  - 1. Interrupted-type pilot system with electric spark ignition.
  - 2. Pilot and main flame controlled by UV detection.
  - 3. AGA (or CGA) approved flame safe-guard programmer system controlling burner operation and ignition timing in accordance with ASME CSD-1 and AHJ requirements.
  - 4. Safety controls shall include:
    - a. Flame detector, shutting down the burner in case of pilot or main flame failure.
    - b. Fuel shutoff in case of high or low gas pressure.
    - c. Fuel shutoff in case of draft failure.
    - d. Pre and post combustion purging.
    - e. High temperature limit controls.
    - f. Low water cut-off and flow switch.
    - g. Blocked flue detection switch.
- E. Boiler air-fuel ratios shall be coupled such that changes in combustion air flow or fuel flow do not affect combustion quality, with automatic adjustments for altitude and temperature induced changes in combustion air density.

## 2.5 BOILER CONTROLS

- A. General: Boiler shall have controls to allow operation in a stand alone "local" mode or as part of a master boiler control scheme where multiple boilers are controlled. When operating in "local" mode, boiler shall operate to a fixed setpoint.
- B. Master Controls: Electronic control system, provided integral with each boiler, to control firing rate and operation of an individual boiler and multiple boilers to maintain system water temperature setpoint. Able to control connected boilers firing rates and which (and how many) boilers are on for maximum system efficiency. System shall be able to control up to

16 boilers. Setpoint shall be able to be reset via outside air temperature and have on/off control via the building EMCS. MTI "Heat-Net" (or approved).

C. System Capabilities:

1. Display: Operating status shall display in English text, indicating the condition of all interlocks and the boiler input percentage. Access to the controls shall be through a completely removable cover leaving diagnostic panel intact and not disrupted.
2. Interlock, Event, and System logging with a time stamp.
3. Advanced PID algorithm optimized for specific boilers.
4. Four dedicated temperature sensor inputs for: Outside Air Temperature, Supply (Outlet) Temperature, Return Temperature (Inlet), and Header Temperature.
5. Automatically detect the optional temperature sensors on start up.
6. Menu driven calibration and setup menus.
7. (8) dedicated 24 vac interlock monitors and 8 dedicated 120 vac system monitors used for diagnostics and providing feedback of faults and system status.
8. Multiple boiler pump or motorized boiler valve control modes.
9. Combustion air damper control with proof time.
10. SUB/RS485 network plug-in to allow firmware updates or custom configurations.
11. BACNET and LONWORKS interface.
12. Alarm contacts.
13. Runtime hours.
14. Outdoor air reset with programmable ratio for hot water supply temperature.
15. Time of Day clock to provide up to four night setback temperatures.
16. Failsafe mode when a building EMCS is controlling setpoint. If communications are lost, the boiler/system shall run off the Local Setpoint.

D. Division 25 Interlock: Provide terminal connections/accessories to indicate boiler alarm status to building EMCS system, and terminals/accessories to allow for boiler enabling/disabling from building EMCS system.

E. Emergency Shutdown: Provide boiler with connections and components to allow for remote shut-down of boiler by emergency wall switch in accordance with code.

F. EMCS Interface: Provide terminal unit controller, with BACnet protocol and to allow connection to building EMCS and transmission of boiler operating parameters to EMCS. Coordinate details with Division 25 to confirm compatibility.

## 2.6 CONDENSATE NEUTRALIZER

A. Type: Double compartment neutralizer, with primary chamber holding water and float valve assembly, secondary neutralizing chemical filled container for neutralizing acidic condensate from boilers and boiler flues. Cleaver Brooks "neutralizer", Fulton "pH Neutralizer" (or approved equal).

B. Construction: Container shall be fabricated of materials suitable for exposure to boiler condensate, with a removable lid accessing both compartments. Ends shall have fittings suitable for connection to drains from boilers/flues served.

C. Capacity: Neutralizer serving boilers shall be rated for the full boiler condensate capacity (when operating at a HWR temperature of 100 deg F, HWS temperature of 120 deg F and 60 deg F ambient) and be able to increase the condensate pH to at least 6.5. Neutralizer serving

flues shall have the same capacity as the unit serving the boiler that the flue is connected to.

- D. Chemical: pH neutralizing chemical as recommended by boiler manufacturer (i.e. magnesium oxide, limestone, etc.). Provide sufficient quantity for 2 years worth of boiler operation.

## 2.7 BOILER FLUE

- A. Type: Double wall factory fabricated flue, listed to UL 1738, Category IV, for use with positive pressure gas fired condensing boilers of the type connected to.
- B. Size: As shown on drawings or as required to match unit connection, whichever is larger.
- C. Clearance to Combustibles: Listed for maximum 2 inch clearance to combustibles.
- D. Construction: Double-wall construction, with inner pipe constructed of AL29-4C stainless steel and outer pipe of type 430 stainless steel. Sections and fittings shall be joined by a mechanical closure system providing a liquid and pressure tight inner pipe with an outer cover to maintain continuity and protection of the outer pipe. Construction shall allow for thermal expansion and contraction of flue without any operational noises or undue stress.
- E. Fittings: Provide fittings, transitions, caps, collars, thimbles, drain fittings, thermometer wells, flashings and related pieces for a complete assembly allowing continuous venting of boiler to outside the building, and accommodating all system requirements.
- F. Termination: Provide with 45 degree angled termination, with screen; type/style as acceptable to the boiler manufacturer.

## 2.8 COMBUSTION AIR DUCT

- A. Type: Galvanized steel duct.
- B. Construction: Galvanized sheet steel, suitable for lock forming without flaking or cracking, conforming to ASTM A653 and A924, having a zinc coating of 0.90 ounces total per square foot for both sides of a sheet, corresponding to coating G90. Construction shall comply with SMACNA standards. Round duct shall be the spiral seam type.
- C. Fittings: Elbows shall be long-radius type with a center-line radius not less than 1-1/2 times the width or diameter of the duct. Where space does not permit the use of long-radius elbows, short-radius or square elbows with turning vanes may be used. Elbows in round duct systems shall be stamped type, welded segmented type, or standing seam segmented type. Increase duct sizes gradually. Transitions for diverging air flow shall be made with each side pitched out not more than 22.5 degrees. Transitions for converging air flow shall be made with each side pitched in not more than 30 degrees.
- D. Termination: Provide with 45 degree angled termination, with screen; type/style as acceptable to boiler manufacturer.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. General: Install boilers as indicated, in accordance with the boiler manufacturers recommendations and instructions, code requirements, and applicable standards. Furnish boilers disassembled as necessary to accommodate access and installation restrictions. Re-assembly of boilers shall be by boiler manufacturer's authorized service representative.
- B. Connections: Connect all piping and services up to boilers as shown on the drawings and as required to provide complete and operational boiler system. Provide gas manifold vent piping to outside building. Install on boilers any items shipped loose with boilers (i.e. relief valves, gauges, etc.).
- C. Drains: Pipe boiler drains and relief valves full size to proper point of drainage. Pipe combustion condensate through condensate neutralizer and on to proper point of drainage. See Section 232129 for combustion condensate drains. Fill equipment and drain traps with water before operating system.
- D. Condensate Neutralizer: Provide separate condensate neutralizer for each boiler. Fill with water and limestone (type/size as recommended by manufacturer) before operating system.
- E. Anchoring: Anchor boiler to building to resist seismic forces.

### 3.2 BOILER VENTING INSTALLATION

- A. General: Install boiler venting as shown on the drawings and in accordance with manufacturer's instructions. Slope flue back toward boiler. Seal flue joints with high temperature sealant; seal combustion air duct per SMACNA standards and Seal Class C.
- B. Supports and Accessories: Provide adequate anchoring, supports, expansion devices, flashing and sealing. All penetrations of building exterior shall be flashed and sealed watertight.
- C. Clearances: Comply with Code requirements and flue listing for clearances to combustibles.
- D. Terminations: Terminate venting with proper clearances and distances to building openings, other boiler vents, and building elements (roof, walls, etc.).
- E. Condensate Neutralizers: Where flue arrangement does not allow draining of flue condensate back to boiler (and to boiler condensate neutralizer), provide flue with drain fitting, p-trap, and drain piping to condensate neutralizer and on to drain. Condensate neutralizer shall be separate from boiler neutralizer.

### 3.3 BOILER CONTROLS INSTALLATION

- A. General: Provide all boiler control wiring, control components, and connections required for proper operation. Provide all system control components (header temperature sensors, outside air temperature sensors, etc.), connections, thermowells, and accessories to provide a complete and operational boiler control system.
- B. EMCS: Coordinate with Division 25 for interconnection of building EMCS to boilers.
- C. Settings: Set boiler controls and safety devices for proper operation; test to verify all devices operate properly.

- D. Wiring: Wiring of items integral with boilers and wiring terminated on the boiler and its panels and sensors shall be by boiler supplier.
- E. Coordinate with Division 25 and Division 26 for wiring to system components and controls external to the boiler and its panels.
- F. Wiring Diagram: A copy of the wiring diagram for the boiler shall be permanently and prominently displayed, under protective covering, in the boiler. Such diagram shall include the coding of the actual wiring by color or by number to permit a ready check of the system.

### 3.4 CLEANING

- A. Heat Exchanger: Flush and drain water side of boiler heat exchanger on completion of installation; run water until clear. After flushing, clean water side of boiler heat exchanger according to manufacturer's written instructions. Provide temporary fill piping/drain piping and cleaning chemicals.
- B. Boiler Exterior: After completing boiler installation, inspect exposed finishes. Remove burrs, and repair damaged finishes on boiler exterior. Clean boiler of all dirt, dust, overspray, and similar extraneous material.

### 3.5 START-UP

- A. Inspection: Boilers shall be inspected by the boiler manufacturer's authorized service representative to verify proper unit installation prior to start-up.
- B. Start-Up: Start-up shall be provided by the boiler manufacturer's authorized service representative. Boilers shall be operated in various modes to test for proper operation, including proper ignition sequence, proper operation of all safety devices, proper control setpoints/operation, proper fuel flow, proper fuel/air ratio and proper burner modulation. Boilers shall be adjusted for optimum efficiency, considering system operation and boiler application. All adjustments shall be made in accordance with manufacturer's instructions.
- C. Duration: Start-up services as listed herein shall be for a minimum of four hours (on site time) for each boiler.
- D. Witnessing: Start-up may be witnessed by the Engineer and Owner's representative (at their option). Notify the Engineer when the start-up is proposed to occur, to allow a mutually agreed upon time to be arranged.
- E. Written Report: Submit a written report by the boiler's manufacturer authorized service representative detailing all inspection and start-up procedures and findings.
- F. Code Inspection: Contact and coordinate with AHJ for boiler installation inspection.

### 3.6 OWNER INSTRUCTION

- A. General: Instruction, notification, and scheduling shall comply with Section 220500. After start-up has been satisfactorily completed, provide Owner with boiler operation and maintenance instructions.
- B. Instruction: Instructions shall include: system start-up, shut-down, emergency shut-down,

normal control operation, safety aspects, maintenance and repair instructions. Instruction shall be by the manufacturer's authorized service representative.

- C. Duration: Instruction period shall be for a minimum of four hours for each different boiler type.

### 3.7 COMMISSIONING

- A. The Products referenced in this section are to be commissioned. The Contractor has specific responsibilities for scheduling, coordination, startup, test, development, testing and documentation of the commissioning. The Contractor shall provide a documented and signed record to verify that all equipment and systems installed under this contract have been inspected and functionally tested to verify full compliance with the contract specifications.

END OF SECTION





## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Chiller.
- B. Electric Heat Tracing.
- C. Chiller Start-Up.
- D. Owner Training and Instruction.

### 1.3 SUBMITTALS

- A. General: Submittals shall comply with Section 220500.
- B. Product Data: Submit product information on all products. Submit performance data for chiller unit, showing performance as a function of chilled water temperature and ambient temperature. Provide information showing chiller overall dimensions, service points and service clearances, and location of all chiller connections.

### 1.4 QUALITY ASSURANCE

- A. Ratings: Chiller performance shall be rated in accordance with AHRI standard 550/590. Unit performance and efficiency shall comply with code.
- B. Construction: Chiller construction shall be designed to conform to ANSI/ASHRAE 15, NEC, ASME standards, and code.
- C. Factory Test: Unit shall be operated and fully tested at the factory prior to shipment.
- D. Ambient Conditions: Unit and all components shall be able to withstand ambient temperatures from -10 deg F to 125 deg F, plus direct exposure to sun and weather elements. Unit shall be able to operate and produce chilled water between ambient temperatures of 50 deg F and 125 deg F.

### 1.5 WARRANTY

- A. One Year: Entire chiller shall be warranted by the manufacturer to be free of manufacturing defects for one year, in accordance with Division 00 and 01. All labor and materials associated with unit repairs shall be included in the warranty.
- B. Extended: Chiller compressors and refrigeration circuit and its components (piping, valves,

accessories) shall be warranted by the manufacturer for an additional four years after the one year warranty (total of 5 years). All labor and materials associated with compressor replacement and refrigeration circuit repairs shall be included in the warranty.

## 1.6 REFERENCES

- A. ANSI/ASHRAE 15: Safety Standard for Refrigeration Systems.
- B. AHRI 550/590: Performance Rating of Water Chilling Packages Using the Vapor Compression Cycle.
- C. ASTM B117: Salt Spray and Salt Fog Testing.
- D. ASTM 1654: Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Products shall comply with Section 220500, Paragraph 2.1, Acceptable Manufacturers.
- B. Chiller: Trane, Carrier, JCI/York, Daikin.
- C. Heat Trace: Ray-Chem.

### 2.2 PACKAGED OUTDOOR CHILLER

- A. Type: Packaged outdoor chiller with air cooled condenser and multiple rotary screw compressors; for use with R-134A or R-410A or R-407C refrigerant.
- B. Capacity: Unit shall have a minimum cooling capacity as scheduled on the drawings at the conditions shown, certified to comply with AHRI performance and rating standards.
- C. Frame and Panels: Unit frame shall be one-piece welded assembly of minimum 14 gauge zinc coated steel. Unit panels and access doors shall be constructed of minimum 16 gauge zinc coated steel. Exterior surfaces shall be cleaned, phosphatized, and finished with electrostatically applied baked enamel finish, manufacturer's standard color, and yield an ASTM D1654 rating of 6 or better when subjected to a 1000 hour salt spray test per ASTM B117.
- D. Compressors, Motors, and Refrigeration Components:
  - 1. Compressors: Rotary screw compressor, semi-hermetic type, direct drive, with variable speed compressor, differential refrigerant pressure oil flow and, oil heater. Unit shall have quantity of compressors scheduled.
  - 2. Refrigeration Circuits: Unit shall have at least two independent refrigeration circuits. Each refrigeration circuit shall include expansion valve, replaceable core filter/drier, liquid line sight glass, liquid line shutoff valve, suction and discharge pressure gauges (each circuit) panel mounted with manual shutoff valves (gauges not required where system controls include pressure transducers and ability to visually display suction and

discharge pressures at unit control panel). Unit shall be complete with proper operating charge of refrigerant and oil.

- E. Evaporator: Shell and tube design with seamless copper tubes roller expanded into tube sheets and with removable heads (or be of brazed plate stainless steel construction). Designed, tested and stamped in accordance with ASME Code for refrigerant side working pressure of no less than 350 psig and water-side working pressure shall be no less than 150 psig. Pressure drop shall not exceed the value scheduled on the drawings at the gpm shown. Each shell shall include drain connection, vent connection, bulbwells for low temperature controller, and 3/4" closed cell PVC foam insulation. Design shall accommodate required number of independent refrigeration circuits.
- F. Condenser Fan and Motors: Shall be vertical discharge, direct-drive, propeller type. Fans shall be statically and dynamically balanced, with steel blades and zinc-plated steel hubs. Three-phase motors with permanently lubricated ball bearings, class B (or better) insulation, built-in current and thermal overload protection and weather tight slinger over shaft. Provide with PVC coated steel wire safety guards over fans.
- G. Condenser Coil: Air cooled type, with aluminum fins mechanically bonded to seamless copper tubing. Unit shall have sub cooling circuit with liquid accumulator and be factory tested at 425 psig air pressure, vacuum dehydrated. Provide with louvered metal grilles for coil protection, PVC coated or with baked enamel finish same as specified for unit frame and panels.
- H. Controls, Safeties, and Electrical:
  - 1. General: Unit shall have complete factory installed controls that allow for standalone unit operation. Controls shall be microprocessor based, and shall include all temperature and pressure sensors, printed circuit boards, wiring, raceway, power terminals, control circuit terminals, and accessories for proper operation. All unit controls shall be factory installed and tested. Controls shall regulate leaving chilled water temperature by automatic compressor sequencing, condenser fan sequencing, load limiting, and anti-recycle features. Controls shall maintain leaving water setpoint to plus or minus 1 deg F of setpoint. Unit shall consider return water temperature, leaving water temperature, and rate of change of these values to optimize compressor operation. Unit shall have controls to equalize run time between compressors. Controls shall limit compressor operation at start-up to prevent excessive electrical demand.
  - 2. EMCS Interface: Unit shall have a controller to interface with Division 25 and allow for the control and communication indicated; protocol used shall match the Division 25 control system. Unit shall have terminals (and associated controls) that allow for external remote enable/disable of the unit when these terminals are connected to each other (by the Division 25 control system). Unit shall have terminals (and associated controls) that allow for external remote reset of the unit's chilled water setpoint; such terminals shall accept a 4-20 mA or 0-10 vdc signal (from the Division 25 control system) to accomplish this reset. Coordinate control connections and required signals with the Division 25 Contractor to ensure compatibility and to allow the sequence of operation specified herein and in Division 25.
  - 3. Circuit Boards: Shall be protected to prevent RFI and voltage transient damage. Items requiring field wiring shall be factory wired to terminal strips to allow field termination at terminal strips and not at circuit boards.
  - 4. Ambient Protection: Unit controls shall be capable of withstanding the specified ambient temperature range without adverse effects, and shall be suitably enclosed to be

protected from the weather, physical damage, and vandalism. Unit shall have ventilation fans, heaters, or other devices as necessary to allow components to withstand ambient conditions.

5. Microprocessors: Memory shall be non-volatile type requiring no battery or capacitive back-up, while maintaining all data.
6. On/Off/Auto: Provide unit with manual switch for local manual control (on/off) or automatic control (via EMCS enable).
7. Digital Display: Provide with keypad, multi-character and multi-line liquid crystal display. Display shall allow full operator adjustment of unit and display of unit diagnostic information, operating status, setpoints, and control functions. Display shall be in clear English not requiring look-up of coded messages, and have at least two lines and 40 characters per line. Keypad shall be touch sensitive type, with minimum 16 keys. Access shall be able to be password protected to prevent changes by unauthorized personnel. Display shall indicate status of all connected control devices (e.g. temperature and pressure sensors, safeties) and be able to perform diagnostic to test operation of all control devices.
8. Compressor Current Sensing: Unit shall have controls to allow measurement of amperage draw on each compressor, and be displayed at the unit's Digital Display, and provide an output to the building EMCS.
9. Control Safeties: In addition to code required safeties, unit shall have safety controls to prevent operation that may damage the unit or be unsafe. Such safeties shall as a minimum include protections for the following conditions:
  - a. Loss of refrigerant charge.
  - b. Low water flow.
  - c. Low chilled water temperature.
  - d. Low and high superheat.
  - e. Low control voltage.
  - f. High refrigerant pressure.
  - g. Low oil pressure
10. Low ambient controls: Unit shall have all necessary safeties and controls to allow operation at the specified ambient conditions.

I. Electrical:

1. General: All power wiring shall be factory installed from unit power terminals to all unit devices requiring power. Provide all disconnects and fusing on internal circuits as required by code.
2. Control Power: Unless indicated otherwise, provide unit with control transformer for powering unit controls, and all associated wiring and accessories.
3. Motor Electrical Overloads: Shall be through definite-purpose contactors and calibrated, ambient compensated, magnetic trip circuit breakers. Circuit breakers shall open all 3 phases in the event of an overload in any one phase (single-phasing condition).
4. Power Supply Monitor: Provide system to detect phase loss, phase reversal, phase imbalances, incorrect phase sequence, low line voltage, and similar adverse power conditions. System shall stop unit operation and indicate description of fault at unit Digital Display.
5. Power Disconnect: Provide unit with factory installed HACR rated circuit breaker, configured to allow complete unit power disconnect without opening unit.
6. Starters: Where any compressor's running load amps exceed 100, the compressor shall have a wye-delta closed transition starter to reduce in-rush current on compressor start.

- J. Heater: Unit shall have internal thermostat controlled heater (or heat tape) to protect unit from freezing down to -20 deg F ambient temperature. Unless indicated otherwise, provide unit with control transformer for powering unit heater, and all associated wiring and accessories (unless indicated to be served by a separate power source).
- K. Flow Switch: Furnish with flow switch for field installation, NEMA 3R rated, with SPDT contacts. Provide chiller with terminal connections for wiring to flow switch to allow unit operation only when flow switch confirms flow.
- L. Vibration Isolators: Neoprene vibration isolation pads; See Section 220548.
- M. Acoustic Treatment Enclosure: Unit shall have acoustic treatment specified and added features to comply with specified sound level (see drawing schedule). Acoustic materials shall be specifically designed by the chiller manufacturer and suited for the application, arranged and installed to reduce unit noise levels. Treatment shall include:
  - 1. Compressor Mufflers.
  - 2. Acoustic insulating material on compressor suction and discharge lines.
  - 3. Flexible connectors on compressor suction and discharge lines.
  - 4. Maximum speed of condenser fans adjustable.
  - 5. Acoustic enclosure over unit compressors.

### 2.3 ELECTRICAL HEAT TRACING

- A. Type: Self-regulating electrical heat tracing cable to prevent pipeline freezing; UL listed. Raychem "XL-Trace" (or approved).
- B. Construction: Heater shall consist of two (2) 16 AWG tinned-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature all along its length, allowing the heater to be crossed over itself without overheating. The heater shall be covered by a radiation cross-linked modified polyolefin dielectric jacket. Heater shall be cable capable of being cut to desired length in the field.
- C. Voltage/Capacity: The heater shall operate on line voltages of 120, 208, 220, 240, or 277 volts without the use of transformers. See drawings for power source and voltage to be used for each application on this project. Heater shall have a minimum capacity of 5 watts/linear foot at 50 degrees F.
- D. Accessories: Provide the following accessories:
  - 1. Power Connection Kit: Shall include junction box, terminal connectors, and accessories allowing connection of power wiring to heater.
  - 2. Thermostat: Bulb type thermostat, with NEMA 4x enclosure, 3 foot capillary, fixed setpoint of 40 degrees F. Provide with contactors (in NEMA 4x enclosures) as required to allow thermostat to control heater.
  - 3. Tee/Splice/End Kits: Shall allow for connection of tee heater wiring, splicing connections, and end seal termination of heater.
  - 4. Labels: Provide label reading, "Electric Traced", minimum one per 50 feet of heater. Locate labels at power connection kit location, end termination and other in-between locations as appropriate.
  - 5. Tape: Fiberglass tape for attaching heater to pipe.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. General: Install in accordance with manufacturer's written instructions, code, and best professional practices. Comply with Section 220500.
- B. Locations: Install equipment at locations indicated and as shown on the drawings.
- C. Chiller Components: Connect and install all items shipped loose with units.
- D. Mounting: Provide concrete pad and supports at unit as indicated on the drawings. Set unit on specified vibration isolators. Anchor unit to isolators and isolators securely to concrete pad (or to building structure).
- E. Heat Tracing: Provide heat tracing of all piping, fitting/valves, and accessories at unit which carry water and are subject to freezing. Heat tracing shall not be applied until after system has been successfully pressure tested. Secure the heater to piping with cable ties or fiberglass tape. Apply "electric traced" signs to the outside of the thermal insulation, subject heat to testing using a 100 VDC megger. Minimum insulation resistance should be 20 to 100 megohms regardless of length. See Division 26 for connection of power from panel to heat tracing power connection kit.

### 3.2 START-UP

- A. General: Start-up and subsequent system checks shall be done by the manufacturer's authorized service representative.
- B. Initial Checks: Prior to operating units, checks shall be made to insure that all equipment, piping, and controls are connected and operating properly. As a minimum, check for: proper voltage and phases, correct compressor oil level, valves open, pump operation and adequate water flow, correct electrical connections, complete control connections, overload heaters installed in compressor motor starters, all unit safety devices properly set and connected, unit heaters operational, condenser fans rotating correctly, fans lubricated, coils clear of obstructions, and other items as listed by the manufacturer are properly provided/connected and operating to insure safe and proper unit operation.
- C. 72 Hour Checks: Provide checks in accordance with manufacturer's instructions; as a minimum review the following:
  - 1. Observe the compressor oil level. If low, operate the system for three to four hours, checking the oil level frequently. If it remains low, add oil.
  - 2. Check the refrigerant flow in the liquid line sight glass. The flow should be solid with no evidence of flash gas. If bubbles of flash gas appear, check the system for leaks; repair if necessary and add refrigerant.
  - 3. Check the temperature of the liquid line from the inlet of the filter-drier to the expansion valve. The temperature should be uniform. If a decided temperature difference exists across a valve or fitting, a restriction is evident. The restriction is causing a pressure drop which, in turn, is causing the refrigerant to flash. Such a pressure drop produces bubbles of flash gas which will appear in the sight glass. Remove and clean the restricted part.

4. Measure the superheat of the suction gas. If necessary, readjust the superheat setting of the expansion valve.
  5. Observe the system operating pressures.
  6. Clean all strainers in the chilled water circuits.
- D. One Week Check: After the system has been in full operation for one week, provide these final checks and adjustments: Observe the general operation of the system: system pressures, compressor oil level, liquid line sight glass, condensing equipment, etc.
- E. Written Report: When all of the above checks have been completed, a written report from the manufacturer's authorized service representative shall be provided. This report shall list all units checked, items checked, check results, any items which may impair proper unit operation, and the name and phone number of the actual individual(s) doing the check. The report shall include a statement stating whether or not all units are operating as specified. Separate data/record sheets shall be provided for each of the above units.

### 3.3 OWNER TRAINING AND INSTRUCTION

- A. After all testing and adjustments have been satisfactorily completed, the Owner shall be provided with operator instructions (including start-up, shut-down, emergency, maintenance, and repair instructions) by the manufacturer's authorized service representative. Training time may be scheduled to match weather conditions which allow the best review of system operation.
- B. Time Period: Instruction period shall be for a minimum of four (4) hours.
- C. Instruction and notification shall comply with Section 220500.

### 3.4 END OF WARRANTY REVIEW

- A. General: Within 30 days of end of project warranty period, provide inspection and review of unit operation. Arrange mutually agreeable timing of review with Owner. Review shall be performed by the manufacturer's authorized service representative.
- B. Review: Observe unit operation and perform (as a minimum) the manufacturer's recommended annual service inspection.
- C. Written Report: Submit a written report of findings.

### 3.5 COMMISSIONING

- A. The equipment and systems referenced in this section are to be commissioned per Division 01 and Section 230800. The contractor has specific responsibilities for scheduling, coordination, startup, test development, testing and documentation. Coordinate all commissioning activities with the Commissioning Authority.

END OF SECTION





## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Air Handling Units.

### 1.3 SUBMITTALS

- A. General: Comply with Section 220500.
- B. Product Data: Submit product information on air handling units and all components, including details of construction, materials of construction, data on unit components, unit dimensions, and weight. Submit fan curves showing SP vs. CFM and BHP vs. CFM with system operating point clearly marked. All submittals shall include data indicating compliance with indicated capacity and specified standards.
- C. Shop Drawings: Submit drawings of units showing all dimensions, locations of unit components and connections.
- D. Sound Power: Submit sound power level data showing sound power levels referenced to 1 picowatt for each of the eight octave bands.

### 1.4 GENERAL REQUIREMENTS

- A. Standardization: All air handling units shall be the product of the same manufacturer.
- B. Substituted Equipment: The drawings show design configuration based on a particular manufacturer's equipment (i.e. basis of design). Use of another manufacturer's equipment (i.e. substituted equipment) that is configured different from what is shown will require redesign of mechanical ductwork, piping, electrical, structural, unit support systems, and general building construction to accommodate the substituted equipment. Such redesign shall meet the requirements and have the approval of the Architect/Engineer prior to fabrication. Contractor shall submit complete shop drawings showing all alternate unit installation plans and details; shop drawings shall comply with Section 220500. The redesign shall be equal or superior in all respects to the Architect/Engineer's design (as judged by the Architect/Engineer), including such aspects as equipment access, ease of maintenance, duct connection locations, unit electrical requirements, noise considerations, vibration unit performance, and similar concerns. Cost of redesign and all additional costs incurred to accommodate the substitutional equipment shall be borne by the contractor. Contractor is cautioned that certain aspects of the equipment cannot be fully evaluated until items are installed and operational, and all added costs after installation to make units equal to the basis of design shall be by the Contractor.

- C. Make-up Air Units: Shall be same as specified air handling units except without return air damper, and shall operate on 100% outdoor air.

## 1.5 QUALITY ASSURANCE

- A. General: Comply with Section 220500.
- B. Manufacturer: Air handling units and major components shall be products of manufacturing firms regularly engaged in production of such equipment whose products have been in satisfactory use in similar service for not less than 10 years.
- C. AMCA: Fan performance ratings shall be based on tests made in accordance with AMCA standards and fans shall bear the AMCA certified seal.
- D. Factory Wiring: Units with factory wiring shall be factory UL approved and labeled.

## 1.6 WARRANTY

- A. General: See Division 00 and 01. All products shall be warranted by the manufacturer to be free of defects in material and workmanship for the warranty period. All labor and materials associated with unit repairs shall be included in the warranty.
- B. Extended Warranty: Entire air handling unit and VFD shall have one year additional warranty.

## 1.7 REFERENCES

- A. AMCA 210: Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
- B. AMCA 260: Sound Rating of Ducted Air Moving and Conditioning Equipment.
- C. AMCA 300: Reverberant Room Method for Sound Testing of Fans.
- D. AHRI 410: Standard for Forced Circulation Air Cooling and Air Heating Units.
- E. ASTM D-2247: Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Products: Comply with Section 220500, Paragraph 2.1, Acceptable Manufacturers.
- B. Air Handling Units: Silent-Aire, Petra, Innovent, Daikin, Scott-Springfield.
- C. Variable Frequency Drives: ABB.

### 2.2 GENERAL

- A. Guards: Provide the fans and drive assemblies with enclosed safety screen per WISHA and

OSHA Standards. Provide fans with inlet screens as required per WISHA and OSHA requirements. For units less than 24-inches high, where allowed by safety standards, and where unit casing provides protection and access door is clearly labeled as to the hazard, guards may be omitted.

- B. Balancing and Shafting: The shafting of the fan shall be sized not to exceed 75 percent of the first critical speed under the specified operating conditions, and the lateral static deflection of the shaft shall not exceed 0.003 inches per foot of the length of the shaft. In larger sizes, shafting shall be hollow to lessen the weight of the rotating parts and insure longer bearing life. The shaft and fan wheel(s) shall be dynamically balanced in two planes as a complete unit to a maximum residual unbalance of 0.15 oz. at 95 percent of the fan wheel radius in each plane.
- C. Motors: Shall be UL listed and as specified in Section 220500. Motors used with VFD's shall be designed and rated for VFD use. Provide with shaft grounding provisions.
- D. Duct Connections: Units shall be furnished with attachment angles and/or flanges as required for attaching connecting ductwork.
- E. Capacities: Shall be no less than as scheduled on the plans. Fan capacities shall be in accordance with AMCA standards. Coils shall be certified in accordance with AHRI Standard 410.
- F. Controls: Coordinate with Division 25 and provide required interfaces between air handling equipment and building control system.
- G. Gasketing: Where units are furnished in sections, unit manufacturer shall furnish unit with gasketing to allow sealing of adjoining sections.

## 2.3 AIR HANDLING UNITS

- A. Type: Draw through direct drive type air handler, with hot water heating coil, chilled water cooling coil, return air dampers, and outdoor air dampers.
- B. Casing:
  - 1. General: Constructed of minimum 16 gauge G-90 galvanized steel, welded or bolted to minimum 10 gauge galvanized steel frame. Unit shall be reinforced for maximum anticipated static pressure involved, but no less than 1.5 times scheduled unit total static pressure. Unit casing shall be able to withstand this pressure with no more than 0.01 inch casing deflection, and no more than 0.5% cfm leakage (of unit scheduled cfm). Unit shall be furnished in sections as required to allow installation (or future removal) in the space available. Sections shall be gasketed and sealable by field bolting.
  - 2. Liner: Interior of cabinet shall be insulated with minimum 2-inch thick, 1.5 pound per cubic foot density fiberglass duct lining applied with mechanical fasteners 12 inch-on-center and adhesive. Provide with 22 gauge galvanized steel perforated liner inside entire unit, except utilize solid liner at coils, and at mixed air portion of unit.
  - 3. Base: Fully welded, structural steel construction, with full perimeter steel c-channel for base support. Provide steel cross supports (tubing, channels, or angles) to insure unit rigidity. Provide base with lifting lugs to allow for crane lifting.
  - 4. Floor: Constructed of minimum 16 gauge galvanized steel outer panel, two inch thick rigid insulation and 12 gauge diamond plate inner floor panel. Provide with 1.5-inch

perimeter angle around entire unit and each floor opening to ensure unit is internally watertight. All floor seams shall be caulked and sealed.

5. Access Doors: Double wall construction, and same construction as unit casing, full size of section accessed (but not wider than 24") hinged type, with extruded aluminum doorframe, built in thermal break, and full perimeter gasket. Corners of doors shall be welded. Doors shall be opened by releasing multiple latches or similar method requiring no tools. A 12-inch round hermetically sealed double glazed laminated glass window shall be provided in each door. Provide access doors to each section of the unit, both sides of unit (except where access on opposite side is prohibited by building structure, one side access is adequate).
6. Access Panels: Unit shall have removable side access panels to allow coil removal, and side access panels to allow removal of largest fan component.
7. Drain Pans: Drain pans shall be provided at all coil sections mixed air sections, and at moisture eliminators. Fabricate from 16 gauge 304 stainless steel extend past cooling coil to capture all carryover moisture. All pans are to be triple pitched for complete drainage with no standing water in the unit. Insulate with minimum 1/2-inch foam insulation, and have "Double Bottom" construction with welded corners. Provide stainless steel drain connection (size as required by Code) extended to the exterior of the unit base rail. Units in excess of 160 inches width shall have drain connections on both sides. All drain connections shall be piped and trapped separately for proper drainage. Furnish field installable p-traps for discharge of condensate.
8. Finish: All exterior surfaces shall be painted with a baked enamel finish capable of withstanding a 500 hour salt spray test per ASTM B117. The color shall be manufacturers standard.
9. Pipe and Electrical Chases: Provide unit with necessary pipe and electrical chases to allow all connections to internal unit components, and to exterior piping and utilities. All piping shall be isolated from the air stream.

C. Fans:

1. General: Steel or aluminum construction, multi-blade backward inclined plenum type, direct drive.
2. Vibration Isolation: Fan(s) and motor(s) shall be mounted internally in the fan cabinet on an integral base. This assembly shall be isolated from the cabinet by steel springs of 1" deflection. Springs shall be free-standing, seismically housed steel, with leveling bolts, selected to a maximum transmissibility of 5 percent. Isolator shall be mounted on a neoprene, or fiberglass, high frequency absorber with no metal-to-metal contact between the spring housing base and the base of the fan cabinet. Isolators restraints shall be rated for the seismic zone that the project is located in.

D. Coils:

1. Tubes: Shall be 5/8-inch, 3/4-inch, or 1-inch OD copper tubes expanded into full fin collars for permanent fin-tub bond and expanded into seamless copper headers (or cast iron headers) for permanent leak-tight joint. All copper joints shall be brazed.
2. Fins: Shall be plate-type aluminum or copper fins with full fin collars for maximum fin-tub contact and accurate spacing, mechanically bonded to tubes for permanent fin-tube bond.
3. Casing: Coils shall be fully encased in the unit casing, and be mounted on stainless steel angle racks and constructed to allow each coil to slide out individually.
4. Piping Connections: Coil piping connections shall be on the same side of unit, and be extended through casing, with factory escutcheon and seal. Provide plugged threaded vent connection at coil high point.

5. Tests: All coils shall be proof tested at 1.5 times maximum working pressure, then leak tested at maximum working pressure. Minimum test pressures shall be 300 psig proof test and 200 psig leak test.
- E. Filters: Unit shall be designed to hold 2-inch thick filters, type as specified in Section 234000, with minimum filter face area as indicated. Access for filter maintenance shall be through a full height access door on the side of the unit.
- F. Outside Air/Return Air/Exhaust Air Dampers:
  1. General: Unit shall have outside air, and return air dampers to allow for 0 to 100% outside air, and full return air. Configuration shall be as shown on drawings.
  2. Dampers: Galvanized steel or aluminum airfoil frames and blades, minimum of 12 gauge extruded aluminum or minimum 16 gauge galvanized steel. Blades shall be of a single unit airfoil design 6-inch wide. Frames shall be extruded aluminum channel with grooved inserts for vinyl seats. Pivot rods shall be 7/8-inch hexagon extruded aluminum interlocking into the blade section. Bearings shall be of a double sealed type with Celcon inner bearing on a rod within a Polycarbonate outer bearing inserted into the frame to prevent the outer bearing from rotating. Damper seals shall be designed for minimum air leakage by means of overlapping seals. Jack shaft assemblies shall be provided for multiple damper installations. Sized for maximum face velocity of 1500 feet per minute.
- G. Electrical:
  1. General: Unit shall be configured for two point wiring; one for unit fan and one for unit lights. Unit shall be furnished with all necessary wiring, raceway, transformers, and accessories to connect power to all unit devices requiring electrical power. Electrical shall comply with NEC and local code requirements. Unit shall have a disconnect for each power circuit. Disconnects shall comply with NEC, be accessible from outside unit enclosure, able to be padlocked in the "off" position.
  2. Fan VFD: Furnish units with VFD's mounted on unit and factory wired to motor. VFD's shall be as specified in Division 25. Include provisions for field power being connected to unit VFD without cutting unit casing.
  3. Lights: UL listed wet location lensed LED type, one for each unit section. Provide switch on each side (or end) of unit for light, 3-way type. Shall be factory wired to switches and to unit 115 V/1 PH power circuit.
- H. Controls: All unit controls are by Division 25.
- I. Sound Performance: Unit sound power levels shall not exceed the following (dB re: 1 picowatt):

CFM	Unit Capacity Location	Octave Band, Hz							
		<u>63</u>	<u>125</u>	<u>250</u>	<u>500</u>	<u>1000</u>	<u>2000</u>	<u>4000</u>	<u>8000</u>
5,000 <	Outlet	83	82	81	72	74	71	68	62
	Inlet	80	80	78	69	71	68	65	60
> 5,000	Outlet	87	86	85	76	79	76	73	67
10,000 <	Inlet	85	85	83	75	77	74	71	65
> 10,000	Outlet	89	86	92	94	89	87	82	75
	Inlet	87	84	90	92	87	85	80	73

### PART 3 EXECUTION

### 3.1 INSTALLATION

- A. General: Air handling units installation shall be in accordance with the manufacturer's written instructions, code, and best construction practices. Units shall be installed in locations shown on drawings and in accordance with the Contract Documents.
- B. Mock-up: The Contractor shall provide a sample air handling unit installation prior to installing and connecting other units. Such mock-up shall be at the AHU unit's final installation location. Selected unit to be mocked up is of Contractor's choice, but selected unit shall be typical to most units, and shall be agreed to by the Engineer. Mock-up shall include all supports, bracing, duct connections, motorized dampers, actuators, control connections, etc. See Sections, 232113, 233100, and Division 25 for related work.
- C. Support: Units shall be evenly supported and braced to allow for proper unit operation. Units shall be base supported. Provide seismic anchorage and bracing; see Sections 220529 and 220548.
- D. Vibration: All units shall be installed with vibration isolators so that no sound or vibration is transmitted to the structure. See Section 220548.
- E. Connections: Provide flexible connections in ductwork connections to all units.
- F. Drain Piping: All drains from units and drain pans shall be piped to the closest floor drain or point of drainage. Provide unit primary condensate drains with p-traps; see Section 232128.
- G. Multiple Coils: Multiple coils of the same type shall be headered together for single supply and single return connections. Header piping shall be made as equal in length as possible; provide with isolation valves in piping to each coil with balancing valves in the return piping.
- H. Sealing: Unit casing shall be sealed to eliminate all leakage. All damaged lining/gaskets/seals shall be repaired. Unit shall be thoroughly cleaned of all debris prior to operation.

### 3.2 FIELD START-UP

- A. Prior to air balancing and testing, check fans for correct rotation, and prepare units for operation per manufacturer's recommendations.
- B. Subsequent to installation, and prior to air balancing, the installing Contractor shall perform functional tests and start-up for a minimum period of 3 days with various control settings to assure proper operation over the full design range.
- C. All air handling equipment shall be tested for operation, bearing integrity and coil performance.

### 3.3 COMMISSIONING

- A. The equipment and systems referenced in this section are to be commissioned per Section 019113 – General Commissioning Requirements and Section 230800, Commissioning of Mechanical Systems. The contractor has specific responsibilities for scheduling, coordination, startup, test development, testing and documentation. Coordinate all commissioning activities with the Commissioning Authority.

END OF SECTION





## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Air Conditioning Units.
- B. Refrigeration Piping and Accessories.
- C. System Leak Testing and Charging.
- D. Start-Up.

### 1.3 SUBMITTALS

- A. General: Shall comply with Section 220500.
- B. Product Data: Provide complete product information on all units; include cooling performance capacities as a function of indoor and outdoor coil db/wb temperatures and indoor coil air flow rates, fan performance (cfm vs. esp), unit efficiencies, dimensions and information on all filters and accessories. Provide information showing dimensions and location of refrigerant, power, and control connections.
- C. Installation: Submit manufacturer's installation instructions.
- D. Start-Up Report: Submit air conditioning unit inspection and start-up report.

### 1.4 QUALITY ASSURANCE

- A. Listing: Units shall be listed by an approved testing laboratory for the use and application intended.
- B. Rating and Certification: Cooling performances shall be tested and rated in accordance with AHRI 210/240.
- C. Applications: Units shall be intended for commercial use and shall include all manufacturers recommended accessories for proper operation for the application intended.
- D. Code Compliance: Units shall be rated in accordance with recognized standards and meet code requirements for energy efficiencies. Units shall be constructed and designed to conform to applicable codes and standards.
- E. Standardization: In interests of Owner's standardization, all equipment of the same type shall be the product of the same manufacturer.

- F. Operating Conditions: Unless more extreme temperatures are noted elsewhere, or required by local conditions or the specific application, unit shall comply with the following:
  - 1. Unit and all components exposed to ambient conditions shall be able to withstand ambient temperatures from -10 deg F to 125 deg F, plus direct exposure to sun and weather elements without adverse effects.
  - 2. Unit shall be able to operate and produce cooled air between ambient temperatures of 0 deg F and 125 deg F.
- G. Alternate Manufacturers: The project has been designed around units by the manufacturer scheduled on the drawings. Alternate manufacturers may be used (see Acceptable Manufacturers, Paragraph 2.1 and Section 220500); however, any redesign (from what is shown on the drawing) to mechanical, electrical, structural or general construction to accommodate such an alternate manufacturer shall be provided by the Contractor. Furthermore, such redesign shall meet the requirements and have the approval of the Architect/Engineer prior to fabrication. Contractor shall submit complete shop drawings showing all alternate unit installation plans and details; shop drawings shall comply with Section 230500. The redesign shall be equal or superior in all respects to the Architect/Engineer's design, including such aspects as equipment access, ease of maintenance, duct connection locations, unit electrical requirements, noise considerations, unit performance, and similar concerns. Cost of redesign and all additional costs incurred to accommodate alternate manufacturers shall be borne by the Contractor.
- H. Commissioning: See Division 01 and Section 220800 for commissioning efforts required.

## 1.5 WARRANTY

- A. General: Entire unit shall be warranted to be free of all manufacturing defects and meeting all Contract Document requirements for a period of one year after Owner project acceptance.
- B. Compressors: Unit compressors shall be warranted by the manufacturer for five years after Owner project acceptance. All labor and materials associated with compressor replacement and repair shall be warranted.

## 1.6 REFERENCES

- A. AHRI 210/240: Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment.
- B. ASME B16.22: Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- C. ASME B16.26: Standard for Cast Copper Alloy Fittings for Flared Copper Tubes.
- D. ASTM B280: Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. All products shall comply with Section 220500, Paragraph 2.1; Acceptable Manufacturers.

- B. Air Conditioning Units: Mitsubishi, Daikin, LG.
- C. Refrigerant Pipe and Fittings: Domestic manufacturers only.

## 2.2 AIR CONDITIONING UNIT

- A. Type: Split system ductless air conditioner.
- B. Indoor Unit: Wall (or ceiling) suspended unit (configuration as indicated on plans), with fan, adjustable discharge outlet, air filter, evaporator coil, refrigerant metering device, heavy gauge steel chassis, white plastic enclosure, controls, condensate pan and drain connection, and related accessories to operate properly with outdoor unit.
- C. Outdoor Unit: Outdoor condenser and compressor unit, with high efficiency rotary compressor, condenser coil, condenser fan, accumulator, refrigerant piping, wind baffle accessory, heavy gauge steel chassis, baked enamel finish steel cabinet, controls, coil guard, mounting legs, and related accessories to provide capacity indicated.
- D. Capacity: As scheduled on drawings at the conditions indicated. Unit shall provide cooling down to 0 deg F ambient. Unit shall be able to operate with refrigerant runs up to 164 feet long. Shall be rated in accordance with AHRI standards.
- E. Refrigerant: Units shall be for use with refrigerant R-410A or R-407C.
- F. Electrical and Controls: Indoor and outdoor units shall be provided with all contactors, relays, wiring terminals, safety controls, microprocessor devices, and accessories to allow for complete unit operation requiring only connection of room controller, power, and interconnection between indoor and outdoor units. Room controller shall be the electronic type, with liquid crystal display, room temperature sensor, on/off/auto functions, temperature setpoint, fan speed indicator, and self diagnostic display.
- G. Condensate Pump: Provide unit with condensate pump. Where not available internal to unit, provide external type, with holding tank, controls, and gpm capacity at least 4 times unit condensate rate, at 10 feet of head. Provide mounting assembly and accessories for completely connected and functioning unit.
- H. EMCS Interface: LonWorks controller to interface with Division 25 controls to allow for the specified sequence and communication indicated. Interface shall allow external enable/disable, reset of setpoint, equipment status, and alarm indication.

## 2.3 REFRIGERANT PIPING AND ACCESSORIES

- A. Piping: Hard drawn ACR copper tubing per ASTM B280, Type L, with silver brazed joints and wrought copper fittings per ASME B16.22. Use only long radius elbows. Flared fittings (at equipment connections only) shall comply with ASME B16.26. Soft copper tubing may only be used on runs less than 50-feet or where necessary (i.e. when routing through sleeves, or similar poor access areas).

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. General: Install in strict accordance with manufacturer's written instructions and code.
- B. Location and Arrangement: Install all equipment at locations and as shown on the drawings. Install so as to allow maximum access to unit. Prior to selecting unit final location, confirm that: proper unit clearances and access will be provided; no adverse airflow conditions are present; confirm location and installation details with other trades. Units shall be level and aligned with building walls. Set outdoor unit on concrete pad (or roof sleepers); anchor to pad (or sleepers).
- C. Complete Connections: Connect and install all items shipped loose with units; provide and connect all utilities and accessories as required for proper unit operation. See Section 232128 for cooling coil condensate drain piping.
- D. Refrigerant Piping: Shall be silver brazed. Bleed dry nitrogen through piping during brazing to minimize oxidation. Keep all open ends of piping capped when not being worked. Soft copper shall have long radius bends; install without kinks or excess bends. Piping shall be routed concealed, except where routed outdoors and where noted. Piping shall be ran plumb and square to building walls, and in a neat professional manner. Provide sight glass in refrigerant liquid piping at outdoor unit.
- E. Refrigerant Valves: Provide isolation valves on refrigerant piping connections at the outdoor unit (unless unit has integral service valves). Provide valve with access port on larger volume systems to aid in system vacuum testing (or as required for other purposes).
- F. Refrigerant Charge: Units shall be checked for proper refrigerant charge and oil level and charged to proper levels after all leak testing and evacuation work has been completed. Refrigerant to be added to the system shall be delivered to the site in factory charged containers and charged into the system through a filter/drier.
- G. Cleaning: Units shall be thoroughly cleaned of all debris prior to operation. Units shall be clean and in new condition prior to Owner acceptance.
- H. Operation: Units shall not be operated until all construction activities that generate dust, dirt, fumes, or odors are complete; system checkout has occurred; and the Engineer has reviewed the system and granted approval.

### 3.2 LEAK TESTING AND EVACUATION

- A. Disconnect and isolate from the system any controls, relief valves, or other components that may be damaged by the test pressure.
- B. Connect oil-pumped, dry nitrogen to the system through a pressure reducing gauge manifold. Charge enough nitrogen into the system to raise the pressure to 140 psig (or as required by the local Code authority).
- C. Test all joints for leaks with a glycerin soap solution. Check the manifold gauge for any drop in pressure. Tap all solder/brazed connections with a rubber or rawhide mallet sufficiently hard to start any leak that might subsequently open from thermal expansion/contraction or vibration.
- D. Repair any leaks found by completely disassembling the connection, cleaning the fitting and remaking the connection. Re-test the system after repairs are made.

- E. When the above tests are successfully completed, allow the system to remain under test pressure (140 psig or as required by the local code authority) for 24 hours. Note the initial pressure and temperature. If the system pressure has not changed (when corrected to account for any change in temperature) the system may be considered free of leaks.
- F. When all testing is completed the system shall be completely evacuated of all air and moisture. Connect a vacuum pump to the system and evacuate the system to 500 microns, and let stand for a minimum of 12 hours. If the vacuum reading remains unchanged, the system may be charged with refrigerant.

### 3.3 START-UP

- A. Initial Checks: Prior to unit operation, the system shall be inspected to ensure all equipment and controls are properly connected and ready to operate. As a minimum, the following items shall be checked.
  - 1. Adequate refrigerant charge.
  - 2. Gauges installed to read suction and discharge pressure.
  - 3. Proper voltage at outdoor unit.
  - 4. Proper voltage at indoor unit.
  - 5. Unit safeties properly set and connected.
  - 6. Fan motors lubricated and ready to operate.
  - 7. Temperature controls connected.
  - 8. Pipe leak testing completed.
  - 9. Condensate drain installed.
  - 10. System service valves in proper position.
  - 11. Controls properly connected and powered.
- B. Initial Operation: After start-up, check unit for proper unit operation including: proper fan rotation, no excessive vibration, no unusual noises, proper unit cycling in response to room temperature, no excessive room temperature swings, no safeties or electrical devices tripping out.
- C. Written Report: Submit written report detailing all inspection procedures and findings leak test results, amount refrigerant charge installed, and final start-up/operation results.

### 3.4 COMMISSIONING

- A. The Products referenced in this section are to be commissioned per Division 01 Section 230800. The Contractor has specific responsibilities for scheduling, coordination, startup, test, development, testing and documentation. At a minimum, the Contractor shall provide a documented and signed record to verify that all equipment and systems installed under this contract have been inspected and functionally tested to verify full compliance with the contract specifications. In many cases, this shall require the Contractor to create or otherwise provide procedures and checklists for approval by the Commissioning Consultant prior to the start of functional testing. Reference Division 01 Section 230800 and coordinate all commissioning activities with the Commissioning Consultant.

END OF SECTION



**DIVISION 25**  
**INTEGRATED AUTOMATION**





## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 SECTION INCLUDES

- A. Control System Design.
- B. Complete Mechanical System Controls.
- C. Control Devices, Components, and Wiring.
- D. Control System Commissioning.

### 1.3 SUBMITTALS

- A. General: Comply with Section 220500.
- B. Product Data: Submit manufacturer's product data for all items to be used. Provide a complete materials list, labeled to match labeling used on shop drawing, with manufacturer and model number. Clearly indicate specific each item's control features (e.g. range of operation, accuracy, electrical characteristics, material of construction, etc.). Provide a schedule listing all control valves, control dampers, sizes, flow rates, pressure drops, Cv's, and related data to clearly identify application.
- C. Shop Drawings: Submit shop drawings of complete control system, including the following information: interconnect drawings showing all wiring and control connections, all control device locations, sequence of operation for all controlled systems, building floor plans with all proposed thermostat and other control device locations shown.
- D. Labeling: Submit list of proposed component labeling.
- E. Qualifications: Submit the following information:
  - 1. Background and history of company that will be contracted with to do the work of Division 25. Indicate staff size, shop UL listing capability, years of experience with control system to be installed on this project, etc. Indicate specific people that will be assigned to this project.
  - 2. List any of the sub-contractors to be used, and information on working relationship: i.e. projects done together, history, etc.
  - 3. List of similar projects completed by the Company, with information on each project, i.e when completed, description, size, dollar value, when completed, project references (Owner or Architect), and any other pertinent projects.
  - 4. Submittal of system communication architecture, general layout, and programming protocol.
  - 5. Submittal of major products to be used, including but not limited to:

- a. Air Terminal Units Controllers.
- b. Thermostats.
- c. Actuators.
6. Company's service and maintenance capabilities.
7. Lead Programmer resume.
8. Project Managers (or Project Superintendent) resume.
9. Other pertinent data to allow the Owner and Engineer to evaluate qualifications.

F. Commissioning Reports: Submit documentation showing commissioning work and results.

#### 1.4 QUALITY ASSURANCE

- A. Listing: All network controllers, central system controllers and local user displays shall be UL Listed under Standard UL 916, category PAZX.
- B. Electrical Interference: All electronic equipment shall conform to the requirements of FCC 15, governing radio frequency electromagnetic interference and be so labeled.
- C. Skilled Workers: The entire control system shall be installed by skilled electricians, technicians, and programmers, all of whom are experienced, properly trained and qualified for the work they perform. Contractor shall submit evidence of workers' experience and training upon request of the Engineer.

#### 1.5 GENERAL REQUIREMENTS

- A. Single Contractor: One single Company shall be responsible to design, furnish and install the complete Division 25 control system. Any subcontracted installation work shall be done by firms experienced and qualified in the work they perform, and subject to approval by the Engineer.
- B. Local Contractor: System shall be designed, programmed, and commissioned by local office personnel, with their office facilities, located within 100 miles of the project location.
- C. Qualifications: Firms performing the Division 25 work shall meet the qualifications listed below. Firms listed below have been pre-qualified as a convenience to bidders.
  1. Have installed control systems of the type required for this project in at least 6 projects of similar or greater complexity in the last 2 years. These similar or more complex projects shall involve integrating controls of another contractor.
  2. Be qualified by the manufacturer of the system being installed to install the type of controls and of the magnitude required for this project. Such pre-qualifications shall include titles as "Authorized Control Integrator", "Independent Field Office", "Authorized Factory Representative" or similar.
- D. Licensing: Provide licensing which allows the Owner to make modifications, additions, expansion, and interconnections to all aspects of the system without limitation. Manufacturer's software licensing agreements shall be configured to allow the system to be "open" and non-proprietary. The Owner shall have full ownership for the system and access.
- E. Payments: The Contractor is advised that in addition to payments held out for retainage and project final completion (i.e. punchlist work) as specified elsewhere, the work of this specification Section may be limited to a maximum payment of 90% of the scheduled value of the work until all system are proven operational and have been properly checked out by

the installing Contractor.

- F. Service Allowance: Include 16 hours of control labor for special work (i.e. software changes, system consultation, relocation of control devices and other services) during construction as required by the Owner or Engineer. The Engineer and Contractor will jointly track the amount of time used. Only time directly authorized and agreed to by the Engineer may be tracked as part of this allowance. This allowance is for work outside of other required project work, and is for specific tasks assigned to the Contractor by the Owner or Engineer.
- G. Programming Point Names: Custom point naming is required to match the Owner's standard point naming scheme. Coordinate with Owner to confirm standards.
- H. Spare Parts: Contractor shall furnish the Owner with minimum of the following spare parts, of same type as used in this project:
  - 1. Two spare VAV box terminal controllers.
  - 2. Two room temperature sensors/thermostats.
  - 3. Two current sensing relays as used on fans.
- I. Warranty:
  - 1. Basic: System shall be warranted to provide the sequence of operation and basic features specified, with the accuracy and flexibility specified. The system shall be repaired or replaced, including materials and labor, if in Owner's reasonable opinion, system is other than as warranted.
  - 2. Emergency Service: During the warranty period maintain a 24 hour emergency phone service and be able to respond by a trained and qualified Controls Engineer familiar with the installed system. The Contractor shall be able to communicate with the system for purposes such as program algorithm alterations, operational evaluations, trouble-shooting, etc.; said response shall be within six hours, with site visits (as necessary) in no less than two weekdays.
  - 3. Warranty Service Allowance: Include 24 hours of control technician/programmer's time for special service (i.e. software changes, system consultation, setting up additional trends, etc.) and other services during the warranty period as required by the Owner or Engineer. The Owner and Contractor will jointly track the amount of time used. Only time directly authorized and agreed to by the Owner may be tracked as part of this allowance. This allowance is for work outside of other required project work, and is for specific tasks assigned to the Contractor by the Owner or Engineer.
  - 4. End of Warranty Service: At the end of the warranty period, the Contractor shall provide a re-check of the entire system operation, including calibration testing of a sample number of components and providing any necessary control adjustments for proper system operation. Such work shall be for a minimum of 8 hours on site.
  - 5. Extended Warranty: System shall be warranted for 18 months.

#### 1.6 PRE-QUALIFIED FIRMS

- A. As a convenience to bidders, the following firms have been pre-qualified:
  - 1. Washington State branch office of Honeywell Controls.
  - 2. Sound Energy, using Honeywell Controls.

#### 1.7 REFERENCES

- A. UL 916: Energy Management Equipment.

- B. FCC 15: Code of Federal Regulations, Title 47, Part 15, Federal Communications Commission Regulations.
- C. AMCA 500-D: Laboratory Methods of Testing Dampers for Ratings.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. General: Products shall comply with Section 220500. See Section 220500, Paragraph 2.1 for Acceptable Manufacturer requirements.
- B. Control System Manufacturer: Honeywell.
- C. Actuators: Belimo.
- D. Control Valves: Honeywell, Belimo.
- E. Local Workstation Computer: Dell, Sony, Hewlett-Packard, Toshiba.
- F. Local Workstation Printer: Hewlett-Packard, Epson, Canon.
- G. Control Dampers: Ruskin, American Warming and Ventilating, Greenheck.
- H. Variable Frequency Drives (VFD's): ABB.
- I. Carbon Dioxide Sensors: Vulcan, Vaisla, Honeywell.
- J. Other Control Components and Accessories: Idec, Hoffman, McDonnell, Tridelta, Veris, Kele, Edwards, Mamac, APC, Barksdale, Mark-Time, Functional Devices, and control system manufacturers listed.

### 2.2 BASIC SYSTEM

- A. General: The system shall be a distributed processing type direct digital control (DDC) system. System shall provide complete stand-alone temperature control/monitoring and energy management for this project, using a network of various independent controllers, sensors and associated devices interconnected in a communicating network.
- B. System Protocol: System shall utilize an open (i.e. non-proprietary) communications protocol which allows the use of control components by different manufacturers to be installed as part of the system with automatic adaption and incorporation into the system with minimal programming. System shall be a BACnet compliant type with all component communication using the protocols and standards as defined by ANSI/ASHRAE 135. LAN type shall be Contractor selected (complying with Contract Document requirements). System shall be internet accessible using standard web browsers such as Windows Explorer and be based on Tridium "Niagara AX" software utilizing Jace controllers.
- C. Version: System shall be latest version of the manufacturer's standard commercial building DDC system.

- D. Expansion: System shall have a fully modular architecture, allowing expansion through the addition of controllers, and control devices.
- E. Network: All controllers shall be interconnected in a communicating network to provide facility wide access to work stations and sharing of information. A Local Area Network (LAN) shall be provided to interconnect controllers for high speed data transmission. Failure of a single or multiple controllers shall not cause loss of communication between other LAN-connected controllers still active. The control system LAN shall be separate and independent from other building LAN's (except for a single data terminal connection at a single system workstation).
- E. Full DDC: All items to be controlled/monitored shall be by DDC. No line voltage thermostats, line voltage switches, etc. that provide direct system control are allowed, unless specifically noted.
- F. System Performance:
  - 1. Graphics: System shall display a graphic with at least 20 dynamic points with all current data within 10 seconds of being initially displayed. System shall refresh a graphic with at least 20 dynamic points with all current data within 8 seconds.
  - 2. Object Command: Commands of a binary object entered at local workstations shall be executed at the commanded device within 2 seconds of being entered; analog objects shall start to adjust within 2 seconds.
  - 3. Current Data: Any data used or displayed at a controller or local workstation shall be current within the previous 6 seconds.
  - 4. Alarm Response: Maximum time between an alarm event at it being annunciated shall be 45 seconds.
  - 5. Program Execution Frequency: Applications shall be capable of running as often as every 5 seconds; select execution times that are consistent with the process under control and provide optimum comfort and control of setpoints without excess deviation. Controllers shall be able to execute PI and PID control loops at a selectable frequency of at least once per second; with the process value and algorithm output updated at this same frequency.
  - 6. Reporting Accuracy: Control system reporting end-to-end accuracy shall be no less than the following:
    - a. Space, Duct, Water Temperatures: Plus/minus 1 deg F.
    - b. Outside Air Temperatures: Plus/minus 2 deg F.
    - c. Airflow at VAV Terminal: Plus/minus 10% of full scale.
    - d. Airflow at Measuring Stations: Plus/minus 5% full scale.
    - e. Water Flow: Plus/minus 5% full scale.
    - f. Air Pressure in Spaces: Plus/minus 0.01-inches wg.
    - g. Air Pressure in Ducts: Plus/minus 0.1-inches wg.
    - h. Water Pressure: Plus/minus 2% of full scale.
  - 7. Stability: System shall provide stable and accurate control operation without excessive variation of controlled variables; variation shall in no case be more than 1.5 the reporting accuracy for temperatures, and the same as the reporting accuracy for other variables. System shall operate without invalid alarms or with excessive alarms.

## 2.3 SYSTEM FEATURES

- A. General: Controllers, operator workstation, control components, and accessories shall all be combined to form a complete system providing the sequences of operation/functions

specified and having the features specified. System shall monitor and control all functions relating to building environment, utilities, energy usage, and mechanical systems operation. The point monitoring and controlling functions to be performed by the system shall include but not limited to the following capabilities:

1. Digital inputs (e.g. a contact closure of a control device).
  2. Analog inputs (varying electrical signal from a control device to a controller).
  3. Digital output (e.g. a contact closure by a controller).
  4. Analog outputs (varying electrical signal from a controller to a control device).
  5. PWM (pulse width modulation) with feedback position indication.
- B. Controllers: The system controllers shall directly control all valves, fans, HVAC equipment, dampers, coils, system equipment, and similar devices. All control software shall be implemented in the controllers.
- C. Controller Failure: Upon failure of any controller system shall display off-line occurrence for each individual affected point. Provide communication verification to each NAC for each I/O channel. If communication is disrupted, show error count for each attempt to communicate for each registered point per NAC. Operator shall be able to update count and reset to zero.
- D. Zone Control: Provide zone-by-zone control of space temperature, usage scheduling, equipment status reporting, and override timers for off-hours usage.
- E. Setpoints: Zone temperature setpoints, equipment setpoints, pressure setpoints and all other controlled parameters shall be able to be set by an operator (except where indicated otherwise). System shall have global command ability to override all settings of the same type to the same value. All setpoints shall be operator adjustable (via common English language commands).
- F. Password and Security: Access to system shall be by priority password security system to prevent unauthorized use. Minimum of five levels, each assignable to dedicated function keys. Invalid passwords shall lock data base access after three attempts. Password shall not be needed for access to monitoring programs. Operator may select individual security level assignments for each operation and menu selection available.
- G. Time Control: System shall have capability for each equipment to have its own independent time schedule; including occupied/unoccupied modes and optimum start cycles. In addition, system shall have capability for each equipment that could be operated on a seasonal basis (e.g. boiler in heating season, chiller in cooling season, associated pumps, de-stratification fans, baseboard heaters, AC units, etc.) to have independent time of year seasonal schedules.
- H. Auto-Restart: System shall start automatically on power failure, with a sequence to prevent excessive electrical demand due to all equipment starting at the same time, or undesirable affects due to improper sequencing of equipment. Provide staggered start times for all equipment to prevent more than 10 kW of electrical load from starting at the same time (except where not possible due to individual equipment size exceeding this size). Provide a two minute delay (adjustable) between loads (or as required to allow for a proper re-start).
- I. Time Schedule Override: Bypass devices shall send signal to control system indicating requirement for time schedule override operation. The operator shall program the time of override operation at the keyboard from 1 to 15 hours; set initially for 2 hours. Override time

remaining to be displayed as part of system graphics; and operator shall be able to alter override time or turn area back to automatic.

- J. Run Time: Equipment run time totalization and start/stop totalization of all equipment connected to system; may be trended totalization information, with no required auxiliary equipment.
- K. Menu Modification: Operator shall have complete capability to modify displays, menus and menu format headings, data base information, with no required auxiliary equipment.
- L. Energy Usage:
  - 1. Peak Demand Recording: The building's electrical demand shall be measured; demand peak in kW and its date and time of occurrence shall be recorded. These values shall be observable by an operator. Provide a KW-hour trend log. Provide demand reading program that matches method and time base used by local utility company to bill for demand so that control system demand readings match the utility readings.
  - 2. Power Recording: Measure building's electrical energy usage; current annual, monthly and daily total building electrical power usage shall be recorded. Provide a KWH trend log. Measure usage of specific systems and equipment as specified.
  - 3. Gas Recording: Measure building's (and components as indicated) natural gas energy usage; current annual, monthly and daily total building electrical power usage shall be recorded. Measure usage of specific systems and equipment as specified.
- M. Clock: Real-time clock shall be self-contained and accurately controlled by a quartz crystal. The clock shall be set via the keyboard and may be viewed on the display. A battery standby power supply shall be used to maintain clock operation when primary power fails. When primary power returns, the system shall automatically restart to the appropriate schedules with accurate clock time and require no action from personnel to re-initialize.
- N. Disk System:
  - 1. System shall be able to store data base on standard digital disk or load data base from the disk. Operator to be able to program system to automatically dump data base to disk storage system at end of each day for the purpose of updating all point data information and logs.
  - 2. The disk system shall be activated to load or store data to the system controllers on system initialization or as permanent changes as recorded. Disk system shall not be utilized for routine system operation.
- O. Alarms:
  - 1. For each analog input point allow operator assignable high and low alarm limits; for each digital input point allow operator assignable alarm.
  - 2. For each analog input alarm and each digital input alarm, allow the following assignable alarm responses:
    - a. Provide system output to sound horn or flash remote light as directed on alarm occurrence.
    - b. Display English-language description of alarm on system graphics.
    - c. Print out alarm description and operator-created alarm message.
    - d. Require acknowledgment by operator and print occurrence if directed by owner.
    - e. Store previous 300 alarms, with description, time of occurrence, time of acknowledgment, and time of return to normal. Provide for review of alarm history on display and printer.

- f. Provide 100 programmable alarm messages, up to 256 characters each.
  - 3. Operational Alarms:
    - a. Provide for 200 operational (non-maintenance type) alarms which indicate a safety device alarm or equipment failure alarm (related to an operational issue).
    - b. Failed Function Alarm: Provide alarm for each equipment that controls heating or cooling: if unit calls for heating (or cooling) but the temperature of the media (i.e. air or water) leaving the equipment does not vary appropriately from the entering temperature of the media; indicating equipment failure. Provide similar alarms for pumps and fans (using proof of flow device pressure) and water heaters.
  - 4. Maintenance Alarms: Provide for 100 maintenance alarms of at least 256 characters. These alarms shall occur to indicate normal maintenance requirements; i.e. upon the arrival of a predetermined calendar date, upon the passage of a specified equipment run time or upon passage of a specified number of equipment start/stops.
  - 5. Train the Owner in the development of all alarms and program the first 25.
- P. Logs:
  - 1. Trend Log: Provide trends for all input and output data and the ability to log the data. For each trend log, operator may assign multiple points and an interval sampling rate of 1 minute to 96 hours. Store time segments. Provide for review of data on graphic display and printer. Each trend log shall be able to be assigned individual start/stop times/dates in advance. System shall automatically begin entry into each log as scheduled. Each point in the log shall have 360 entries, all data stored for future retrieval. Trends shall be formatted for ease of reading.
  - 2. Current Alarm Log: An alarm log shall track and display all points currently in alarm.
  - 3. Alarm History Log: Log last 100 alarms as to time of occurrence, time of acknowledgment and time of return to normal. Maintenance alarms shall be separate from operational type alarms.
- Q. Scheduling:
  - 1. Time Schedules: The Control System shall provide time clock schedule with at least 100 time schedules. Each schedule to be 8-day type, 6 entries per day. All entries to be in 12 hour AM/PM format. The complete schedule shall be displayed at one time on the operator workstation for easy editing. Each time program shall be able to include on/off, high/low speed or duty cycle commands, or Analog Control Values as applicable for the application. Equipment may be assigned to named schedules, with master revisions to the schedule revising all assigned equipment.
  - 2. Holiday Schedules: A minimum of 24 holiday time schedules shall be available and shall be assigned to any number of available points.
  - 3. Holiday schedule shall display entire year and shall also allow for an interval holiday time, program showing holiday start date to end date (example: December 24 to January 2).
  - 4. Schedules shall provide control of all equipment as indicated in the sequence of operation. Coordinate with Owner for the times for the final project schedules.
- R. Demand Limiting: Provide a demand limiting program with a hierarchy of equipment loads to be shed. System shall support at least 100 loads and three demand meters.
- S. Warm-up Mode: Control System shall have warm-up mode prior to occupied mode on heating to pre-warm building prior to occupancy. Time of beginning warm-up cycle shall be determined by an optimum start/stop program.



- T. Optimum Start/Stop: Control System shall have optimum start/stop program to reduce run time of HVAC equipment. Optimum start/stop program shall consider building mass, building temperatures, outdoor air temperatures, and other system factors in determining time of system start-up or shut-down. Program shall record previous warm-up times versus actual warm-up times and shall adjust the program algorithm so that program calculated warm-up time corresponds to actual.
- U. System Graphics:
1. Graphics: Provide complete system color graphics with displays of all controlled systems. Graphics shall allow operator capability of constructing additional floor plan drawings, mechanical equipment diagrams, piping diagrams, and similar systems drawings at will, while system is on line. Graphics to be color dynamic, displaying current monitored system values. Graphics shall be menu driven from keyboard keys and from mouse. System shall use English language and acronyms selected to allow operators to use the system without extensive training or without programming backgrounds. Software shall use command strings in a request-response sequence in which the machine prompts the operator for all required information; operator response required shall be the appropriate parameter input data. Software shall contain edit functions and escape modes to eliminate continuous logic loops requiring system reboot to escape. Coordinate with Owners staff to develop all operational data to satisfaction of Owner.
  2. Building Plans: Graphics shall include building plans showing locations of all controlled or monitored equipment, areas served, thermostat locations, and significant major control device locations (e.g. CO2 sensors, outside air sensors, etc.).
  3. Equipment Summary: Display shall include a summary display of all system measured variables (i.e. all control devices) for equipment, and include (but not be limited to):
    - a. Summary status of all controlled or monitored equipment.
    - b. Equipment ID number and zone (or area) served.
    - c. Zone temperature.
    - d. Zone heating and cooling setpoints (adjustable).
    - e. Zone mode (heating, cooling, float).
    - f. Discharge temperature of HVAC units.
    - g. Fan status and commanded value.
    - h. Outside air damper position (percentage open).
    - i. Alarm status of equipment (contrasting colors).
    - j. Heating and cooling valve positions.
    - k. Economizer disable setpoint (adjustable).
    - l. All safety control devices.
  4. Detailed status of mechanical equipment:
    - a. Equipment identification, location, area served, and description of unit and system.
    - b. Provide all information required to be sent to GUI for each equipment and any other control loop data indicative of unit operation.
    - c. Schematic of system with appropriate temperatures, flows, etc. interposed on schematic. Provide schematic for each hydronic system, fan system, steam system, domestic HW, and other systems where extensive measurements are made.
    - d. Alarm conditions as listed for each equipment under Sequence of Operation portion of specifications. Alarm condition shall be indicated in a contrasting color from normal operation.
    - e. Unit Run Times:

- 1) Annual run time.
  - 2) Total life run time.
  - 3) Number of starts/stops.
  - 4) Run time shall be reset by operator (provide operator confirmation that change is desired before making change).
  - f. Unit and zone time schedules.
  5. Time schedules (daily and annual).
  6. Operational Alarms.
  7. Time and date of last update of listed information.
  8. Record of daily outside air temperatures.
  9. Record of annual daily building temperatures (selectable from any zone or combination of zones).
  10. Trend Logs.
  11. Run times of all equipment in one display.
  12. All measured control signals (i.e. all points) transmitted to system controllers shall be available for display. Provide organized format and menu for ease of operator display of this information.
  13. Building Floor plans indicating location of each thermostat and temperature of space served by that thermostat.
  14. Summary of all space temperatures on a single graphic display.
  15. Summary listing of all AHU's. List to include unit no., area served (room no. and name), space temp, SA temp, OA damper position, alarm indication, and 2 other variables as selected by Owner.
- V. All percentage values on actuators shall indicate percentage open.
- W. Provide adjustable date and time stamp on main graphics page.
- X. Provide link on main graphics page navigating to pdf files (or equivalent) files showing sequences of operation and as-built drawings.

## 2.4 CONTROLLERS

- A. General: Shall be manufacturer's standard controllers used for commercial DDC systems complying with the system communication protocol specified and allowing the system to provide the specified features and sequence of operation. Controllers shall be listed, certified, or in some definitive way deemed compliant by an appropriate independent agency that they comply with the system communication protocol being utilized.
- B. Types: Type, capacities, arrangement and features shall be Contractor selected to provide an overall system complying with Contract Document requirements.
- C. Operating Conditions: Controllers shall be capable of operation over a temperature range of 32 deg F to 130 deg F and a humidity range of 5% to 95% (non-condensing).
- D. Network Area Controller (NAC): Shall be modular, multi-tasking, microprocessor based direct digital controller, capable of forming a complete interconnected/communications. Shall provide the interface between the LAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NAC. It shall be capable of executing application control programs to provide:
1. Calendar functions.

2. Scheduling.
  3. Trending.
  4. Alarm monitoring and routing.
  5. Time synchronization.
  6. Network management functions for control devices.
  7. The NAC must provide all hardware features and accessories as necessary, including ethernet port and battery backup, to provide a complete and operational control system.
  8. Provide with flash memory for long term data backup (if battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity).
  9. The NAC shall support a standard Web browser access via the Intranet/Internet and provide multiple user access.
  10. Controller mounted display with LCD screen with user friendly menu for system access.
- E. Terminal Unit Controllers (TUC's): Controller specifically designed for control of individual air handling units, fans, VAV terminal units, and similar type units; controllers shall be microprocessor based and shall contain a non-volatile resident program to allow for proper sequencing of controlled equipment. TUC shall interface to the building control system a multi-drop communications network. An individual controller shall be provided for each piece of unique equipment. Each terminal controller shall be accessible for purposes of control and monitoring from a central or remote operator's terminal as specified herein.
- F. Graphic User Interface (GUI): Shall consist of a personal computer, and include a keyboard, modem, printers, monitor, and interface devices for communication to system NAC's and to the system. The system shall allow full interface to entire system for monitoring, equipment control, database management, system performance analysis, trending, programming, management reports, and all other functions necessary to operate and manage the control system. The GUI shall communicate with the system controllers and with other GUI's. There shall be no limit on the number of simultaneous users accessing the system via their GUI and the internet.

## 2.5 TEMPERATURE SENSORS

- A. Room Temperature Sensors: Solid state electronic type, employing a resistance type output. Factory calibrated to an accuracy of plus/minus 0.5 deg F with a temperature range of 32 to 130 deg F in normally occupied areas and -40 to 140 deg F in other areas, with the following features:
1. Space temperature display.
  2. Momentary push button for placing room's system into occupied mode when pressed.
  3. Means for adjusting temperature setpoint up or down with setpoint display; limited by software to up or down 2 deg F.
  4. Communication port to allow interconnection of field computer into system, or have an integral display which shows system parameters and allows adjustments via sensor pushbuttons.
  5. Integral CO2 sensor may be used in lieu of separate wall mounted where features and operation match specified wall carbon dioxide sensor.
- B. Room Temperature Sensor Guards: Lockable, slotted, clear plastic type.
- C. Duct Freeze Protection Thermostat: Low temperature thermostat, electric type, automatic

reset, non-averaging 20 feet long sensing elements that activate sensor contacts whenever any 6-inch section or more of any portion senses a temperature at the thermostat setpoint. Provide with two sets of contacts, one hard-wired to stop unit operation and one for EMCS alarm input.

- D. Duct Temperature Sensor: Shall be solid state electronic type, employing a resistance type output. Factory calibrated accuracy of plus/minus 0.5 deg F with a temperature range shall be -40 to 160 deg F. The sensor shall include a utility box and gasket to prevent air leakage and vibration noise. For all mixed air and preheat air applications, install bendable averaging duct sensors with a minimum 5 foot long sensor element installed so as to sense a representative sample of the medium being controlled.
- E. Liquid Immersion Temperature Sensor: Shall be solid state electronic type, employing a resistance type output. Factory calibrated accuracy of plus/minus 1 deg F with a temperature range 0 to 250 deg F. Provide brass thermowells and install sensor probe with heat conductive grease. Probe and sensor head shall be removable without breaking fluid seal. Install sensors in top of pipe for horizontal runs and at a positive slope on vertical runs to prevent condensation from flowing to sensor head.
- F. Outside Air Temperature Sensor: Solid state electronic type device, for outdoor installation, factory calibrated accuracy of plus/minus 0.5 deg F, with a temperature range of -20 to 180 degrees F. Provide a sun shield and weatherproof assembly.

## 2.6 ACTUATORS

- A. General: Actuators shall use a brushless DC motor controlled by a microprocessor with protection from overload at all angles of rotation. Run time shall be constant, independent of torque. Actuator shall have manual positioning mechanism and direction of rotation control switch and visual position indicator. Housing shall be NEMA rated to suit the conditions at the actuator location.
- B. Type: Proportional or two position or floating point type, as required for application. Proportional type shall modulate in response to a 2-10 VDC, or 4 to 20mA control input. Provide with auxiliary switches as required for sequence of operation and to allow for safe operation of items served (and interlocked items), switches shall meet requirements for "double insulation" so an electrical ground is not required.
- C. Automatic Closure: Actuator shall spring return upon power interruption, spring return position shall be fail-safe as dictated by freeze, fire or temperature protection requirements; except that actuators required to be the fast operating type may utilize a capacitor discharge for fail-safe closure in lieu of spring (subject to Engineer's approval). Spring return is not required for air terminal units or zone damper.
- D. Performance: Actuator power and torque shall be sufficient to match dampers or valves being controlled and allow proper damper and valve operation against system pressures liable to be encountered. Actuator shall be capable of driving control devices from full closed to full open in less than 90 seconds (unless indicated otherwise) and where fast operating type are required (i.e. where interlocked with equipment operation). Where actuators serve valves or dampers directly serving equipment (e.g. boiler water flow control valves) or are interlocked with equipment operation (e.g. make-up air equipment dampers) verify required operating time of actuator with equipment manufacturers and timing of other system

components to allow for proper system operation without nuisance shutdowns of equipment or creating undesirable effects due to improper actuator response time.

- E. Accessories: Units shall be complete with all brackets, and hardware required for mounting and to allow for the proper control for the application.

## 2.7 ACCESSORIES

- A. Wiring and Conduit:
  - 1. Basic Materials: As specified in Division 26.
  - 2. Power Wiring: 18 AWG minimum and rated for 300 VAC service. Wiring for circuits greater than 24 V shall be as specified in Division 26.
  - 3. Analog Signal Wiring: Field-installed analog signal wiring shall be 18 AWG single or multiple twisted pair. Each cable shall be 100 percent shielded and have a 20 AWG drain wire. Each wire shall have insulation rated for 300 VAC service. Cables shall have an overall aluminum-polyester or tinned-copper cable-shield tape.
  - 4. Life Safety Applications: Wiring that performs code required life safety control (e.g. shutdown of equipment), control of engineered smoke systems, fire alarm interface and similar functions shall comply with code and NFPA standards for fire alarm system wiring and the specific application.
- B. Labels:
  - 1. General: Shall comply with Section 220500.
  - 2. Control Devices: Labels on control devices shall use the same designation that appears on the control shop drawings and an indication as to purpose; except that devices in finished rooms shall be labeled as to the generic item controlled for better user understanding (i.e. 'Room Exhaust Fan', 'Hood Fan').
  - 3. Wiring: Wiring labels shall be the self-laminating or heat shrink type with numbering, lettering, or an alpha-numeric identifier indicating the wire signal/power purpose and matching the designation that is used on the control drawings
- C. Control Cabinets: Wall mounted, NEMA rated construction, type and rating to suit location environment, UL listed, minimum 14 gauge sheet metal, hinged front door with latch. Size as required to house controls. Controls/devices shall be logically assembled in cabinet, with all devices and cabinet labeled.
- D. Relays/Contactors: Shall be the single coil electrically operated, mechanically held type. Positive locking shall be obtained without the use of hooks, latches, or semi-permanent magnets. Contacts shall be doubled break silver to silver type protected by arching contact where necessary. Number of contacts and rating shall be selected for the application intended. Operating and release times shall be 100 milliseconds or less. Contactors shall be equipped with coil transient suppression devices to limit transients to 150% of rated coil voltage. Relays shall have mechanical switching to allow manual operation of relay and LED light to indicate the energized state.
- E. Thermowells: See Section 220900.
- F. Miscellaneous Sensors/Transmitters/Switches/Transformers: Shall be manufacturer's standard, designed for application in commercial building HVAC control systems, compatible with other components so as to provide sequence of operation specified.

- G. Gas Sub-Meters: Shall be suitable for pressures and flows to suit application; with accuracy of plus/minus 1% and repeatability of 0.5%; pressure drop at max flow shall be no greater than 0.5 psi; provide with straightening vanes. Submit shop drawing of proposed locations. Coordinate with Division 22 contractor for installation of monitoring devices.

## 2.8 SWITCHES

- A. Current Monitoring Switches: Electric current sensing device with integral switching contacts. Device shall sense current (amperage) through the conductor the device is applied to and activate switch action (to make and break contacts) once current reaches a preset value. Device shall be able to be clamped around conductor, and be removable. Switch rating, size, switching current, and type selected by Contractor to suit application and provide the required function. Provide type specifically rated for the motor and load type being applied to.
- B. Air Flow Switches: General Purpose utilizing differential air pressure, SPDT snap-acting contacts, adjustable 0.1in. W.C. to 2.0 in. (minimum), neoprene diaphragm, all aluminum construction.
- C. Water Flow Switches: General purpose liquid flow switch, SPDT snap-acting contacts, adjustable, neoprene diaphragm, in a dust-tight enclosure, rated 150 psig and 250°F.
- D. End Switches: Shall be momentary type limit switches for monitoring the motion of an object at a prescribed arc of rotation or set linear movement. The switch shall be mounted on the exterior of the duct so that the trip lever is aligned with the damper vane. Mechanical adjustments in the switch case shall permit the proper lever action for tripping the mercury switch contacts. The switch shall have a SPDT contact arrangement that exceeds the load requirements for both voltage and current.
- E. Bypass Switch: Shall be momentary contact type push button. Install in standard wall box with stainless steel cover.
- F. Wall On/Off Switch: Standard wall box type switch, single pole, with illuminated switch for when controlled item is on. Provide with stainless steel wall plate, labeled as to function.
- G. Emergency Shutdown Switch: Mushroom head, red color, non-spring return, with maintained contacts, NEMA 1 (or better) enclosure. Label as to function
- H. Interval Timer - Push Button Type: Momentary contact type illuminated pushbutton with metal operator, amber LED light, and stainless steel cover plate. Sized to suit standard electrical wall junction box. Label as to function.

## 2.9 PRESSURE AND VELOCITY SENSOR/TRANSMITTERS

- A. Air Velocity Transmitter: Shall be a duct mounted instrument that measures the difference between total pressure and static pressure to get velocity pressure. Measurement shall be by a pitot tube located in the moving air stream or by a duct mounted air flow measuring station. The transmitter shall be an industrial quality device that produces a linear output directly proportional to the input utilizing an integral square root extractor. The air velocity span shall be a segment of the range between 200 and 5000 feet per minute.
- B. Air Pressure Transmitter: Shall universally measure very low static or differential pressure

using a variable capacitance technique. Static pressure shall measure in ranges from 0 to 10 inches water column. Differential air pressure shall have a range of 0 to +/-0.5 inches. Transmitter accuracy, including non-linearity, hysteresis and non-repeatability shall be within 1% of full scale. Provide zero and span adjustments for a proportional output of 4-20ma.

- C. Air Differential Pressure Sensor: Electronic transducer, incorporating linear variable differential transformer type sensing element with two-wire 0-10 VDC transmitter. Accuracy shall be +/- 2% of full scale. Submit chosen spans for review.
- D. Liquid Differential Pressure Sensor: Single pole, single throw switch, bellows type, with adjustable range, suitable for application intended.

## 2.10 LOCAL OPERATOR'S WORKSTATION

- A. General: Desktop computer, with keyboard, software, modem, printers, monitor, and interface devices for system communication and communication with the system. Operator station shall provide full interface to entire system for monitoring, equipment control, database management, system performance analysis and management reports. The operator terminal shall communicate with the system controllers and with other operator terminals.
- B. Computer: Shall have following minimum requirements:
  - 1. OptiPlex 9010, Core i5-3470 quad core 3.2 GHz/6MB.
  - 2. 8GB, 1600 MHz DDR3, 2DIMM.
  - 3. Integrated Video Card, Intel 4500.
  - 4. 500 GB SATA Hard Drive, 6 Gb/s with 16 MB with Data Burst Cache.
  - 5. Windows 7 with XP mode.
  - 6. 16x DVD +/- RW S.A.T.A.
  - 7. OptiPlex Resource CD.
  - 8. Next Business Day Parts and Labor On-Site Response, Initial Year.
  - 9. Next Business Day Parts and Labor On-Site Response, 2YR Extended.
  - 10. 20.0 Inch Monitor with graphic card.
  - 11. Keyboard and Mouse: The system shall be fully menu-driven. All system titles, prompts, and instructions to be in English language and user friendly. All entries to be in natural units, i.e., a setpoint value shall be entered in its actual control value, such as 74°F. All operator commands, changes, and data displays identified in the sequence of operation shall be available and executable at single operator's terminal within ten (10) seconds.
  - 12. Four USB ports.
  - 13. Ethernet Card: Shall be 10/100 Mbit card.
  - 14. Accessories: Provide all serial expansion ports for all interface devices and all required cables.
- C. Printer: Inkjet color printer terminal, complete with cables (as required for connection to operator terminal). Provide with two full sets of all required ink cartridges.
- D. UPS: Standalone UPS to serve local operator's workstation.
- E. Software: Provide all necessary software, fully programmed and customized to provide complete system features and functions specified. Software shall support Dynamic Data Exchange (DDE). Provide installable copies of all software required for proper operation of the EMS and the User Interface. This includes the EMS software, User Interface Operating

System, and any required drivers.

- F. Desk and Chair: Steel fabricated desk with shelf hutch above, laminated desk top surface, black or dark brown color; minimum size 30" wide x 24" deep. Cushioned office type chair with backrest, adjustable height.

## 2.11 HYDRONIC CONTROL VALVES

- A. Valves shall be fully proportioning, with modulating plugs or characterized ball for equal percentage of linear flow characteristics. The valves shall be sized by the control manufacturer and be provided with actuators of sufficient power for the duty intended. Valve body and actuator selection shall be sufficient to handle system pressure and shall close against the differential pressures liable to be encountered in the system.
- B. 1/2 Inch Through 2 Inch: Valves shall be constructed with a cast-brass body and screwed ends.
- C. 2-1/2 Inch and Above: Valves shall be constructed with a cast iron body and have flanged connections.
- D. Valves shall be selected for a maximum 4.0 psi pressure drop at design flow unless indicated otherwise.
- E. Unless otherwise noted, heating valves shall be normally open; cooling valves shall be normally closed.
- F. All valve actuators for valves 1-1/2 inch and shall have field manual positioning capability to allow manual positioning of valve in absence of control power.

## 2.12 CONTROL DAMPERS

- A. Type: Low leakage control dampers, parallel blade or opposed blade type as selected by Division 25 contractor to best suit application (unless a specific type is indicated).
- B. Leakage: Class 1A leakage rated in accordance with AMCA 500-D.
- C. Construction: Construct of galvanized steel, except where installed in ducts of stainless steel or aluminum construction or handling corrosive air, shall be of stainless steel or aluminum construction (to match duct material) or have corrosion resistant coating. All materials in contact with the airstream shall be suitable for the conditions without deterioration. Frame shall be minimum 16 gauge with reinforced corners.
- D. Blades: One-piece airfoil shape, not exceeding 6 inches in width, minimum 16 gauge, with neoprene, extruded vinyl or butyl rubber edge seals and flexible metal jamb seals; linkage interconnecting all blades and actuator axle.
- E. Bearings: Nylon, molded synthetic, or oil impregnated sintered metal bearings (or other materials as conditions require).

## 2.13 CARBON DIOXIDE SENSOR – WALL

- A. Type: Wall mounted non-dispersive infrared (NDIR) type carbon dioxide sensor.



Honeywell C7262A (or approved).

- B. Performance: Measuring range 0 to 2000 ppm CO<sub>2</sub>, accuracy plus or minus 3% of reading (including repeatability and calibration uncertainties) from 59 deg F to 85 deg F. 1% of full scale. Shall have long term stability of 5 years (i.e. no more than 5% of full scale error after 5 year operation).
- C. Housing: ABS molded plastic housing, white, with vent openings.
- D. Output:
  - 1. Analog: Shall provide 4 to 20mA, and 0 to 10V outputs, selectable by output jumpers.
  - 2. Relay: SPST normally open contacts, set to close at 800 or 1000 or 1200 ppm CO<sub>2</sub>, selectable by jumper settings.
- E. Power: 24 volt ac/dc, 50/60 Hz, maximum 2 watt power consumptions.
- F. Calibration: Automatic calibration algorithm based on evaluation of occupied versus unoccupied periods.

#### 2.14 CARBON DIOXIDE SENSOR – DUCT

- A. Type: Duct mounted non-dispersive infrared (NDIR) type carbon dioxide sensor. Vaisala GMD20 (or approved).
- B. Performance: Measuring range 0 to 2000 ppm CO<sub>2</sub>, accuracy plus or minus 3% of reading (including repeatability and calibration uncertainties), non-linearity plus or minus 1% of full scale. Shall have long term stability of 5 years (i.e. no more than 5% of full scale error after 5 year operation).
- C. Housing: ABS molded plastic housing, white, with vent openings. Provide with enclosure and accessories for mounting to duct and obtaining sample gas airstream.
- D. Output: Shall provide 4 to 20mA, 0 to 20 mA, and 0 to 10V outputs, selectable by output selection jumpers.
- E. Display: Provide with liquid crystal display showing CO<sub>2</sub> ppm reading.

#### 2.15 VARIABLE FREQUENCY DRIVES

- A. Type: Adjustable frequency and voltage variable speed controller, pulse width modulated type.
- B. Controller: Shall be housed in a NEMA 1 (or better) enclosure, and shall provide 6 to 60 Hz adjustable torque output. Standard Features:
  - 1. Start-stop speed selection.
  - 2. Manual speed potentiometer.
  - 3. Input fuses.
  - 4. Insensitive to incoming power phase sequence.
  - 5. Adjustable volts/Hertz.
  - 6. Output frequency stabilized to + 0.5% of set speed for +10% to -5% change in line voltage of 15 degrees C change in ambient temperature.

7. Three-phase output voltage regulated to + 1% of rated voltage with +10% to -5% variations in plant power.
  8. Standard off-the-shelf, NEMA B and synchronous motors (3600, 1800, 1200 rpm) usable without derating controller.
  9. Automatic shutoff under output short circuit conditions or when load current exceeds 150% of maximum output amps (RMS).
  10. Input fuses.
  11. Line transient protection to prevent power line transients from harming the controller.
  12. Relay contact to provide external signal for alarm and run condition.\*
  13. Monitor lamps (or LCD display) indicating: power on, zero speed, enabled, unit failure (with type indicated).
  14. Hand-Off-Auto switch.
  15. Auto restart after power outage.
  16. Isolated Process Control Follower - accepts 0 to 5 mA, 1 to 5 mA, 4 to 20 mA, 10 to 50 mA, 0 to 10 V D-C or 25 to 250 V D-C signal.
  17. Input Disconnect (meeting NEC requirements for unit power disconnect).
  18. Output Contactor - for positive motor disconnect.
  19. Output Overloads - using individual phase bimetallic thermal sensors.
  20. Ammeter - ampere scale depending upon drive rating.\*
  21. Voltmeter - 0 to 500 volt (460 volt drives); 0 to 750 volts (575 volt drives).\*
  22. Frequency Meter - 0 to 120 Hz scale.
  23. Manual Bypass - To switch the motor to or from the controller to the line.\*
- \* Not required on units serving fans under 2 hp.
- C. VFD shall be for use with specified equipment. Unit shall accept appropriate control signal and provide for variable speed operation of unit served.
- D. System shall be fully compatible with motors furnished, and shall be free of audible noise exceeding an NC of 45 in any octave band.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

- A. General: Provide all computer software and hardware, operator input/output devices, sensors, relays, switches, dampers, actuators, conduit, tubing, wiring, motor starters, transformers, control cabinets, power panel circuit breakers, system design, and all other components required to provide a complete control system with the system features and sequence of operation specified. Select control components with proper characteristics to suit the application, meet specified system performance, provide specified system features, and provide the specified sequence of operation.
- B. Room Sensors: Room sensors (i.e. thermostats) shall be mounted at 48" above finished floor, unless indicated otherwise. Thermostats shall control the equipment which affects the temperature serving the space the thermostat is located in, unless indicated otherwise. Not all room sensors are shown on the drawings and those shown are preliminary only. Contractor shall indicate all final room sensor locations on submittal drawings. Contractor is responsible for coordinating locations to avoid chalkboards, tack boards and other interferences.
- C. Electrical Power and Wiring:

1. General: All work shall comply with code and Division 26 requirements. Run conduit and wiring in neat lines, parallel with building construction and coordinated with other trades. Use wire type and size as required by code and recommended by component manufacturers and to suit the application conditions.
  2. Conduit: All wiring shall be installed in conduit and in accordance with Division 26 section of these specifications, except that low voltage wiring within ceiling plenum spaces and in mechanical mezzanine areas may be ran without conduit provided that plenum rated cable is used. Install all conduit and wiring parallel to building lines.
  3. Electrical Power:
    - a. Scope: It is the responsibility of the Division 25 Contractor to provide power for all control devices requiring electrical power. Coordinate with the Division 26 Contractor to confirm which panels and circuits are to be utilized. Provide all electrical wiring, conduit, junction boxes, circuit breakers, grounding, panel circuit breakers (of proper size/type), transformers, enclosures and all other components as needed to power all control devices in accordance with code and Division 26 requirements.
    - b. Sources: Power for control devices shall be obtained from electrical panels and not from power serving the equipment (unless noted otherwise or the Engineer gives approval). Utilize panels located closest to the items served to the greatest extent possible. Where the building has a generator, equipment served by the generator shall also have their control power (i.e. power to control devices which allow the item to be controlled and monitored) shall also be served by the generator (this is in addition to any required UPS').
    - c. Uninterruptible Power Supplies (UPS'): All system JACE's, network area controllers, designated system work stations and similar high level integration components or user interface components shall obtain their power from UPS'.
  4. Service Loop: Provide minimum of 6" extra wiring at all wiring terminations for ease of future maintenance/servicing. Such extra wiring shall be neatly coiled/bundled to allow for uncoiling when the connected equipment is serviced.
- D. Equipment Interconnect Wiring:
1. General: In addition to control wiring between equipment and control devices (furnished under this Section) to accomplish the specified sequence, provide added control wiring to interconnect equipment and to interconnect equipment and associated control/safety devices. Provide as required by the equipment manufacturers to allow for proper operation of the equipment and system.
  2. Minimal Wiring Required: For bidding purposes, assume a minimum of four low voltage wiring connections for each piece of equipment to an adjoining/connecting piece of equipment and/or device(s), and special wire type and special connectors as required by the equipment manufacturer. Coordinate and review all requirements with manufacturers, contractor installing the equipment, and local representatives to confirm scope.
  3. Equipment: This work applies to:
    - a. Split system HVAC Equipment: Between indoor and outdoor units, or between the indoor unit and its thermostat.
    - b. Chillers: Between chillers and devices for field installation in the chilled system.
    - c. Boilers: Between the boilers and devices for field installation in the boiler system.
    - d. Kitchen Hoods: From hood safety devices to HVAC equipment serving the hood or kitchen, kitchen hood fire suppression (from fire suppression contacts to HVAC equipment serving the area the fire suppression serves).

- E. Labeling: All control components, except regular room thermostats, shall be labeled. All control wiring shall be labeled except where color coded wiring is used and the control shop drawings clearly identifier wiring for each color and it is fully consistent through-out the entire project. Submit list of proposed labeling prior to installing.
- F. Complete Functions: Provide complete system totally programmed to provide all specified functions, including but not limited to:
  - 1. Time and Holiday Schedules.
  - 2. Alarm Limits.
  - 3. Optimum Start of Each Zone.
  - 4. Dynamic Graphic of Each Distinct Floor Area; include graphic key to allow changes in graphic display.
  - 5. Dynamic Graphic of Each Mechanical System; include graphic key to allow changes in graphic display.
  - 6. Summary of All Zone Temperatures.
  - 7. Summary of Data for Each Zone.
  - 8. All Displays Specified in Sequence of Operation.
  - 9. Master Menu and Graphics as requested by the Owner.
  - 10. All Controller Setpoints and Operational Values Required.
  - 11. Demand Limiting.
  - 12. Optimum Start/Stop and Warm-up.
- G. Energy Metering:
  - 1. General: Provide all necessary wiring, components, software, and accessories to meter energy usage; see paragraph "Monitoring Data", WSEC, and drawings for items/areas to be metered. Coordinate with other trades for installation of meters, CT's, and similar devices in systems. At electrical panels, utilize deices integral with the panels where such items have been provided; see electrical drawings and specifications for such devices. Unless clearly indicated as being provided by Division 26, assume all such devices are by this Section.
  - 2. Electrical: Provide all necessary wiring, components, software, and accessories to meter building electrical energy usage. Coordinate with other trades for installation of meters, CT's, and similar devices in systems. Unless clearly indicated as being provided by Division 26, assume all such devices are by this Section.
  - 3. Gas: Provide building gas consumption/flow, boiler consumption/flow, and water heater consumption/flow. Provide all necessary piping, wiring components and accessories to allow monitoring of the meter. Coordinate with Division 22 contractor to ensure correct installation.
- H. Electrical Phase Loss: Provide all necessary wiring, components, software, source of power, and accessories to monitor building electrical power quality and 3-phase power; initiate shutdown of 3-phase powered mechanical equipment on loss of a phase.
- I. On/Off Status Indication: All devices which indicate on/off status to GUI, shall have this on/off status manually or automatically controlled from GUI, and shall have positive proof of on or off by differential pressure switch or other applicable device.
- J. Time Clock Bypass Switch: Provide integral with each room sensor. Provide additional ones as indicated on the plans and where room sensor is not accessible. Bypass switch shall serve unit that supplies space in which bypass switch is located. Activation of by pass switch shall put unit(s) bypassed into the occupied mode as well as all equipment interlocked with

the bypassed units. Bypass shall be for 2 hours, but shall be adjustable in 30 minute increments at the GUI.

- K. OA Sensors: Provide at least two OA sensors for this project, with display at the GUI; use average of two for control purposes. Provide logic to allow disuse of "Bad" OA sensor and indicate alarm.
- L. TUC: To simplify controls and mechanical service and trouble-shooting, the TUC shall be mounted inside a waterproof cabinet on the side of rooftop units. This shall allow all controls maintenance and trouble-shooting to be made while at the unit location.
- M. Programming: Provide complete system totally programmed to provide all specified M, monitoring data, communications and features.
- N. CO2 Sensors: Duct mounted type, installed in the return ducts for areas (or units) indicated to have such sensors, except where a wall sensor is indicated on the plans provide a wall mount type. Install where units would be easily accessible for maintenance. Indicate locations on floor plans with submittals.

### 3.2 MONITORING DATA

- A. General: Monitoring information shall be provided at graphic user interface. Provide all necessary controls/devices to provide the data indicated. Monitoring data listed is not a "points list" but is a list of items that shall be monitored and is in addition to data (or "points") required by the sequence of operation and other specification requirements. A complete "points list" shall be compiled by the Division 25 Contractor based on all system requirements and sequence.
- B. Chiller:
  - 1. Unit commanded on/off status.
  - 2. Entering water temperature.
  - 3. Leaving water temperature.
  - 4. Alarm Indication each compressor circuit (connect to unit contacts).
  - 5. Compressor on/off (digital signal via CT's at power supply to each compressor).
  - 6. Water temperature setpoint.
  - 7. Water temperature setpoint adjustment.
- C. Heating Water Loop and Cooling Water Loops:
  - 1. Main return temperature.
  - 2. Main supply temperature.
- D. Exhaust Fans:
  - 1. Fan on/off status.
  - 2. Fan commanded status (on/off).
  - 3. Fan failure alarm; (i.e. not "proven" on when commanded on).
- E. Air Handling Units (all units with fans and ability to heat or coil environmental air):
  - 1. Zone temperature.
  - 2. Zone temperature setpoint.
  - 3. Unit commanded mode (heating/cooling).
  - 4. Supply air temperature off unit.

5. Mixed air temperature at unit.
  6. Percent commanded heating or cooling.
  7. Override status.
  8. Outside air and return damper positions (% commanded open).
  9. Fan on/off.
  10. Fan commanded position (on/off).
  11. Alarm/trouble conditions, shall include as a minimum: freezestat alarm; fan not "proven" on when should be on; heat failure alarm - SA temp not warmer than ma and unit is in heating; cooling failure alarm - SA not cooler than ma and unit is in cooling; "false" cooling or heating call - i.e. Unit calls for heating when OA temperature is above 70 deg F, unit calls for cooling and OA temperature is below 30deg F).
  12. Carbon dioxide levels (in return air).
  13. VFD commanded percentage (for units with VFD's).
  14. Commanded damper positions.
  15. Duct static pressure and setpoint (where used for control).
  16. Space pressurization and setpoint (where used for control).
- F. Water Heater:
1. Leaving HW temperature.
  2. HWC temperature (at HWC pump).
  3. High tank temperature alarm (10 degrees above scheduled tank temperature).
- G. Circulating Pumps:
1. On/Off status (by differential pressure device or flow switch).
  2. Failure alarm (i.e. not "proven" on when commanded on).
  3. VFD commanded percentage (for units with VFD's).
- H. Boiler:
1. Boiler commanded on/off status.
  2. Alarm indication (connect to unit contacts).
  3. Boiler leaving temperature.
  4. Boiler control (local – hand/off/auto, EMCS – hand/off/auto).
- I. Duct and Unit Heaters and Electric Heaters:
1. On/Off Status.
  2. Space temperature.
  3. Space temperature setpoint.
- J. Miscellaneous:
1. Outside Air Temperature (two locations).
  2. MDF Room Temperature. Indicate alarm if above setpoint.
  3. Fire Alarm Status.
  4. Cooler Temperature. Indicate alarm if above setpoint.
- K. Energy Metering:
1. Building overall electrical consumption and demand.
  2. Building overall gas consumption and peak flow rate.
  3. Electrical consumption and demand at panels as indicated on the plans.
  4. Gas consumption and peak flow rate at boilers.
  5. Gas consumption and peak flow rate at water heaters.

- L. VAV Terminal Units:
  - 1. Airflow (cfm).
  - 2. Leaving air temperature (for terminal units with heating coils).
  - 3. Primary damper commanded percentage open.
  - 4. Heating coil valve commanded percentage open.
  - 5. Space temperature.
  - 6. Space temperature setpoint.

### 3.3 START-UP

- A. Calibration and Commissioning: As each part of the systems become operational, this Contractor shall calibrate all sensing and readout devices and shall test and observe the operation of each and every air moving and/or heating unit and shall adjust all controls so that the items function according to the intent of the specifications. The control contractor shall commission all controls prior to the work of Section 220800 being done. This commissioning work shall include a point-to-point check of all devices, check of sequences, check of proper wiring, and documentation substantiating the work.
- B. Report/Statement: After making all necessary system testing and adjusting, the Contractor shall submit a report to the Engineer indicating all testing/adjustment work done and comment on how system is operating. Such report shall be signed by the individual directly responsible for supervision of the installation of the control system. When the Contractor feels that the system is complete and ready for review by the Engineer, Contractor shall submit a written statement (signed by same individuals as for report) stating that the system is in compliance with the project requirements and ready for review.
- C. Owner Instruction: See Section 220500.
- D. Start-up Trend Logs: The Contractor shall submit to and review with the Engineer daily for a period of four weeks after substantial completion a hard copy log of the following:
  - 1. Five Owner selected room temperature values at 15 minute intervals.
  - 2. Outside air temperature values at 15 minute intervals.
- E. Warranty Trend Logs: Two months after Owner acceptance of the work, the Contractor shall submit to and review with the Engineer a single tabulated 30 day hard copy printout of the systems historical data containing the following information:
  - 1. Date.
  - 2. Hour by hour zone temperature, for five Owner selected rooms.
  - 3. Hour by hour OA temperature.
- F. Documentation: Contractor shall provide a hard copy documentation of the software application program for each digital controller (TUC, NAC). Documentation provided shall include block software flow chart showing the interconnection between each of the control algorithms and sequences for systems utilizing program listings. A program listing shall be printed onto the same blueprint, along with the program flow chart, and description of the sequence of operation. A hard copy of this document shall be stored and maintained in each stand-alone digital controller panel. System acceptance shall not be completed until this documentation is provided and located in each panel.

### 3.4 ENGINEER REMOTE ACCESS

- A. Provide programming and coordination to allow remote access to the control system graphics by the Engineer, accessed from the Engineer's office via Internet Explorer (or similar web-browsing software). Provide separate login/password for Engineer for such access. Contractor shall also provide efforts for setting up Trends and instructing the Engineer in setting up trends. This remote access shall be maintained prior to Substantial completion, through the warranty period.

### 3.5 COMMISSIONING

- A. The Products referenced in this section are to be commissioned per Division 01 and Section 220800. The Contractor has specific responsibilities for scheduling, coordination, startup, test, development, testing and documentation. At a minimum, the Contractor shall provide a documented and signed record to verify that all equipment and systems installed under this contract have been inspected and functionally tested to verify full compliance with the contract specifications. In many cases, this shall require the Contractor to create or otherwise provide procedures and checklists for approval by the Commissioning Consultant prior to the start of functional testing. Coordinate all commissioning activities with the Commissioning Agent.

END OF SECTION



## PART 1 GENERAL

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 220500 apply to this Section.

### 1.2 WORK INCLUDED

- A. Control System Design.
- B. Control System Sequence of Operation.

### 1.3 SUBMITTALS

- A. General: Comply with Section 220500.
- B. Sequences: Submit complete description of sequence of operation for all systems. Sequence submitted shall not be a direct copy of the sequence specified herein, but shall be written to reflect the actual control sequence provided and to more closely match the actual programming used.
- C. Programming: Submit copy of system programming logic.

### 1.4 GENERAL REQUIREMENTS

- A. Modifications: Software, graphics, and sequences shall be revised and updated as necessary to reflect Owner or Engineer desired changes. Contractor to include in bid no less than 16 hours of control technician's/programmer's time to accomplish the required system modifications.
- B. Sequence Terminology: Wherever the control sequences refer to an article, device or piece of equipment in the singular number, such reference shall mean to include as many of such articles, devices, or equipment as are shown on the plans, required for the sequence, or required to complete the installation. Wherever the control sequence refers to an operating stage in the singular number, such reference shall mean to include as many stages as are specified for the equipment and shall mean analog (i.e. proportional) type control where specified for the equipment (reference drawings and equipment specifications).

## PART 2 PRODUCTS

NOT USED

## PART 3 INSTALLATION

### 3.1 GENERAL

A. DDC:

1. General: All sequences shall be provided by the DDC control system, unless specifically noted otherwise. Where a wall switch control is indicated, or interval timer, or any other devices these shall provide an input to the DDC with the DDC system providing an output for control as specified.  
Exceptions: Split system AC units shall be controlled by their own integral controls.
2. Additional Sequences: See Section 255000 for system requirements that relate to control sequences and drawings for additional control sequences.
3. Control Action: Sequences which involve maintaining a setpoint in response to variable conditions shall use proportional-integral (PI) or proportional-integral-derivative (PID) control (unless noted otherwise). Sequences shall comply with the system performance (and other) requirements of Section 255000.

B. Complete System:

1. General: Provide all devices as required to allow for automatic control as specified herein. Provide complete system with sequences of operation as specified herein. Provide all control interconnections between indoor and outdoor units, all required control connections between equipment components, and to any other devices needed for proper operation.
2. Various thermostats, motorized dampers, and other devices are not shown on the drawings but are required per the sequence of operation specified. Coordinate with Engineer for location of all such devices prior to installing. Indicate proposed locations on submittals.

C. Settings:

1. Adjustability: All settings, setpoints, and differentials shall be adjustable. All setpoints indicated are initial settings.
2. Confirm Settings: Confirm with Owner all setpoints, all time schedules, and all other adjustable programming parameters before substantial completion.
3. Thermostat Setpoints: Shall be adjustable at operator's workstation, with initial settings as follows unless indicated otherwise:

Occupied Heating	70 degrees F
Unoccupied Heating	65 degrees F
Occupied Cooling	75 degrees F
Unoccupied Cooling	85 degrees F

D. Time Control:

1. Control system shall provide time schedules for occupied/unoccupied mode switching for all items having sequences with occupied/unoccupied modes, and for all items indicated as having time schedule control.
2. Provide independent time schedules for all mechanical equipment, except where equipment is indicated to be interlocked to other equipment.
3. Provide seasonal (i.e. time of year) control for all mechanical equipment.
4. Provide a single Holiday Schedule or Master Holiday schedule for logical equipment groups as directed by the Owner at submittal time and revised by the Owner during the Owner training. At the end of the warranty period readjust the grouping of equipment as directed by the Owner.
5. Provide independent optimum start schedules (i.e. warm-up cycles) for mechanical equipment indicated to have (or required to have) optimum start.

E. Hand-Off-Auto Control: Provide all control devices and connections to allow Hand-Off-

Auto (HOA) control of all controlled items; where unit starters or VFD's provide HOA control no additional controls are required, but this Section controls shall be arranged to allow for HOA controls.

- F. Average Thermostats: Where average thermostats are indicated on plans combine and average requirements from each sensor and use these average requirements to control unit. Averaging shall combine the deviation from setpoint from each thermostat and rate of change of this deviation combined to create control values as if they are from a single thermostat to determine control actuation. Each thermostat shall have the same functions as the other. Provide means (at GUI, in single screen command) the ability to select between use of either thermostat.
- G. Variable Speed Operation: On variable speed (including staged) equipment, start equipment low speed (or other appropriate speed as recommended by equipment manufacturer or system requirements) and control speed changes at a rate that is coordinated with other equipment to provide proper system operation without undesirable effects, nuisance trips and system alarms.
- H. Alarms: Provide alarms for the following:
  - 1. Status of item does not equal commanded status (where proof of status is monitored, e.g. supply fan not proven on when commanded on).
  - 2. Equipment in alarm (where equipment alarm state is monitored).
  - 3. System response is not consistent with commanded response (e.g. air handling unit SA temperature is not less than MA temperature and unit is commanded to cooling).
  - 4. Freezestat alarm.
  - 5. Safety device alarm (where device is monitored by or connected to the control system).
  - 6. Space temperature in alarm range (10 deg F or more above cooling setpoint; 10 deg F or more below heating setpoint).
  - 7. Sensor failure (out of range).
- I. Fire/Smoke Shutdown:
  - 1. Smoke Detector: Provide necessary conduit, wiring, and accessories to shutdown each unit upon activation of that unit's smoke detectors. Connections shall be hardwired; independent of any control system logic, so that failure of control system or loss of control system will in no way prevent the shutdown of each unit. In addition to shutting down the unit with the alarmed smoke detector, all equipment interlocked or served by that unit shall be off. Other units shall also shut-off as required to avoid building pressure differentials and similar undesirable effects.
  - 2. Fire Alarm System: Shut-down all air handling equipment when the building fire alarm system goes into alarm. Contacts in the fire alarm system are available for this purpose. This shut-down may be accomplished by use of control logic and is not required to be hardwired but shall be of a fail-safe nature so as to provide the necessary shut-down in case of control failure and the control components shall be rated for such purposes (as required by the AHJ).
- J. Automatic Restart:
  - 1. General: Equipment shall automatically restart after being shut-off by a power outage, fire alarm, smoke detector, or similar alarm (or fault); upon clearing of the alarm (or fault). System shall revert to its normal operation for the conditions at the time of restarting.

2. Controlled Restart: Provide controlled re-start by building wing or building floor and in a manner to prevent pressure differentials, equipment issues, or other undesirable effects. Provide time delay on the re-start of equipment 2.5 KW and larger to minimize electrical surges.
- K. Interlocks: May be accomplished by software rather than field hard wired relays or other devices, except for: fire alarm shut-down of equipment 2000 cfm and greater, freezestat shutdown, boiler and chiller emergency shut-off switches, where required by manufactures, where required by AHJ, and where noted to be hard-wired.

### 3.2 AIR HANDLING UNITS AND RETURN FAN – VAV

- A. General:
  1. Control unit's cooling, heating, and system dampers (economizer) in proper sequence to satisfy the supply air temperature setpoint.
  2. Heating and cooling shall be properly sequenced so that there is no overlap between the use of heating and cooling.
  3. Controls shall evaluate the supply air deviation from setpoint and the rate of change of this deviation to determine the heating/cooling and economizer operation so as to satisfy the supply air setpoint without excess variation in supply air temperatures.
- B. Occupied Mode:
  1. Fans:
    - a. Supply Fan shall run continuously at speed required to satisfy SA static pressure setpoint. Locate SA static pressure sensor at a point approximately 2/3 out into system; verify location with Engineer; verify setpoint with balancer and Engineer.
    - b. Return Fan: Interlock return fan with supply fan so that fan operates when supply fan is on. Control return fan speed to track supply fan (i.e. as SA fan flow increases RA fan flow increases); coordinate settings with air balancer. Measure space pressurization to limit RA fan if space pressure goes below setpoint (initially set as .05-inches).
  2. Initial Setpoints on Start-up: SA setpoint shall be 55 deg F (adjustable), SA static pressure setpoint shall be design pressure (as determined by Balancer), approximately 1.5-inches wc (adjustable). These values shall reset after 5 min unit initial start-up period.
  3. Heating: Modulate heating coil control valve to satisfy the supply air temperature setpoint.
  4. Cooling: Unit shall use an outside air economizer as the first stage of cooling. Economizer shall be dry bulb type, using OA temperature sensor, Mixed Air (MA) temperature sensor and Supply Air (SA) temperature control scheme. Economizer shall be enabled only when OA temperature is less than the units Return Air (RA) temperature. The OA/RA/EA dampers shall be modulated as required to satisfy the SA temperature setpoint and shall be limited by a MA sensor low limit setpoint (54 degrees F, adjustable). Modulate cooling coil valve (in conjunction with economizer) to satisfy the supply air temperature setpoint as the final stage of cooling.
  5. SA Temperature Reset: Whenever the OA temperature is greater than the MA temperature low limit setpoint and less than the RA temperature, unit discriminator control shall reset the SA temperature. Discriminator control shall use the room requiring the most cooling to control the supply air temperature setpoint. Static pressure reset shall be locked out. Supply air temperature shall be reset between 55

deg F and 65 deg F. Example of acceptable discriminator logic (perform test/adjustment every 5 minutes); initial AHU SA setpoint = 60 deg F:

IF ALL VAV UNITS COMMANDED < 100%, THEN RAISE AHU SA SETPOINT 1 DEG F

IF ANY VAV UNIT COMMANDED 100% AND SPACE IS ABOVE SETPOINT, THEN LOWER SA SETPOINT 1 DEG F

ELSE NO CHANGE IN SA SETPOINT

6. Static Pressure Reset: Whenever SA temperature reset is not being utilized, provide supply fan static pressure reset. Supply fan static pressure shall be reset to satisfy the most demanding zone (i.e. so at least one VAV unit damper is 100% open with space at setpoint). Supply static pressure shall reset between 0.75 inch wc (adjustable) and the system design pressure (determined by balancer) 2 inch wc (adjustable). Example of acceptable discriminator logic (perform test/adjustment every 5 minutes); initial static pressure setpoint = design value less 0.5 inch wc (1.5 inch wc).

IF ALL VAV UNITS COMMANDED < 90% OPEN, THEN LOWER SA STATIC PRESSURE SETPOINT 0.2 INCHES WC

IF ANY VAV UNITS COMMANDED < 90% OPEN AND SPACE IS ABOVE SETPOINT, THEN RAISE SA STATIC PRESSURE SETPOINT 0.2 INCHES WC

ELSE NO CHANGE IN SA STATIC PRESSURE SETPOINT

7. OA Dampers: OA dampers shall be under CO2 control when unit is in heating, and under economizer and CO2 control when unit is in cooling; whichever is calling for the most open OA damper position (i.e. the economizer or the CO2 control) shall control the OA damper. CO2 controls shall open the OA damper to maintain RA CO2 level setpoint (initial setpoint shall be 600 ppm) and shall open if any space served CO2 level is exceeded. OA damper shall not close below the minimum airflow setting indicated on the plans; coordinate with balancer for minimum setting.
8. RA/EA Dampers: Return Air (RA) dampers shall operate in unison and in opposite direction of OA dampers. Exhaust Dampers (EA) shall be full open when relief fan is on.
9. When unit's fan is off its control valves shall be fully closed (unless required to be opened by a control sequence).

C. Unoccupied Mode:

1. General: Unit shall operate same as for the unoccupied mode except that fans shall cycle, OA damper shall be closed, unit shall be in either a heating or cooling mode at start-up, no SA temperature or SA static pressure reset used.
2. Fan: Unit fan shall cycle on/off, with fan activated when two or more areas are below or above unoccupied mode setpoints.
3. Heating: When activated by areas which are below setpoint, unit shall operate in the heating mode, with a constant 65 deg F (adjustable) supply air setpoint.
4. Cooling: When activated by areas which are above setpoint, unit shall operate in the cooling mode with a constant 55 deg F (adjustable) supply air setpoint.

- D. Warm-up Mode: Unit shall operate as in the unoccupied mode (OA dampers fully closed) until the space temperature has warmed up to the occupied mode heating setpoint, then unit shall operate as specified for the occupied mode. Discharge air temperature in the warm-up mode shall be limited to 65 deg F (adjustable).

E. Night Cool/Purge Mode:

1. General: Mode is to operate in anticipation of warm weather to use cool night air to pre-cool building mass to reduce occupied mode high temperatures. Provide toggle at graphics for each unit to activate or deactivate Night Cool/Purge Mode.
  2. Mode Activation: Shall be allowed if the previous day's OA temperature exceeded purge OA setpoint of 75 deg F (adjustable).
  3. Sequence:
    - a. Shall only be allowed to operate when space is in the unoccupied mode, between hours of 1 AM and 5 AM (adjustable); and only when OA temperature is 5 deg F (adjustable) lower than the space temperature (use average of all sensed spaces).
    - b. Fan shall operate at low speed.
    - c. Outside air dampers shall open 100%.
    - d. Fan shall continue to operate until return air temperature is within 2 deg F (adjustable) of the outside air temperature, or return air temperature has been cooled to the pre-cool mode setpoint of 68 deg F (adjustable).
  4. Heating Setpoints: Spaces served by unit shall have their heating setpoint adjusted to be 5 deg F less than what would otherwise be for the occupied period occurring after this mode has occurred (to prevent heat activation).
- F. Mode Control: Unit's mode of operation shall be determined by time schedule and time schedule override; warm-up mode shall be initiated by optimum start controls.
- G. High Static Pressure Safety: Provide a high static pressure safety on all system supply and return fans to stop fans due to excessive static pressure in ductwork.
- H. VAV Fans Start: Supply and return fans shall start in minimum CFM position. Fans shall slowly increase CFM output until duct static pressure setpoint (or space pressurization setpoint) is reached.
- I. Freeze Protection:
1. Freezestat: Units shall have freezestat on leaving side of the heating water coil which shall stop unit operation if it senses an air temperature of 35 deg F or less (adjustable). Upon activation of freezestat, unit's heating coil valve shall open 100%, OA damper shall close, and an alarm indicated.
  2. Freeze Prevention Mode: Mode shall be enabled or disabled via toggle at graphics. If OA temperature drops below Freeze Protection setpoint 35 deg F (adjustable), unit operates as in the unoccupied mode but using space occupied mode space temperature setpoints. OA dampers remain fully closed. System shall remain in Freeze Protection mode until a.) time clock schedule changes to occupied mode or b.) OA temperature increases 5 deg F (adjustable) above Freeze Protection setpoint for more than 60 minutes (adjustable); at which point system shall revert back to normal unoccupied mode.

### 3.3 AIR HANDLING UNITS - CONSTANT VOLUME

- A. General:
1. Control unit's cooling, heating, and system dampers (economizer) in proper sequence to provide a supply air temperature that will satisfy space conditions.
  2. Heating and cooling shall be properly sequenced so that there is no overlap between the use of heating and cooling.

3. Controls shall evaluate the space deviation from setpoint and the rate of change of this deviation to determine the heating/cooling and economizer operation so as to satisfy supply air setpoint without excess variation in space temperatures.
- B. Occupied Mode:
1. Fans: Supply fan shall run continuously. Interlock relief fan with supply fan and OA damper so that relief fan operates when supply fan is on and OA damper is commanded open. Relief fan airflow shall be vary to maintain space pressurization setpoint; initial setpoint shall be +0.03 inches wc.
  2. Heating: Modulate heating coil control valve as required to provide a supply air temperature that will satisfy the space temperature setpoint.
  3. Cooling: Unit shall have an outside air economizer as the first stage of cooling. Economizer shall be dry bulb or enthalpy type, using OA temperature sensor, Mixed Air (MA) temperature sensor and supply air (SA) temperature control scheme. Economizer shall be enabled only when OA temperature (or enthalpy) is less than the units Return Air (RA) temperature (or enthalpy). The OA/RA dampers shall be modulated as required to satisfy the SA temperature control scheme and shall be limited by a MA sensor low limit setpoint (initial setpoint 54 degrees F). Shall operate in the cooling mode as the final stage of cooling. Modulate cooling coil control valve to provide a supply air temperature that will satisfy space setpoint as the final stage of cooling.
  4. RA/EA Dampers: Return Air (RA) dampers shall operate in unison and in opposite direction of OA dampers. Exhaust Dampers (EA) shall be full open when relief fan is on.
  5. When unit's fan is off its control valves shall be fully closed (unless required to be opened by a control sequence).
- C. Unoccupied Mode: Unit supply fan shall cycle on and off with heating/cooling modulated as required to maintain unoccupied setpoints. OA damper shall be fully closed unless economizer cooling is required.
- D. Warm-up Mode: Unit shall run as in the unoccupied mode (outdoor air dampers fully closed) until the space temperature has warmed up to the occupied mode heating setpoint, then unit shall operate as specified for the occupied mode. Discharge air temperature in the warm-up mode shall be limited to 90 deg F (adjustable).
- E. Night Cool/Purge Mode:
1. General: Mode is to operate in anticipation of warm weather to use cool night air to pre-cool building mass to reduce occupied mode high temperatures. Provide toggle at graphics for each unit to deactivate Night Cool/Purge Mode.
  2. Mode Activation: Shall be automatic based on the previous day's OA temperature exceeding 75 deg F (adjustable).
  3. Sequence:
    - a. Shall only be allowed to operate when space is in the unoccupied mode, between hours of 1 AM and 5 AM (adjustable); and only when OA temperature is 5 deg F (adjustable) lower than the space temperature.
    - b. Fan shall operate at low speed.
    - c. Outside air dampers shall open 100%.
    - d. Fan shall continue to operate until room temperature is within 2 deg F (adjustable) of the outside air temperature, or space has been cooled to the pre-cool mode setpoint of 67 deg F (adjustable).

4. Heating Setpoints: Spaces served by unit shall have their heating setpoint adjusted to be 5 deg F less than what would otherwise be for the occupied period occurring after this mode has occurred (to prevent heat activation).
- F. Mode Control: Unit's mode of operation shall be determined by time schedule and time schedule override; warm-up mode shall be initiated by optimum start controls.
- G. Freeze Protection:
  1. Freezestat: Units shall have freezestat on leaving side of the heating water coil which shall stop unit operation if it senses an air temperature of 35 deg F or less (adjustable). Upon activation of freezestat, unit's heating coil valve shall open 100%, OA damper shall close, and alarm indicated.
  2. Freeze Prevention Mode: Mode shall be enabled or disabled via system graphics. If OA temperature drops below Freeze Protection setpoint 35 deg F (adjustable), unit operates as in the unoccupied mode but using space Occupied Mode space temperature setpoints. OA dampers remain fully closed. System shall remain in Freeze Protection mode until a.) time clock schedule changes to Occupied Mode or b.) OA temperature increases 5 deg F (adjustable) above Freeze Protection setpoint for more than 60 minutes (adjustable); at which point the system reverts back to normal Unoccupied Mode.

### 3.4 EXHAUST FANS

- A. General: See "Control" column on Fan Schedule for which of the following control method is required. See notes on plans for control of fans not listed below and other requirements.
- B. Wall Switch: Fan shall be controlled by on/off wall switch. Fan shall be on when switch is in the on position, and be off otherwise.
- C. Time Schedule: Fan shall run from time schedule.
- D. Thermostat: Fan shall run when temperature rises above setpoint, and shall be off once space temperature falls 2 deg. F or more below setpoint.
- E. Time Schedule and Thermostat - IT Rooms: Operate fan when either time schedule or thermostat call for operation. Thermostat shall be set for 75 deg (adjustable); when space temperature exceeds setpoint fan shall operate.

### 3.5 PUMPS

- A. Domestic HW Circulation Pumps: Pump shall be enabled to operate by time schedule. When enabled, pump shall be controlled in conjunction with a sensor in the hot water recirculation line. When HWC falls to 5 degrees F below setpoint, the pump shall run; when temperature returns to setpoint, pump shall be off. Setpoint and differential shall be adjustable. Initial setpoint shall be 5 degrees less than domestic hot water setting for system used on.
- B. Boiler Pumps: See Boiler Sequence.
- C. Heating Secondary Pumps: See Boiler Sequence.
- D. Chiller Pump: Pump shall be interlocked with chiller and shall be on when chiller is enabled



on. Provide delay-on and delay-off control so that chiller is commanded on after pump is commanded on, and pump continues to run after chiller is commanded off. Delay shall be 1 minute.

- E. Chiller Secondary Pump: Pump shall operate whenever chiller is enabled. Provide VFD and control pump to maintain system differential pressure constant. Measure differential pressure at approximate 2/3 point of system.

### 3.6 BOILERS AND PUMPS

- A. General: Each boiler shall be controlled by the EMCS in Off and Auto modes, and by local Off- Auto-On switches.
- B. EMCS Off: Boiler shall be off.
- C. EMCS Auto:
  - 1. General: Provide OA temperature and calendar schedule control of hydronic system. Provide on delay to allow for proof of pump operation; see pump sequences.
  - 2. Heat Recovery Chiller: If chiller is on, and heating is required, and heating loop setpoint is below chiller heat output temperature (initially set at 130 deg F), open 3-way valve to chiller to allow heat recovery. If any of these conditions are not true, valve shall be closed.
  - 3. Lead Boiler: Lead boiler shall be enabled when the OA temperature is at (or below) the "OA On" setpoint and the calendar schedule allows for boiler operation. Boiler shall be disabled whenever the OA temperature is 3 deg F (or more) above the "OA On" setpoint or the calendar schedule does not allow boiler operation. Initial "OA On" setpoint shall be 63 deg F (adjustable at graphics); initial calendar "On Period" shall be September 15 to May 15 (adjustable at graphics). Boiler shall operate after chiller heat recovery stage is activated.
  - 4. Lead/Lag Sequence: Provide operator selection of which boiler is lead and which is lag at graphics. Once the boiler system is enabled, the lead boiler shall operate. The lag boiler shall operate once the difference between the heating system HWS setpoint and the main HWR temperature equals or exceeds the "Lag Differential Setpoint"; initial setpoint shall be 25 deg F (adjustable at graphics). Once the "Lag Differential Setpoint" is 15 deg F or less the Lag boiler shall be disabled. Disable chiller heat recovery when lag boiler is activated.
  - 5. Alarm: Upon a boiler alarm, that boiler shall be disabled and the other boiler activated. Provide graphic to indicate alarm and this change has occurred.
  - 6. Local Control: When any boiler is in local Off or On control it shall be removed from the EMCS control scheme. Provide graphic to indicate boiler is in local Off or On modes.
- D. Local Control:
  - 1. General: Provide boiler room control panel with an Off-Auto-On control switch for each boiler. This local control shall be hard wired and independent of the EMCS and any programming logic.
  - 2. Off: Boiler shall be off.
  - 3. Auto: Boiler shall be controlled by EMCS.
  - 4. On: Heating loop pump and boiler pump shall be enabled, boiler shall be enabled after one minute delay (by relay).

- E. EMCS Temperature Control:
1. Boiler Firing: Each boiler has its own integral controls to control the boiler firing rate to satisfy the HWS setpoint. Boilers shall use a common HWS header temperature sensor (furnished with boilers), with each boiler's setpoint reset by the EMCS.
  2. HWS Setpoint: The HWS setpoint shall be automatically reset by the EMCS, and shall be the same for each boiler. Each boiler shall receive an independent signal, reset using the following schedule (adjustable):

<u>Outdoor Air Temp</u>	<u>HW Supply Temp</u>
40 deg F	160 deg F
65 deg F	110 deg F
- F. Emergency Shutdown: Connect boilers to wall mounted emergency shutdown switches (locate at each exit from the boiler room) to shut-down all boilers when activated.
- G. Boiler Pumps: Pump shall be interlocked with boiler served, to be on when boiler is enabled and off when boiler is disabled. Provide delay-on and delay-off control so that boiler is enabled after pump is commanded on, and pump continues to run after boiler is disabled. Delay shall be 1 minute.
- H. Heating System Pumps:
1. Lead Pump: Pump shall be activated whenever a boiler pump is operating.
  2. Lead/Standby Sequence: Provide operator selection of which pump is lead and which is standby at graphics. Provide flow detection and time delay relay to allow automatic transfer to standby pump in case of lead pump failure; de-energize lead pump when transfer occurs. Provide manual reset means at GUI and in boiler room to restore normal pump operation after standby operation. Provide alarm indication at GUI and in boiler room (red light) to indicate lead pump failure. Automatically alternate lead and standby pumps weekly (provide means to manually override alternating schedule at graphics).
  3. Pumps shall be controlled by variable frequency drive (VFD). Provide a VFD for each pump. Provide differential pressure sensor to control VFD (and pump speed) to maintain system differential. Locate differential pressure sensor in main HWS/HWR piping, approximately 2/3 out into the system; confirm final location of sensor with Engineer prior to installing. Verify setpoint with balancer.

### 3.7 CHILLER

- A. Water Temperature: Chiller staging and water temperature control shall be by integral controls furnished with chiller (see Section 236400).
- B. On/Off Sequence: Chiller shall be enabled to operate by an outdoor air thermostat and time schedule. When outdoor air temperature is 3 degrees above setpoint and time schedule is in the enabled mode, the chiller and pump shall be enabled. When the outdoor air temperature is below setpoint or the time schedule is in the disabled mode, the chiller and pump shall be off. Initial setpoint shall be 60 degrees F and shall be adjustable at the GUI. Initial time schedule (adjustable) shall enable the chiller from April 15 to June 30 and from August 15 to September 30, and during occupied hours within those periods.
- C. OA Reset: Provide linear OA reset of CHS temperature from chiller between the following limits; coordinate with Section 236400.

<u>OA Temperature</u>	<u>CHS Temperature</u>
75°	46°
85°	40°

### 3.8 DOMESTIC WATER HEATERS

- A. Temperature Control: Furnished with water heaters.
- B. High Temperature Shutdown: Provide water heaters with hard wired high temperature shutdown safety, which will stop water heater operation and alarm at EMCS; set initially for 10 degrees F above water heater setpoint.
- C. Emergency Shutdown: Connect water heater controls through wall mounted emergency shutdown switches to completely stop unit operation when switch is pressed.

### 3.9 MISCELLANEOUS

- A. Heat Tracing: Connect up heat tracing thermostat. Set and adjust for proper operation.
- B. Miscellaneous Dampers/Devices: See plans for other dampers and devices requiring control. Provide control indicated. For dampers in ductwork serving exhaust fans, damper shall be open when fan is commanded on and off when fan is off; provide time delay as needed to prevent excessive pressure in duct or building. Where control is not indicated provide standard sequence typical for such devices in similar projects/applications.
- C. Unit Heaters: Control by space thermostat; when space is above setpoint operate heater fan and modulate valve to maintain space setpoint. When space temperature falls below setpoint heater fan shall be off and valve closed.
- D. Exterior Lighting Control: Provide separate time schedules to allow for control of exterior lighting. Connect to Division 26 provided relays for this purpose at Division 26 lighting panel. Provide Photocell to lockout selected zones when Outside ambient light level exceeds setpoint (adjustable). See Electrical Drawings for number of zones.
- E. Kitchen Hood: Provide necessary interconnections from hood control panel and hood fire suppression contacts to stop exhaust fan operation, stop make-up air unit operation, and de-energize power to items located under the hood.

### 3.10 VAV TERMINAL UNITS - WITH HEAT

- A. General:
  - 1. General: Unit damper and heating coil shall be controlled by space temperature sensor to vary the air volume and air temperature supplied to the space to satisfy space setpoint.
  - 2. Airflow: Airflow shall vary between maximum and minimum positions scheduled. Airflow shall be constant for fixed room thermal requirements and modulate using the variation of room temperature from setpoint. Unit damper operation shall be pressure independent with commanded airflow constant (plus or minus 5%) regardless of pressure variations at terminal unit inlet. Unit airflow shall be measured (using inlet average velocity pressure and inlet duct area factor)

3. Heating Coil: Heat output shall vary from 0% to 100% to meet space setpoint requirements using variation of room temperature from setpoint and the rate of change of room temperature to control the heat coil valve.
- B. Occupied Mode:
1. When SA Temp is less than Space Temp: When space temperature rises above setpoint, the air volume to the space shall increase to maintain the space setpoint. As the space temperature falls, the air volume to the space shall decrease to maintain the space setpoint. If space temperature continues to decrease once the VAV terminal unit is at minimum airflow the heating coil control valve shall modulate to maintain space conditions.
  2. When SA Temp is 3 Degrees greater than Space Temp: If space temperature drops below setpoint, the air volume to the space shall increase to maintain the space setpoint. As the space temperature rises, the air volume to the space shall decrease to maintain the space setpoint. As the space temperature falls, the air volume to the space shall increase to maintain the space setpoint. If space temperature continues to decrease once the unit is at maximum airflow the heating coil control valve shall modulate to maintain space conditions.
- C. Unoccupied Mode:
1. AHU Off: Damper set in the minimum airflow position, heating coil control valve closed.
  2. AHU On: Same as for the occupied mode but using unoccupied mode setpoints.
- D. Warm-Up Mode: Shall coincide with AHU warm-up mode. Same as for the occupied mode.

END OF SECTION

**DIVISION 26**  
**ELECTRICAL**



## PART 1 GENERAL

### 1.1 SECTION INCLUDES

- A. General requirements specifically applicable to Division 26 in addition to provisions of General Conditions, Supplementary Conditions, and Division 01.
- B. General requirements of this section also apply to Divisions 27 and 28.

### 1.2 SCOPE OF ELECTRICAL WORK

- A. Provide electrical systems and Work described, identified, specified, referenced, and shown in the Project Documents that are covered under Divisions 26, 27, and 28 of the Construction Specifications Institute (CSI) and/or as otherwise regulated by national, state, and local electrical codes. Electrical Work includes providing all equipment, materials, devices, appurtenances, and accessories necessary to provide complete and operating systems according to the intent of Project Documents.
- B. Electrical work is not limited to Division 26, 27 and 28 specifications and what is shown on the electrical drawings. The Contractor is responsible to review all Project Documents for additional Electrical Work and requirements and to include this work as part of their scope under the Contract.

### 1.3 REGULATORY REQUIREMENTS

- A. Comply with requirements of the following codes as adopted and supplemented by authority having jurisdiction:
  - ANSI/NFPA 70 - National Electric Code (NEC)
  - NFPA 101 - Life Safety Code
  - IBC - International Building Code (IBC)
  - IMC - International Mechanical Code (IMC)
  - WAC 296-46B - Washington State Electrical Safety Standards, Administration, and Installation
  - Washington State Energy Code (WSEC)
- B. Comply with additional codes and regulations referenced in other sections.
- C. Comply with additional codes and regulations required by authority having jurisdiction.
- D. Obtain and pay for permits, and inspections from authorities having jurisdiction over work included under applicable Division Sections.
- E. Include all testing, shop drawings, and documentation required by the inspection authorities for permitting and final approval.

### 1.4 SUBMITTALS

- A. Comply with requirements of Division 01. Unless otherwise specified, furnish product data and shop drawings to Architect/ Engineer as follows:

1. Product information sheets shall be neat, readable, 8.5 x 11 inch, submitted in PDF format. Generic product sheets with multiple products or product descriptions shall clearly highlight or otherwise indicate which product is being furnished.
  2. Furnish product submittals with index tabs between categories or in separate submittals that correspond to each section of the specifications. Transmittal shall indicate name of the Project, Owner, Architect, Engineer, Contractor, and Date of Submittal.
  3. Furnish system design shop drawings in PDF format. Title block shall include Project, Owner, Contractor, and Date of Submittal.
  4. Furnish product data and shop drawings specifically indicating any conflict or deviation from requirements of contract documents.
- B. Confirm dimensions, ratings, and specifications of electrical materials, devices, fixtures, and equipment conform to project requirements prior to furnishing submittals. Coordinate electrical requirements with utilization equipment submitted under other sections and verify that voltage, phase, and rating are compatible with work shown in the electrical project documents.
- C. Provide shop drawings showing proposed feeder and branch circuit wiring plan required under Section 260500.
- D. Do not order materials or commence Work until applicable submittal has been reviewed and the Architect/Engineer has approved or taken other appropriate action.

#### 1.5 SUBSTITUTIONS

- A. Comply with requirements of Division 01. Products specified by naming one or more manufacturers establishes a basis for quality, styling, capacity, and function. Unless otherwise specified, written requests for substitution must be received at least 14 days prior to Bid Opening by Architect/Engineer who will determine acceptability of proposed substitution. Written acceptance must be obtained from Architect/Engineer prior to Bid Opening.
- B. Substitution requests may be submitted for any manufacturer or named product unless specified as "no substitute".
- C. Substitution approval does not relieve the Contractor of complying with the work requirements or the concept and intent of the project documents. Pay for any and all additional project costs that may be caused by Contractor requested substitutions, regardless of whether or not additional costs are overlooked, missed, or unforeseen, and regardless of when substitutions may be approved.

#### 1.6 RECORD DOCUMENTS

- A. Comply with requirements of Division 01. Maintain at project site one set of clean, dry, and legible red-lined record drawings for submittal at Contract Close-out. Record information concurrently with construction progress.
- B. Incorporate all electrical changes in the contract documents. Include supplementary instructions (ASIs), requests for information (RFIs), field authorizations (FAs), cost change directives (CCDs) and accepted proposal requests (PRs). Document branch circuit and feeder wiring layouts, revised circuit identification, pull & junction box locations, and actual



dimensioned location and routing of each underground conduit on record drawings. Identify existing concealed electrical components to remain that were uncovered during construction. Provide record drawings for all line and low voltage systems installed.

- C. Record branch circuit routing, switch legs, equipment connections, and home runs on the power and lighting plans. Indicate conduit size, wire counts, and conductor size if greater than a #12 2-wire branch circuit or feeder.

#### 1.7 LABELING

- A. Where labeling that includes room names and numbers is required for any system to identify devices or for programming purposes, use final room names and numbers determined during construction. Verify room names and numbers with Architect prior to manufacturing labels, circuit directories or programming software.
- B. Provide labeling on ceiling tile below for items above ceiling where noted in associated specification section.

#### 1.8 OPERATION AND MAINTENANCE MANUALS

- A. Comply with requirements of Division 01. Unless otherwise specified, furnish one labeled CD in PDF format and two duplicate hard copy printed sets of Operation and Maintenance Manuals prior to completion of contract. Submit hard copy manuals in labeled and indexed 3-ring binder(s).
- B. Include the following information as applicable:
  - 1. Names, addresses, and telephone numbers of the contractor, the installing sub-contractor, and the local representative for each system or equipment.
  - 2. All approved product data and shop drawings.
  - 3. Identify all manufacturer warranties which exceed one year.
  - 4. Model number and serial number of each piece of equipment provided.
  - 5. Data from test results performed under the Contract.
- C. Operation and maintenance data shall include complete parts lists, installation and maintenance instructions, safety precautions, operation sequence describing start-up, operation, and shut-down, internal and interconnecting wiring and control diagrams with data to explain detailed operation and control, and testing methods for each system and item of equipment.
- D. Furnish a draft copy of Operations and Maintenance Manual for Architect/Engineer review and incorporate comments prior to final submittal. Allow 14 days for Architect/ Engineer review.

#### 1.9 CONFLICTS

- A. Notify the Architect/Engineer of any conflicts or discrepancies before proceeding with any work or the purchasing of any materials related to the conflict or discrepancy until requesting and obtaining written instructions from the Architect/Engineer on how to proceed. Where conflicts occur, the most expensive and stringent requirement as judged by the Architect/Engineer shall prevail. Any work done after discovery of such discrepancies or conflicts and prior to obtaining the Architect/Engineer's instructions on how to proceed shall be done at the Contractor's expense.

#### 1.10 WARRANTY

- A. In addition to requirements covered under General Conditions or Division 01, include manufacturer product warranties that exceed one year. Assemble or list warranties that exceed one year in Operation and Maintenance Manuals indicating start date. Certificates of extended warranty shall identify the Owner as the beneficiary.
- B. If the Electrical Contractor does not have offices located within 150 miles of the project, provide a service/warranty work agreement with a local electrical subcontractor approved by the Owner. The service/warranty work agreement shall extend for the contract warranty period, and a copy shall be included in the Operation and Maintenance Manuals.

#### 1.11 INTENT OF PROJECT DOCUMENTS

- A. Drawings and specifications are complementary and what is called for in either is binding as if called for in both.
- B. The drawings are diagrammatic and show the general arrangement of the construction and do not attempt to show all features of work, exact construction details, or actual routing of conduit and cable. Provide all necessary supports, off-sets, bends, risers, fittings, boxes, wiring, and accessories which are required for a complete and operating installation. Determine locations for required electrical outlets and connections prior to rough-in base on equipment product and installation submittal data and/or review of equipment on site.
- C. The level of design presented in the documents represents the extent of the design being furnished to the Contractor; any additional design needed to perform the Work shall be provided by the Contractor. All design by the Contractor shall be performed by individuals skilled and experienced in such work, and where required by local code (or elsewhere in the documents) shall be performed by engineers licensed in the State where the project is located. Include in bid the costs of all such project design; including engineering, drafting, coordination, and all related activities and work. Contractor provided design services shall be included for but not limited to bidder design specifications, temporary electrical systems, layout routing to install the Work and share project space with other building systems, hanger and support systems, seismic bracing, preparation of shop drawings, locating and identifying requirements for equipment and fixture terminations, and methods/means of accomplishing the work.

#### 1.12 COORDINATION

- A. Examine architectural, civil, structural, and mechanical drawings and specifications and consult with other trades, as required to coordinate use of Project space and sequence of installation.
- B. Arrange wiring and equipment to avoid interference with other work and to maximize accessibility for maintenance and repairs.
- C. Coordinate with suppliers and installers to obtain product electrical data, shop drawings, and installation requirements for systems, equipment, and products furnished by Owner and/or other trades as required perform electrical work.
- D. Contractor is responsible ensure that equipment, fixtures, and devices being furnished and installed shall fit the space available, taking into account connections, service access, and

clearances required by product manufacturer and/or Code. Contractor shall make the necessary field measurements to ascertain the space requirements for proper installation, and shall furnish and/or install equipment so that final installation meets the intent of the Project Documents. If approval is received by Addendum or Change Order to use other than the originally specified items, Contractor shall be responsible for specified capacities and for ensuring that items to be furnished will fit the space available.

- E. Contractor is responsible to review all the Project Documents and approved shop drawings provide under other divisions to identify and resolve conflicts between electrical systems and building construction, equipment, cabinets, counters, trim, and special finishes, prior to rough-in.
- F. Facilitate coordination between low voltage system sub-contractors during construction. Include time for a minimum of one meeting with all sub-contractors prior to building rough-in to review requirements for each system per Section 260530. Include a second meeting with all sub-contractors to review requirements for all systems utilizing IP structured cabling prior to cover.

#### 1.13 REQUIREMENTS FOR EQUIPMENT FURNISHED UNDER OTHER SECTIONS OR BY OWNER

- A. Provide power wiring, disconnect switches, electrical connection of equipment, installation of furnished electrical controllers, parts, and accessories, and field wiring for systems, equipment, and products furnished under other divisions or by Owner. Install controllers, operator stations, and control devices such as limit and temperature switches furnished with equipment.
- B. Review equipment submittals prior to electrical rough-in and installation. Verify location, rating, size, type of connections, and required space requirements. Coordinate field wiring requirements and details with supplier and installer. Notify Architect/Engineer of conflicts between requirements for actual equipment being furnished and equipment indicated in contract documents prior to commencing Work.
- C. Provide motor controllers and operator stations unless otherwise indicated on the project drawings.
- D. Make final connections to equipment. Provide cord and plug where required for plug-in connection.
- E. Integrated automation systems covered under Division 25 are not included as part of electrical work.

#### 1.14 DEFINITIONS

- A. Electrical terms used in these specifications are as defined in NEC Art. 100 unless otherwise noted.
- B. Abbreviations: Where not defined elsewhere in the Contract Documents, shall be as defined in RS Means Illustrated Construction Dictionary.
- C. Accessible: Signifies access that requires the removal of an access panel or similar removable obstruction.

- D. Accessible Ceiling: Signifies a space that requires the removal of an access panel or similar removable obstruction.
- E. As Required: As necessary to form a safe, neat, and complete working installation (or product), fulfilling all the requirements of the specifications and drawings and in compliance with all codes.
- F. Concealed: Hidden from view as in walls, trenches, chases, furred spaces, crawl spaces, unfinished attics, and above suspended ceilings.
- G. Conduit: Includes conduit and tubing raceways.
- H. Coordinate: Accomplish the work with all others that are involved in the work by directly discussing the work with them, arranging and participating in special meetings with them to discuss and plan the work being done by each, obtaining and completing any necessary forms and documentation required for the work to proceed, reaching agreement on how parts of the work performed by each trade will be installed relative to each other both in physical location and in time sequence, exchanging all necessary information so as to allow the work to be accomplished with a united effort in accordance with the project requirements.
- I. Equipment Connection: Make branch circuit connection, mount and connect control devices as required. Provide disconnect and overcurrent protection when required by NEC and IMC, if not otherwise indicated or furnished with equipment.
- J. Exposed: Exposed to view in any room, hallway, passageway or outdoors.
- K. Finished Areas or Spaces: Areas and/or spaces receiving a finish coat of paint on one or more wall surface.
- L. Furnish: Obtain and/or prepare and deliver to the project.
- M. Indicated: Shown, scheduled, noted, or otherwise called out on the drawings.
- N. Install: Enter permanently into the project complete and ready for service.
- O. Open Cable or Wiring: Conductors above grade not installed in conduit or raceway.
- P. Panel: Distribution panelboard, lighting and appliance panelboard, load center, and/or low voltage cabinet.
- Q. Provide: Furnish and install complete and ready for service.
- R. Wiring: Conductors in raceway or an approved cable assembly.
- S. Verify: Obtain, by a means independent of the project Architect/Engineer and Owner, the information noted and the information needed to properly perform the work.

#### 1.15 SCHEDULE OF VALUES

- A. Provide Schedule of Values for use by Architect/Engineer to evaluate progress payment requests during construction.

- B. Submit Schedule of Values using the line items included at the end of this Section. Submit Schedule of Values for review and approval. Include additional line items as requested.

## PART 2 PRODUCTS

### 2.1 MATERIALS, EQUIPMENT

- A. General: Furnish only products that are new and free from defects with a manufacture date that is less than six months from date of installation. Where product and applicable software updates or upgrades are available from the manufacturer, furnish the latest version unless otherwise specified. Furnishing discontinued products and/or products of manufacturers who are no longer in business is not permitted.
- B. Listing and Labeling: Furnish and install only products that are listed and labeled by one or more of the following testing laboratories as approved by the Authority Having Jurisdiction:
  - Underwriter's Laboratories, Inc. (UL)
  - ETL Testing Laboratories, Inc. (ETL)
  - Factory Mutual (FM)
- C. Each specified product and system to be furnished shall be from a single approved manufacturer. Providing multiple product brands or manufacturers for each type or category, or for multiple units of the same specified product and/or system, is not permitted.
- D. Products shall be delivered, handled, and stored per manufacturer recommendations. Protect fixtures, materials, and equipment from rain, water, dust, dirt, snow, and damage. Do not install products that have marred, scratched, deformed, or otherwise damaged. Do not install products that have been wet or exposed to the weather prior to assembly and/or installation.

## PART 3 EXECUTION

### 3.1 WORKMANSHIP

- A. Electrical work shall conform to requirements of ANSI/NECA 1-2015, Standard Practice of Good Workmanship in Electrical Construction.

### 3.2 INSTALLATION

- A. Provide all electrical work as specified and shown in the Project Documents. Provide all labor, equipment, material, accessories, and testing for electrical systems complete and operating. Include all scaffolding, rigging, hoisting, and services necessary for delivery and installation of materials and equipment. Include required software applications and associated system programming for electronic products.
- B. Provide as part of the Electrical Work all hangers, brackets, supports, framing, backing, accessories, incidentals, not specifically identified the project documents, but required to complete the system(s) in a safe and satisfactory working condition.
- C. Quantity of materials and layout of the Work shall be provided based on field measurement of the actual project conditions and shall not be based on plan dimensions.

- D. Provide all testing and documentation of electrical systems as required to demonstrate compliance with the Project Documents.
- E. Provide testing, documentation, and filing required to comply with commissioning requirements of Section C408 of the Energy Code. Include documentation in Operation and Maintenance Manuals.

### 3.3 CUTTING AND PATCHING

- A. Provide cutting and patching to complete electrical work and to provide openings in elements of Work for electrical penetrations. Comply with requirements of Division 01.
- B. Locate and execute cuts so as not to damage other work or weaken structural components. Core drill or saw cut rigid materials.
- C. Patch to restore to original condition. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection; for an assembly, refinish entire unit.

Division 26, 27 and 28 Schedule of Values

Mobilization and Temporary Facilities

Electrical Demolition

Electrical Site Work

Lighting Systems Rough-in (Conduit, Handholes, Wire, Pole Bases - Material & Labor)

Lighting Fixtures & Poles (Material & Labor)

Power & Signal Rough-in (Conduit, Vaults, Wire - Material & Labor)

Transformers, Switchgear (Material & Labor)

Lighting Systems

Luminaires, Controls & Inverters Material

Luminaires & Inverters Labor

Branch Circuit Rough-in (Conduit and Wire - Material & Labor)

Lighting Controls Labor

Lighting Controls Programming and Commissioning

Performance Lighting System (Material & Labor)

Power Systems

Distribution Equipment Material (Switchgear, Panels, Transformers, Starters, TVSS, Disconnects)

Distribution Equipment Labor

Feeder Rough-in (Distribution Conduit and Wire - Material & Labor)

Branch Circuit Rough-in (Conduit and Wire for Devices - Material & Labor)

Devices and Trim (Material & Labor)

Equipment Circuit Rough-in (Conduit and Wire for Scheduled Equipment - Material & Labor)

Equipment Connections (Material & Labor)

Signal Systems

Telecommunications Pathway (Material & Labor)

Telecommunications Premises Wiring Material

Telecommunications Premises Wiring Labor & Testing

Clock/Intercom Material

Clock/Intercom Labor, Programming & Testing

Telecommunications Pathway (Material & Labor)

Telecommunications Premises Wiring (Material & Labor)

Auxiliary Gym & Gym AV System Materials

Auxiliary Gym & Gym AV System Labor

Classroom AV Systems Material

Classroom AV Systems Labor

Emergency Responder Radio System Testing

Safety & Security Systems Rough-in - Material & Labor

Intrusion Alarm Materials

Intrusion Alarm Labor & Testing

Access Control System Material

Access Control System Labor

CCTV System Material

CCTV System Labor & Testing

Fire Alarm Rough-in (Conduit and Wire - Material & Labor)

Fire Alarm Trim (Equipment, Devices, Testing - Material & Labor)

Commissioning

Electrical Closeout

Punchlists

O&M Manuals, Record Drawings

Training

END OF SECTION





## PART 1 GENERAL

### 1.1 SECTION INCLUDES

- A. Demolition of systems applicable to Division 26.
- B. Requirements for remodeling applicable to Division 26.
- C. Requirements of this section also apply to Divisions 27, 28, and 33.

### 1.2 RELATED SECTIONS

- A. Demolition, Extension, and Relocation of Existing Installation: Comply with provisions of Division 01.
- B. Disruption of Existing Building Services/Systems: Comply with provisions of Division 01.

### 1.3 EXISTING CONDITIONS

- A. The drawings show portions of existing electrical systems which are to remain, be removed, or be modified under the Contract. Concealed features of existing systems are based on field observation and existing drawings. No guarantee is made as to their correctness.
- B. Contractors shall visit the project site prior to bidding and become familiar with the existing conditions and all other factors which may affect the execution of the work. Include all costs related to existing site conditions in the initial bid proposal.
- C. Failure to visit the project site prior to bid does not relieve the Contractor of the responsibility to provide all required work and a complete installation within the intent of the Contract Documents.

### 1.4 EXISTING UNDERGROUND UTILITIES

- A. Existing utilities in areas of new construction must be identified and located by the Contractor prior to commencing Work. Location of underground utilities shown on plans, are diagrammatic and shall not be considered as a complete representation of all utilities that may exist on site.
- B. Coordinate with Owner to identify and locate existing underground utilities including landscape irrigation in areas of Work.
- C. Prior to excavation, contact and coordinate with local Utilities Underground Location Center to identify and locate existing underground public utility services in areas of Work, including power, water, sewer, telephone, gas, and cable TV.
- D. Prior to excavation, obtain services of a utility locator service to scan areas of Work and to locate and mark where known and unknown private underground utilities or other interfering obstructions exist.

- E. Hand excavate to expose located interfering underground utilities and interfering obstructions before trenching. Provide adequate means of support and protection of exposed utilities.
- F. Existing active utilities damaged or interrupted by the Contractor during construction shall be replaced at the Contractor's expense. Repairs to power and signal systems using junction boxes or splices will not be accepted.

#### 1.5 POWER AND SIGNAL OUTAGES

- A. The facility will be unoccupied during the construction work.

#### 1.6 FIRE ALARM SYSTEM

- A. Comply with alarm, incident response, and fire watch requirements of the Authorities Having Jurisdiction.
- B. Coordinate all planned shutdowns and tests of the fire alarm system with the Fire Department and Alarm Reporting Center. Notify the Alarm Reporting Center of false alarms that occur during construction as required to mitigate Fire Department response.

### PART 2 PRODUCTS

#### 2.1 MATERIALS AND EQUIPMENT

- A. New and Replacement Materials and Equipment: As specified in applicable sections, except product manufacture shall match existing for minor construction and for accessories to equipment that remains.
- B. Materials and Equipment for Patching: Match existing products.
- C. Access Panels: Standard flush metal door for drywall, masonry, or tile, with locks keyed to match electrical panels. Milcor Style M, except Style UFR for fire rated construction. Comply with Section \_\_\_\_.
- D. In finished spaces provide surface metal raceway systems as specified in other sections where existing construction does not permit concealed installation.

### PART 3 EXECUTION

#### 3.1 PREPARATION

- A. Field verify wiring and cabling for existing power and signal systems back to source of supply as required to perform Work.
- B. Disconnect electrical systems in walls, floors, and ceilings being removed.
- C. Provide temporary wiring and connections to maintain existing systems interrupted by new construction.

- D. Carefully remove, store, and reinstall existing removable ceiling tiles and raised floor panels where access to perform work is required.
- E. Carefully remove, store, and reinstall existing light fixtures where access to perform work is required. Provide additional fixture support and seismic bracing for reinstalled fixtures where required to meet current Code.
- F. Cut and Patch conduit penetrations and required holes to access work at walls.

### 3.2 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Remove, relocate, and extend existing systems to accommodate new construction. For selective demolition, refer to architectural and mechanical plans and include electrical demolition to support removal and replacement work not otherwise indicated in electrical drawings.
- B. Electrical demolition includes the disconnecting, removal, and disposal of fixtures, devices and equipment where indicated, along with associated wiring.
- C. The following shall be considered as abandoned unless otherwise indicated:
  - 1. Wiring to fixtures, devices, and equipment being removed or disconnected.
  - 2. Conduit containing conductors or cable that have been disconnected from a source of supply or left empty by the removal of conductors.
  - 3. Open conductors or cable that have been disconnected from a source of supply.
  - 4. Fixtures, devices, equipment, and outlets located in walls, ceilings, and floors indicated to be removed.
  - 5. Fixtures, devices, and equipment identified as being replaced.
- D. Remove abandoned wire and cable for power and signal systems to source of supply.
- E. Remove abandoned conduit, cable, and outlets where exposed and within accessible ceiling, attic, crawl, plenum, and opened wall spaces. Cut conduit flush with walls and floors; patch surfaces in finished spaces. Outdoors remove abandoned conduit and cable down to 24 inches below grade and restore site to its original grade and finish.
- F. Disconnect abandoned outlets and remove devices. Provide blank covers for abandoned outlet boxes in floors, walls, and hard ceilings to remain.
- G. Disconnect and remove abandoned switchboards, panelboards, distribution equipment, and electrical devices.
- H. Disconnect power to utilization equipment being removed or abandoned in place.
- I. Disconnect and remove abandoned light fixtures, including brackets, stems, hangers, pole base and other accessories.
- J. Repair adjacent construction and finishes damaged during demolition and extension work.
- K. Cut-in flush outlet boxes and fish conduit in existing construction of remodeled areas where conditions permit. Flexible conduit is approved where fishing of conduit is required. Where existing construction does not permit flush installation, use surface metal raceway.

- L. Extend existing outlet boxes as required to accommodate new surface treatments or to extend wiring with surface raceway.
- M. Maintain access to existing electrical systems to remain active. Modify installation or provide access panels as appropriate.
- N. Replace, modify or extend existing outlet boxes to meet volume requirements. Cut surfaces as required to replace (or modify) existing outlet boxes and to install supports for new boxes and fixtures and patch to match adjacent surface.
- O. Provide new supports for existing conduit and open cable accessed during construction and which is to remain or be reused, as required to comply with current Code. Comply with requirements of applicable signal system specifications for support of signal cables.

### 3.3 DISPOSITION OF MATERIALS

- A. Prior to start of demolition, coordinate with Owner to identify materials and equipment for salvage. Disconnect and remove items to be salvaged and deliver to an area on site designated by the Owner. Disconnect, remove, and handle salvage material and equipment in a manner so as not to damage or otherwise render unusable.
- B. Materials and equipment removed and not reused or salvaged to the Owner shall become the property of the Contractor unless otherwise indicated. Remove such material and equipment from the Owner's property and dispose legally off site.
- C. Transformers, ballasts, fluorescent lamps, capacitors, oil switches, and other removed materials and equipment which may contain Polychlorinated Biphenyls (PCB's) or mercury shall be considered hazardous waste. Handle, transport, and dispose of these materials and equipment in accordance applicable state and federal laws. Provide to the Owner a certificate of disposal within the one year contract warranty period.

### 3.4 CLEANING AND REPAIR

- A. Luminaires: Clean interior and exterior surfaces, reflectors, and lens. Replace lamps, ballasts, and broken electrical parts.

### 3.5 NAMEPLATES AND CIRCUIT DIRECTORIES

- A. Provide nameplates for existing distribution equipment to indicate new and revised equipment, circuit, and load designations.
- B. Update panelboard and load center circuit directories to indicate changes and additions to each circuit. Updated and existing circuits shall be typewritten on new removable circuit index cards.
- C. Nameplates and circuit directories shall comply with requirements of Section 262000.

END OF SECTION

## PART 1 GENERAL

### 1.1 SECTION INCLUDES

- A. Conduit and Fittings.
- B. Surface Metal Raceway.
- C. Building Wire and Cable.
- D. Wiring Connections and Terminations.
- E. Boxes.
- F. Wiring Devices.
- G. Cord Reels.
- H. Cable Tray.
- I. Supporting Devices.
- J. Requirements for Fire Rated Construction.
- K. Earthwork for Underground Electrical.

### 1.2 RELATED SECTIONS

- A. Excavation and Backfill for Underground Conduit: Comply with Division 31 - Earthwork.
- B. Concrete for Encased Conduit: Comply with Division 03 - Concrete.
- C. Materials and Methods for Utility Services: Comply with Section 260580.

### 1.3 SUBMITTALS

- A. Submit product data for conduit fittings, wire and cable, watertight connectors, wiring devices, floor boxes, cord reels, smoke detectors, and cable tray.
- B. Submit shop drawings for underground feeders, branch circuit raceway and signal system.
- C. Submit shop drawings for installation of cable tray, including wire basket type.
- D. Submit reports for tests required under Part 3 of this section.

### 1.4 OPERATION AND MAINTENANCE DATA

- A. Include data for wiring devices, floor boxes, cord reels, and cable tray in Operation & Maintenance Manuals.

## 1.5 SPARE PARTS

- A. Concealed Service Floor Box Cover Assemblies: Provide to owner (3) each flush cover and carpet flange.
- B. Concealed Service Floor Box Service Plates: Provide to owner (3) each duplex knockout, voice/data, blank single receptacle, and rectangular opening.
- C. Flush Service Floor Box Cover Assemblies: Provide Owner (3) each device plates and carpet flanges for both power and signal (six sets total).

## 1.6 PREPARATION

- A. Prior to first floor rough-in, review spaces with Architect/Engineer to determine exact outlet box location for all wiring devices and low voltage systems.

## PART 2 PRODUCTS

### 2.1 CONDUIT

- A. Rigid Steel Conduit (RGS): ANSI C80.1; hot dipped galvanized.
- B. Intermediate Metal Conduit (IMC): Hot dipped galvanized.
- C. Electric Metallic Tubing (EMT): ANSI C80.3; galvanized tubing.
- D. Flexible Metal Conduit: Galvanized steel. Heavy wall except reduced wall may be used where concealed in building construction.
- E. Liquid Tight Flexible Metal Conduit: Galvanized steel, PVC jacket.
- F. Non-Metallic Conduit: NEMA TC 2; EPC-40-PVC and EPC-80-PVC.

### 2.2 FITTINGS

- A. RGS and IMC Conduit: ANSI/NEMA FB 1; threaded type. Provide hubs and connectors with insulated throat for conduit larger than 3/4 inch diameter.
- B. EMT Conduit: ANSI/NEMA FB 1; heavy wall steel, compression or set screw type. Provide connectors with insulated throat for conduit larger than 3/4 inch diameter. Provide raintight fittings for conduit installed outdoors.
- C. Flexible Conduit: ANSI/NEMA FB 1; steel, single screw squeeze type.
- D. Liquid Tight Flexible Conduit: ANSI C33.84, steel. Provide PVC coated fitting where installed outdoors.
- E. PVC Conduit: NEMA TC 3; solvent welded type, same manufacture as conduit.
- F. Water and Vapor Conduit Sealants: Hydra-Seal S-50 conduit sealing putty or approved; Tyco/Rachem/TE blank duct plug or approved; Polywater FST conduit sealing foam system

or approved.

- G. Metal-Clad Cable: ANSI/NEMA FB 1; steel, heavy wall, single screw squeeze type with insulated throat.
- H. Expansion Fittings for PVC Conduit: Same manufacture as conduit.
- I. Hazardous Locations: UL886; Crouse-Hinds, Appleton, O-Z/Gedney.
- J. Corrosion Protection: Zinc plated minimum indoors and hot dipped galvanized minimum outdoors and indoor wet locations for all metal fittings and accessories.

## 2.3 WIRE MANAGEMENT SYSTEMS

- A. One-Piece Surface Metal Raceway (SMR): Wiremold or approved, steel surface raceway system sized for number of wires, complete with fittings, supports and accessories designed or recommended by product manufacturer. Ivory finish unless otherwise noted.
- B. Two-Piece Surface Metal Raceway (SMR): Wiremold or approved, steel surface raceway system complete with divider, fittings, supports, and accessories designed or recommended by product manufacturer. Suitable for fiberoptic cables. Provide 4000 series with 4050 series thermoplastic overlapping device covers to match wiring devices installed unless otherwise noted. Ivory finish unless otherwise noted.
- C. Multi Outlet Plug Strip Assemblies: Wiremold Plugmold systems or approved, type as noted complete with fittings, supports, and accessories designed or recommended by product manufacturer. Ivory finish unless otherwise noted.
- D. Miscellaneous Wire Management System(s): Wiremold or approved, type as noted complete with fittings, supports, and accessories designed or recommended by product manufacturer. Ivory finish unless otherwise noted.

## 2.4 WIRE AND CABLE

- A. Copper Building Wire, Interior: Type THWN-2, 600 volt insulation; conductors 8 AWG and larger shall be stranded. Type XHHW-2 may be substituted for conductor sizes 4 AWG and larger.
- B. Copper Building Wire, Outdoors: Type RHW/USE-2, 600 volt insulation; conductor 8 AWG and larger shall be stranded.
- C. Fire Rated Building Wire: Type RHH or RHW-2, UL2196, 600 volt insulation, copper conductor, UL classified 2-hour rated cable when installed in approved steel conduit system. Type RHH may be used only in dry locations.
- D. Flexible Cords: Oil resistant thermoset insulated Type SO multi-conductor with identified equipment grounding conductor, sized for connected load of equipment and rating of branch circuit overcurrent protection.
- E. Metal Clad (MC Cable): UL 1569; #12 AWG copper conductors, 600 volt 90 degree C rated conductor insulation, phase identified, with green insulated copper grounding conductor and steel outer covering. Include neutral conductor for switch legs per NEC 404.2(C). Provide

PVC jacketed MC cable listed for the purpose where used in damp or wet locations or where otherwise indicated.

- F. Cord Sets for Electric Ranges: Four conductor, 50 ampere (NEMA 14-50), 6 feet long.
- G. Cord Sets for Electric Dryers: Four conductor, 30 ampere (NEMA 14-30), 6 feet long.

## 2.5 WIRE CONNECTORS

- A. Connectors for Wire Size 10 AWG and Smaller: Insulated steel spring twist-on pressure connector with plastic cap. Outdoors use watertight type with prefilled sealant gel.
- B. Connectors for Wire Size 8 AWG and Larger: Solderless mechanical or compression type with pre-formed or shrink sleeve insulated cover. Outdoors make watertight using shrink sleeve or pigtail cap and sealing mastic.
- C. Outdoor Taps Below Grade for Wire Size #6 AWG and Larger: Ilco PED series underground multi-tap, wire range and number of ports as required.
- D. Gutter/Wireway Taps for Wire Size #6 AWG and Larger: Ilco type PDB series AL/CU lug type distribution block, number of poles and quantity/size of primary/secondary lug ports as required for the application.
- E. Connectors at Pole Bases: WSDOT Spec 9-29.7; waterproof quick-disconnect. Provide fused type for ungrounded conductors.

## 2.6 BOXES

- A. Outlet Boxes: ANSI/NEMA OS 1; galvanized sheet steel, with 1/2-inch male fixture studs or plaster rings as required.
- B. Surface Outlet Boxes Below 8 Feet: Cast aluminum or malleable iron, threaded hubs.
- C. Surface Outlet Boxes for Outdoor and Wet Locations: Cast aluminum with baked enamel or epoxy finish, gasketed cover, stainless steel hardware. Outlet boxes shall have threaded hubs.
- D. Concrete and Masonry Boxes: Galvanized steel, suitable for the purpose.
- E. Junction and Pull Boxes: Outlet box with blank cover except boxes larger than 4 inch square shall be screw cover type, galvanized steel with grey enamel finish, NEMA 1 indoors and NEMA 3R outdoors, unless otherwise indicated.
- F. In-Ground Boxes: Concrete type with locking cover. Provide traffic ratings, dimensions, features, and installation requirements indicated.
- G. Concealed Service Floor Boxes (Conference Rooms, Library, Commons and Work Rooms): Hubbell HBL CFB7G4 series for concrete floor construction in, with steel flush cover/carpet flange assembly, listed for scrub water exclusion.
- H. Concealed Service Floor Boxes (Music/Stage): Hubbell HBL CFB11G4 series for concrete floor construction in, with steel flush cover/carpet flange assembly, listed for scrub water exclusion.



- I. Flush Service Floor Boxes (Serving): Hubbell 2536 series, concrete tight, cast iron, adjustable. Finish as specified under service fittings.
- J. Fire Rated Construction: Recessed outlet boxes and rough-in cans that are installed in 2 hour rated area separation walls shall be UL listed with 1-1/2 hour rating label.
- K. Barriers: Provide permanent barriers in outlet boxes to separate adjacent wiring devices where voltage exceeds 300 volts. Provide permanent voltage separation barriers in outlet and junction boxes to separate wiring above 100 volts from wiring below 100 volts and where otherwise required by Code.
- L. Color Coding of Device and Junction Boxes for Special Systems: Field painted or otherwise manufactured in the specified color, both inside and outside of box and cover. Provide color identification for the following electrical systems: Fire Alarm System - RED, Emergency Systems (NEC 700) - ORANGE.
- M. Sound Attenuation Wrap: UL listed, 0 VOC, sound attenuating wrap for sealing around outlet boxes. SpecSeal SSP Putty Pad or approved.

## 2.7 WIRING DEVICES

- A. Wall Switches: Hubbell 1221, Leviton 1221, Pass & Seymour 20AC1, Cooper 2221; specification grade, 20 ampere, 277 volt, quiet type. Single pole, double pole, 3-way, 4-way as required. Color: Ivory.
- B. Wall Switch with Integral Pilot Light: Hubbell 1221-PLG, Leviton 1221-PLG, Cooper 1221-PLG, Pass & Seymour 20ACI-GPL, specification grade, 20 ampere, 120 volt, quiet type, single pole, 1 horse-power rated, green pilot light illuminates when switch is on. Color: Ivory.
- C. Duplex Receptacles: Specification grade 5362 series, NEMA 5-20R, grounding type, as manufactured by Hubbell, Leviton, Pass & Seymour, Cooper. Color: Ivory, except receptacles on emergency circuit shall be red.
- D. Duplex Receptacles: Tamper resistant, extra heavy duty, specification grade, 20 amp, decora style, NEMA 5-20R, grounding type, as manufactured by Hubbell, Leviton, Pass & Seymour, Cooper. Color: Ivory.
- E. Duplex Receptacles, Counter Tops and Work Surfaces: Same manufacturer, rating, and style as specified for duplex or GFCI receptacles except receptacle assemblies in counter tops shall be listed for countertop applications and Work surfaces shall be listed for work surfaces or countertop applications.
- F. Duplex Receptacles, Controlled: Same manufacturer, rating, and style as specified for duplex receptacles except devices shall have special purpose identification symbol and permanently marked with the word "controlled" visible on face of each receptacle automatically controlled. Color: White. Automatic control devices for receptacles are specified under Section 260920, Lighting Controls.
- G. Ground Fault Circuit Interrupter (GFCI) Receptacles: Same manufacture, rating, and color as duplex receptacles except devices shall comply with UL 943, Class A, with self test.

- H. Duplex Receptacles, Weather Resistant for Damp and Wet Locations: Same manufacture, rating, and color as duplex and GFCI receptacles except devices shall be UL listed as weather resistant and permanent special purpose identification shall be visible on the device.
- I. Special Purpose Receptacles: NEMA WD 5, same manufacture as duplex receptacles; premium specification grade, grounding type, NEMA configuration as indicated on project plans, black color. Provide matching plug for each receptacle.
- J. Flush Mounted Device Plates: Super heavy duty for high abuse application, rigid high impact thermoplastic, smooth finish, color and style to match device. Thermoset, phenolic, urea, nylon, and flexible polycarbonate not approved.
- K. Surface Mounted Device Plates: Raised galvanized steel on steel boxes; cast or stamped sheet aluminum on cast boxes.
- L. Damp and Wet Location Device Plates: ANSI/UL 514D; Commercial grade, low profile, lockable, die cast metal cover assembly, listed as weatherproof when in use and identified as extra duty. Hubbell/TayMac MX series or approved.
- M. Floor Box Service Fittings, Concealed Service: Screw type modular face plates offered by product manufacturer, configuration to match wiring devices provided. Provide blank plates for unused outlets. Provide raceway connection between outlets on opposite side of the box where required to meet application requirements.
- N. Floor Box Service Fittings, Flush Service: Brushed aluminum device plates with matching carpet flange. Receptacle outlets shall have single or duplex hinged lift flaps to match device, listed for scrub water exclusion. Signal outlets shall have hinged lift flap.
- O. Cord and Plug Connectors: Hubbell Insulgrip, Leviton Spec-Master, Slater Metalist series, GE Gator Grip; premium specification grade grounding type cord connector and matching plug, NEMA configuration indicated. Provide with weatherproof boot in damp and wet locations.

## 2.8 CORD REELS

- A. General: UL listed retractable reel assembly for commercial use; steel construction with 12 gauge 3 conductor SJEOOW, 300 volt, 45 foot oil resistant thermoset cord, rated 13 amps at 125 volts, with shock absorbing stop ball, swivel/pivot base, and triple tap w/GFCI power outlet with three 3-wire 15 amp receptacles. Reelcraft L 4545 123 9G cord reel with 600608 (swivel base).

## 2.9 CABLE TRAY FOR COMMUNICATIONS AND SIGNAL CIRCUITS

- A. MDF/IDF Room Cable Tray: NEMA VE 1, class 12A, aluminum center rail open ladder type with 9 inch rung spacing; 4 inch deep with side rails.
- B. Distribution Cable Tray: NEMA VE 1; high strength welded steel 2 inch x 4 inch pattern wire mesh basket type tray, pre-galvanized zinc or zinc plated with clear sealer, 4 inch deep x 12 inch wide unless otherwise indicated. Chalfant VersaTray, Cooper B-Line WB Series, GS Metals Flextray, or approved.
- C. Accessories: Provide manufacturer's standard elbows, tees, clamps, connectors, splice plates,

hangers, brackets, supports, and attachments. Elbows and tees shall have 24 inch radius.

- D. Wall Sleeves: Galvanized steel wall sleeve accessory, flanged each end, and sized to accommodate cable tray installed.

## 2.10 SUPPORTING DEVICES

- A. Metal Conduit Clamps & Straps: Steel, screw type; zinc or cadmium plated minimum indoors, hot dipped galvanized minimum outdoors.
- B. Support Channel: Slotted 12-gauge steel channel with fittings, fasteners, brackets, clamps, floor plates, and accessories required; Pre-galvanized zinc coated (G90) indoors, ASTM 123 hot dipped galvanized outdoors.
- C. Fasteners: Expansion anchors in concrete and solid masonry; toggle bolts in hollow masonry, plaster, or gypsum board wall construction; sheet metal screws in metal construction; wood screws in wood construction; set screw type beam clamps on steel columns and beams; U.L. listed clips for metal studs. Metal parts and accessories to be zinc or cadmium plated minimum indoors and hot dipped galvanized minimum outdoors.
- D. Support Wires: Support wires above accessible ceiling grids, steel #12 AWG minimum.
- E. Roof Supports: Free standing, stackable, 7.5 inch square, one piece molded PVC pipe support with U shaped rolling cradle, MIRO Industries Pillow Block #24-R.

## 2.11 ACCESSORIES

- A. Air-Vapor Barriers:
  - 1. Pre-molded polyethylene box installed in all exterior framing walls (thermal envelope) around recessed outlet boxes. Lessco or equal.
  - 2. Foam electrical outlet gaskets for installation between device plate and finished outlet. Conceal behind device plate.
- B. Pulling Wire:
  - 1. Interior; continuous fiber pulling line, 190# tensile strength.
  - 2. Below grade; Polyester measuring pulling tape 5/8 inch wide, 1800# tensile strength. Muletape.
- C. Warning Tape: 6 inch wide detectable underground warning tape, black lettering, on red background for high voltage, yellow background for medium voltage and general utility, orange background for low voltage, with wording to describe buried installation.
- D. Corrosion Protection Metal Conduit Tape: 3M Scotchrap 10 mill PVC All Weather Corrosion Protection 50 tape and pipe primer system, or approved.

## 2.12 FIRE RATED CONSTRUCTION

- A. Products for Fire Stopping to Seal Around Enclosures and Annular Space between Conduit and Building Construction at Conduit Penetrations: ANSI/UL 1479; Comply with requirements of Division 07.
- B. Conduit Sleeves for Open Cable: ANSI/UL 1479; Fire stop conduit sleeve kit, with

mounting escutcheons, gaskets, end bushings, warning labels, and non-hardening fire stop putty. SpecSeal READY SLEEVE, FS100 (1 inch diameter sleeve) and FS200 (2 inch diameter sleeve), or approved.

- C. Pathway Sleeves for Open Cable, Greater than 2 Inch Diameter: ANSI/UL1497; Fire stop rectangular sleeve kit, 3-inch wide by 3-inch high by 10.5-inch length, expandable in 6-inch increments, self-contained integral fire sealing system that automatically adjusts to the installed cable loading. Provide radius control modules (each end of pathway), single or multiple gang wall kits, and expansion modules as required. Specified Technologies, Inc., EZ-Path System Series 33 or approved.

## PART 3 EXECUTION

### 3.1 WIRING METHODS

A. General:

1. Fixed wiring shall be conductors installed in conduit except where cable is specifically permitted in this specification.
2. Conceal all wiring within construction unless otherwise noted on drawings or specifically authorized by the Architect/Engineer.
3. Where contractor wiring methods require the application of conductor ampacity adjustment or correction factors under NEC 310.15, the contractor shall submit calculations that show Code compliance, except the adjusted ampacity of the conductors installed shall not be less than the circuit overcurrent device rating shown or specified.
4. Conduit sizes shall not be reduced to smaller size than shown or otherwise noted on plans.
5. Feeders shown or otherwise noted on plans shall not be combined to share a common conduit homerun. Branch circuit homeruns shown or otherwise noted on plans shall not be combined to share a common conduit with other circuits.
6. Device Plates: It is the electrical contractor's responsibility to ensure that all line voltage and low voltage system faceplates and visible trim pieces are the same color. Exception: Where stainless steel device plates are used for line voltage systems, low voltage systems may use non-metallic plates of the same color.

B. Conduit Requirements:

1. Rigid Steel Conduit (RGS): May be used in all areas. Required at penetrations thru fire rated construction rated greater than 1 hour and where wiring is located in hazardous (classified) locations.
2. Intermediate Metal Conduit (IMC): May be used in all areas except where RGS is required or indicated.
3. Electrical Metallic Tubing (EMT): May be used in dry and damp locations where not subject to damage. May not be used in concrete, where in contact with earth, or where RGS is required or indicated. May not be used for service entrance conductors inside a building.
4. Flexible Conduit: May be used concealed in casework and where concealed in walls, up to 1 inch maximum trade size. Required for final equipment connections (maximum length 36 inches), to recessed lighting fixtures from an outlet box (maximum length 72 inches), and where raceway passes thru seismic joints. Use liquid tight in damp or wet locations.

5. Rigid Non-Metallic Conduit (PVC): May be used underground. May be used within buildings where encased in not less than 2 inches of concrete. Terminate inside building using RGS or IMC elbow and riser to first coupling above slab on grade.
  6. Corrosive Environments: Use RGS conduit with 40 mil PVC exterior coating and urethane interior coating where exposed within 100 feet of shoreline, and other corrosive environments.
- C. Wire and Cable Requirements:
1. Use copper conductors, except Contractor may use aluminum conductors only for copper conductors sizes 3 and larger providing conductor and conduit sizes are increased to equal ampacity of copper sizes. Submit list indicating conduit and aluminum conductor sizes proposed for Engineer's approval. Engineer's decision as to equivalent sizes for aluminum conductors and conduit will be final.
  2. Metal Clad (MC) Cable: May be used for fixture whips and for branch circuit wiring where concealed in walls or casework between wiring devices in finished spaces and above an accessible ceiling. May not be used for branch circuit homeruns, feeders, or services. May not be used in mechanical ducts or fabricated air plenums. May not be used in concrete or below concrete slabs on grade. May not be used between floors.

### 3.2 SUPPORT - GENERAL

- A. Support wiring, conduit, raceways, boxes, equipment, and fixtures from building structural members. Provide additional framing, channel, or listed support attachments as required to span or support between structural members and to avoid interference from pipes, ducts, and other equipment.
- B. Do not install support anchors to penetrate thru roof deck.
- C. Do not violate the integrity or exceed the capacity of the building structure used for support. Provide/fabricate additional support elements to transmit loads to the floor or other parts of the building structure that can carry the load as approved by the Architect/Engineer.

### 3.3 CONDUIT SIZING, ARRANGEMENT, AND SUPPORT

- A. Minimum conduit trade size 1/2-inch diameter except all homeruns and where installed below grade outdoors conduits shall be 3/4-inch minimum diameter. Prewired 3/8 inch diameter flexible conduit not to exceed 72 inches in length may be used for fixture whips from an outlet box to recessed light fixture.
- B. Arrange conduit to maintain headroom and present a neat appearance.
- C. Route conduit parallel and perpendicular to walls and adjacent piping.
- D. Maintain 12-inch clearance between conduit and heat sources such as flues, steam pipes, and heating appliances.
- E. Locate holes in joists within center third of member depth measured from the edge and at least 24 inches from load bearing points. Maximum hole diameter one inch.
- F. Support conduits from building structure with conduit straps or rods and hangers. #8 solid wire and CADDY clips may be used to hang 3/4-inch diameter conduit and smaller above accessible ceiling spaces.

- G. Group conduit in parallel runs where practical and use conduit rack constructed of steel channel with conduit straps or clamps. Provide space for 25 percent additional conduit.
- H. Do not support conduit with perforated pipe straps or tie wraps. Remove all wire used for temporary conduit support during construction, before conductors are pulled.
- I. Do not bore holes in truss members or notch structural members.
- J. Steel conduit installed as part of a 2 hour fire rated wiring assembly shall be supported 5 feet on center where required by the cable system installation requirements.

### 3.4 CONDUIT INSTALLATION

- A. Use conduit hubs or sealing locknuts for fastening conduit to cast boxes and for fastening conduit to sheet metal boxes in damp locations.
- B. Use conduit bodies to make sharp changes in direction, as around beams.
- C. Use factory elbows for PVC conduit and for bends in metal conduit larger than 1 inch. Conduit bends for signal systems that are greater than 45 degrees shall be minimum radius sweeps as follows:

Under 2 inches	Standard radius
2 inches - 3 inches	24 inch radius
Over 3 inches	36 inch radius
- D. Use factory RGS elbows for PVC conduit runs below grade.
- E. Install insulated bushings on each end of conduit larger than 1 inch.
- F. Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture.
- G. Install pull wire in empty conduits.
- H. Conduit in Concrete Slabs Above Grade: Do not install in concrete slabs above grade except where written approval and installation requirements are provided by the Architect/Engineer.
- I. Metal Conduit Installed Below Grade: Provide 20 mil thick factory PVC coating or field wrapped using corrosion protection tape and primer system with 50 percent wrap overlap; extend 8 inches above grade at risers.
- J. Conduit Below Concrete Slabs On Grade: Install at minimum depth required for vertical penetration of radius bend at conduit risers.
- K. Underground Conduit for Site Power (Below 600 Volts) and Signal Systems: Install to provide 24 inches minimum cover up to final grade unless otherwise indicated or specified. Maintain minimum 7.5 inch on center spacing between power conduits; maintain minimum 12 inch spacing between power conduits and signal conduits; maintain minimum separation from public utilities established by regulation.
- L. Conduits at Roof Decks: Conduit installed within 1.5 inches of the nearest surface of metal corrugated roof decks and conduit concealed within roofing systems on top of roof decks

shall be RGS or IMC conduit.

- M. Install flexible conduit thru oversized bushed sleeve or cored opening where conduit crosses building wall expansion or seismic joints. Provide up to 54 inches of flexible wiring with 6 inches minimum of conduit slack each side of the wall assembly to allow for free movement across the joint.
- N. Install evenly spaced expansion couplings on above ground PVC conduit runs longer than 25 feet. Unless otherwise recommended by manufacturer, maximum spacing for short couplings (2 inch expansion) shall be 40 feet on center and maximum spacing for standard coupling (6 inch expansion) shall be 100 feet on center.
- O. Do not install conduit in concrete slab on grade.
- P. Do not install conduit in direct contact with underside of roof deck.
- Q. Seal all underground conduits entering and terminating within a building or structure using approved non hardening duct seal putty or a sealing bushing. Seal spare conduits using a watertight blank plastic duct plug. Seal all underground conduits entering and terminating below grade, such as in a crawl space or basement, using an approved closed cell foam sealant system.
- R. Provide conduit sealing fittings where conduits pass through hazardous (classified) locations.

### 3.5 CONDUIT PENETRATIONS

- A. Roof Penetrations: Provide flashing around each conduit which penetrates a roof. Materials and installation shall comply with applicable provisions of Division 07 for roofing. Seal top of flashing around conduit with a weatherproof non-hardening mastic.
- B. Exterior Walls: Core drill or cast sleeve for each conduit one size larger than conduit diameter. Seal all openings at each penetration with acrylic weatherproof caulking suitable for painting. Below grade seal with "Chase-Foam" silicone sealant or other approved method acceptable to Architect/Engineer.
- C. Interior Walls and Partitions: Cut one size larger than conduit diameter. Seal all openings at each penetration with low VOC level general purpose interior sealant as specified in Division 07.
- D. Fire Rated Construction: Comply with requirements of paragraph, FIRE RATED CONSTRUCTION, this specification.

### 3.6 SURFACE METAL RACEWAY (SMR)

- A. Provide SMR in lieu of conduit in finished spaces where exposed raceway is specifically indicated or otherwise approved.
- B. Install parallel to building surface in least conspicuous location. Verify routing with Architect/Engineer and make directed adjustments prior to installation.
- C. Where multiple-compartment SMR is used for both signal and power, identify compartments per NEC 386.70.

### 3.7 METAL CLAD CABLE

- A. Arrangement and Support: Comply with requirements specified for conduit. Provide maximum support spacing of 6 feet on center and within 12 inches of terminations.

### 3.8 CONDUCTOR INSTALLATION

- A. Minimum Conductor Size: #12 AWG, except #10 AWG minimum for outdoor and exterior building lighting circuits and #14 AWG minimum for control circuits and for lighting fixture taps not to exceed 72 inches.
- B. Splice conductors only in junction or outlet boxes and handholes.
- C. Arrange conductors neatly at termination such that a clamp-on ammeter may be used.
- D. Clean conduit free of debris before conductor installation; install conductors using pulling lubricant.

### 3.9 ALUMINUM CONDUCTORS

- A. Terminate aluminum conductors with compression lugs and connectors. Compression copper pigtail or pin type connectors may be used at mechanical lugs.
- B. Use anti-oxidant compound on aluminum conductor strands at all connections and terminations.

### 3.10 CONDUCTOR IDENTIFICATION

- A. Provide non-metallic wire markers on each conductor in panelboards and in junction boxes having more than 6 conductors. Identify branch circuit or feeder number for power and lighting circuits.
- B. Color Coding of Insulated Equipment Ground: Solid green.
- C. Color Coding of 208/120 Volt System: Phase A - black, Phase B - red, Phase C - blue, Neutral - white.
- D. Color Coding of 480/277 Volt System: Phase A - brown, Phase B - orange Phase C - yellow, Neutral - gray.
- E. Color Coding of Line Voltage Switch Legs: Pink.
- F. Provide color tracers on neutrals to differentiate circuits on multi-wire branch circuits with separate neutrals.

### 3.11 BOX LOCATIONS

- A. Provide electrical boxes for outlets, junctions and equipment connections as shown and as required for splices, taps, wire pulling, and code compliance.
- B. Electrical box locations shown are approximate unless dimensioned. Obtain equipment outlet locations from equipment manufacturer prior to rough-in. Coordinate outlet and wall switch



locations with casework and finish elements shown on Architectural drawings. Install to fit conditions or as directed.

- C. Change location of wall outlets, wall switches, and lighting outlets up to fifteen feet without charge when requested by Architect/Engineer prior to installation.
- D. Height of outlets unless otherwise directed: See Drawings.

### 3.12 BOX INSTALLATION

- A. Set wall outlet and wall switch boxes vertically.
- B. Support boxes independently of conduit, piping, and ductwork; securely fasten in place.
- C. Provide recessed outlet boxes in finished areas. Flush front edge of box or plaster ring even with finished surface.
- D. Provide blank cover plate over all boxes that do not contain devices or are not covered by equipment.
- E. Do not install flush boxes on opposite sides of a wall within the same stud space. Maintain 24 inch minimum box separation in fire rated wall assemblies.
- F. In-Ground Boxes: Set on 9 inch minimum deep gravel base extending 6 inches minimum beyond each side. Set flush with final grade.

### 3.13 WIRING DEVICES

- A. Ground Fault Circuit Interrupter (GFCI) Protection: Provide for receptacles located outdoors, within 6 feet of sinks, in bathrooms, kitchens, indoor wet locations, locker rooms with associated shower facilities, elevator pits, elevator machine rooms, crawl spaces, garages, service bays, rooftops, at counters and work surfaces where food and/or beverage preparation occurs, and as otherwise indicated. GFCI receptacles are not required where branch circuit is protected by GFCI circuit breaker.

### 3.14 CORD REELS

- A. Install and provide 120 VAC circuit connection in accordance with manufacturer's instructions. Adjust ball stop to set retracted outlet box height as directed by Owner.
- B. Verify reel location with reflected ceiling plans. Provide channel strut and bracing as required for rigid support from building structure.

### 3.15 CABLE TRAY FOR COMMUNICATIONS CIRCUITS

- A. Install in accordance with requirements of NEMA VE 2 and manufacturer's instructions. Provide shop drawings for installation of cable trays showing layout, supports, connectors, accessories, and installation details.
- B. Unless otherwise indicated support cable tray from building structure with center support using 1/2-inch threaded rod. Provide supports at each end, each connection point, and other points required to maintain maximum support spacing of 12 feet on center for ladder type

tray and 6 feet on center for wire basket type tray.

- C. Install warning signs 50 feet on center along cable tray to read "WARNING! DO NOT USE CABLE TRAY AS WALKWAY, LADDER, OR SUPPORT. USE ONLY AS MECHANICAL SUPPORT FOR CABLES."
- D. Seismic Restraint: Provide seismic bracing of suspended cable tray. Comply with product manufacturer's standard installation details and recommendations for Seismic Design Category F.
- E. Coordinate cable tray layout and installation with HVAC and Plumbing requirements. Locate supports to clear ducts, equipment and piping. Allow for offsets to share space at three locations minimum.
- F. Provide wall sleeve wherever cable tray passes through a wall or other permanent partition. Do not install cable through fire rated construction.

### 3.16 FIRE RATED CONSTRUCTION

- A. Verify location of fire rated walls and ceilings with Architectural plans prior to rough-in.
- B. Installation of boxes, rough-in cans, conduits, and sleeves that result in membrane or through penetrations shall comply with IBC 712.1 through 712.4 as required to maintain fire rating of construction assembly. Coordinate locations and construction requirements with General Contractor.
- C. Provide approved conduit and/or pathway sleeve kits for installation of open cable through fire rated construction.

### 3.17 EARTHWORK FOR UNDERGROUND ELECTRICAL

- A. Locating and Protecting Existing Utilities: Existing utilities in areas of new construction must be identified and located by the Contractor prior to commencing Work. Location of underground utilities shown on plans are diagrammatic and shall not be considered as a complete representation of all utilities that may exist on site.
  - 1. Coordinate with Owner to identify and locate existing underground utilities including landscape irrigation in areas of Work.
  - 2. Prior to excavation, contact and coordinate with local Utilities Underground Location Center to identify and locate existing underground public utility services in areas of Work, including power, water, sewer, telephone, gas, and cable TV.
  - 3. Prior to excavation, obtain services of a utility locator service to scan areas of Work and to locate and mark where known and unknown private underground utilities or other interfering obstructions exist.
  - 4. Existing active utilities damaged or interrupted by the Contractor during construction shall be replaced at the Contractor's expense. Repairs to power and signal systems using junction boxes or splices will not be accepted.
- B. Excavation and Backfill: Comply with requirements of Division 31.

### 3.18 LABELING

- A. Outlets: Identify panel and circuit number on faceplate of convenience and special purpose

outlets. Use self-adhesive, polyester or vinyl laminated labels with machine generated alpha-numeric circuit identification, 1/4 inch high black letters on clear background. Exception: Use white letters on black or brown color device plates.

- B. Junction Boxes: Label or mark cover with panel and circuit number. Locate on inside of cover except locate on outside of junction box cover in attics, crawl spaces, equipment rooms and above accessible ceilings.

### 3.19 TESTS

- A. Perform continuity test on all feeder and branch circuit conductors. Verify proper phasing and that no short circuits or accidental grounds exist.
- B. Check all convenience outlets for correct wiring connections using a polarity circuit tester. Test AFCI and GFCI circuits for proper operation with an approved tester.
- C. Torque test conductor lug terminations to manufacturers recommended values.

END OF SECTION



## PART 1 GENERAL

### 1.1 SECTION INCLUDES

- A. Power System Grounding.
- B. Electrical Equipment and Raceway Grounding.
- C. Communication and Distributed Antenna System Grounding.

### 1.2 SUBMITTALS

- A. Submit reports for tests required under Part 3 of this section.

### 1.3 OPERATIONS AND MAINTENANCE DATA

- A. Include data on testing procedures, obtained test values, and correction of deficiencies in the Operation and Maintenance Manuals.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Ground Rods: Copper-clad steel, 3/4-inch diameter, 10 feet long unless otherwise indicated.
- B. Mechanical Connectors at Accessible Ground Rods: Tin-plated, heavy duty, high strength, corrosion resistant copper alloy, hex head bolt and clamp.
- C. Mechanical Connectors at Ground Connections: Heavy duty, solderless, bolted pressure or compression type connectors or clamps labeled as being suitable for the purpose. Manufacturer's standard grounding lug when furnished as part of panelboards and other equipment.
- D. Exothermically Welded Connections: Copper Thermit weld process conforming to manufacturer's instructions; use molds, weld material, tools, and accessories supplied by the manufacturer. ERICO CADWELD or equal.
- E. Ground and Bonding Conductors: Bare, soft drawn copper; stranded for 8 AWG and larger, unless otherwise indicated or specified. Equipment grounding conductors may be insulated with green color identification per Code.
- F. Grounding Bus Bars: UL 467; 1/4-inch thick x 4 inch high tin plated copper bus with predrilled holes for bolted lug terminations, 2 inch high insulated spacers, and stainless steel standoff wall brackets. Provide 16 inch long with holes for (8) horizontal terminations unless otherwise indicated.
- G. Electro-Chemical Ground Rods: UL listed, electrolytic filled copper tube electrode, 8 foot minimum length, 50 year rate life. Provide with 10 inch diameter open bottom inspection handhole, Carson 910 or approved.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Ground electrical service system neutral per Code. Size grounding electrode conductor, main bonding jumper, equipment bonding jumpers, and supplemental electrode bonding connections per applicable paragraphs of NEC Article 250 except when larger size is shown or specified. Minimum of two (2) NEC 250.52 permitted grounding electrodes must be installed and shall include a concrete encased electrode where concrete building foundation is provided.
- B. Make grounding connections which are buried or otherwise inaccessible using exothermic welds. Where installed outdoors, bury ground conductors with minimum 18 inches of cover unless otherwise indicated.
- C. Driven Electrodes: Drive ground rods full depth unless otherwise indicated or specified. Provide 15 feet minimum separation between driven electrodes.
- D. Equipment Grounding Conductor: Provide separate insulated green equipment grounding conductor in feeders and in branch circuits. Provide equipment grounding conductor in non-metallic conduits and flexible conduit. Size equipment grounding conductors per NEC 250.122 unless larger size is shown or specified.
- E. Provide grounding locknuts on each end of feeder conduits serving panelboards. Exception: Provide grounding bushing with bonding jumper where conduit is used as equipment ground.
- F. Provide conduit sleeves where ground conductors pass through concrete slabs. Metal conduit sleeves shall have threaded end extending above slab to accommodate a grounding bushing or conduit hub per NEC 250.64(E).
- G. Provide minimum 1/0 AWG conductor for communications service grounding. Leave 10 feet slack conductor at terminal board. Connect conductor to building ground electrode system.
- H. Ground exposed non-current carrying metal parts of equipment fastened in place or connected by permanent wiring and likely to become energized per Code. In MDF and in IDF rooms, bond cable trays and equipment racks to terminal board ground bus using #6 minimum AWG conductor.
- I. Concrete Encased Electrode: Provide 20 feet minimum of bare copper conductor encased by at least 2 inches of concrete and located within and near bottom of concrete foundation or footing that is in direct contact with earth. Size electrode to match grounding electrode conductor or No. 4 AWG, whichever is larger. Provide 3/4-inch non-metallic conduit sleeve where conductor enters concrete foundation.
- J. Electro-Chemical Electrodes: Set in 6 inch diameter bored hole backfilled with bentonite clay. Provide ground well for inspection access. Provide 20 feet minimum separation from other electrodes.
- K. Grounding Bus Bars: Provide at building electrical service entrance and at all telecommunication terminal boards. Install 12 inches above floor unless otherwise indicated.
- L. Additional Electrodes: Where maximum resistance to ground is specified, provide additional

driven electrodes as needed to meet specified requirements or provide one electro-chemical ground rod set in 6 inch diameter bored hole backfilled with bentonite clay. Provide handhole for inspection access and 15 feet minimum separation from other electrodes.

### 3.2 ISOLATED GROUNDING SYSTEMS

- A. Provide a separate insulated grounding conductor, green with yellow stripe, and connected to ground only at service or separately derived power source.

### 3.3 SEPARATELY DERIVED SYSTEMS

- A. Ground secondary neutral and housing of all transformers and Uninterruptible Power Supply (UPS) per Code. Size grounding electrode conductor, bonding jumper, equipment bonding jumpers, and supplemental electrode bonding connections per applicable paragraphs of NEC Article 250 unless larger size is shown or specified. In addition, provide a driven ground electrode when indicated.
- B. Install grounding electrode conductor in 1 inch conduit between transformer and grounding electrode connection. Bond free end of conduit to grounding electrode conductor using grounding type bushing or hub.

### 3.4 ANTENNA SYSTEMS

- A. Provide equipment grounding per NEC and Emergency Responder Radio Antenna Repeater System Shop Drawings.

### 3.5 TESTS

- A. Service Entrance Ground Electrode System: ANSI/IEEE 81; measure and record ohmic value by performing fall of potential tests using a ground testing megger. Tests shall be performed with the ground electrode system disconnected/isolated from neutral and with the test current probe located at least 100 feet from the nearest ground system electrode.
- B. Separately Derived Systems: ANSI/IEEE 81; measure and record ohmic value of ground resistance between main grounding system and each separately derived transformer neutral point by performing two point method tests.
- C. Maximum Acceptable Resistance to Ground: 25 ohms.

END OF SECTION





## PART 1 GENERAL

### 1.1 SECTION INCLUDES

- A. Conduit sleeves, risers, and horizontal pathways and outlet rough-in for structured cabling and other low voltage systems to include lighting control, audio video (AV), television (TV), amplified sound, intrusion alarm, access control, video surveillance (CCTV), master clock, and intercom.
- B. Telecommunications Terminal Boards.

### 1.2 RELATED SECTIONS

- A. Section 260500 - Basic Materials and Methods.
- B. Section 260526 - Grounding and Bonding.
- C. Section 260920 - Lighting Controls.
- D. Section 271001 - Telecommunications Structured Cabling System.
- E. Section 274116 - Audio Video Integrated System.
- F. Section 275116 - Public Address System.
- G. Section 275123 - Integrated Electronic Communications and Clock Network.
- H. Section 281300 - Electronic Access Control.
- I. Section 281600 - Intrusion Alarm System.
- J. Section 282300 - Closed Circuit Television System.

## PART 2 PRODUCTS

### 2.1 OUTLETS

- A. Lighting Controls, Access Controls and Intrusion Alarm: 4-11/16-inch square x 2-1/8-inch deep outlet box with single gang plaster ring. Provide blank device plates on unused outlets. Provide multi-gang box and/or plaster ring where otherwise indicated on plans.
- B. Telecommunications Stations, CCTV: 5 inch square x 2-7/8-inch deep outlet box with single gang plaster ring. Provide blank device plates on unused outlets. Provide multi-gang box and/or plaster ring where otherwise indicated on plans. RANDL Industries Inc. or equal.
- C. Two-piece Surface Metal Raceway: Provide single gang or combination power/signal device mounting bracket and cover plate for indicated outlets as required. Provide blank device plate on unused outlets.

- D. Clocks and Speakers: Install specialty backboxes specified under related specification section(s).
- E. Audio-Visual Equipment: Legrand Evolution Series wall boxes with cover unless otherwise noted on drawings.

## 2.2 MATERIALS

- A. Boxes, Conduit, Raceway, Device Plates, Cable Tray: Comply with section 260500.
- B. Fire Rated Sleeves: Comply with section 260500.

## 2.3 TELECOMMUNICATIONS TERMINAL BOARDS

- A. 3/4-inch plywood mounting board with Class A fireproofing, locations and size as indicated. Paint white with two (2) coats of fire retardant paint. At least one fire retardant stamp or permanent label shall be visible on each sheet of plywood.

# PART 3 EXECUTION

## 3.1 INSTALLATION

- A. General: Comply with Section 260500.
- B. Outlets:
  - 1. Mounting height unless otherwise directed: See Drawings.
  - 2. Do not install signal outlets on same side of wall stud common with electrical outlets or vertical power wiring.
  - 3. Raceway: Comply with requirements of Section 260500. Unless otherwise indicated, provide conduit concealed inside wall or casework from each outlet up to nearest accessible ceiling space of same floor or homerun under floor to nearest terminal. Where construction does not permit concealed raceway, utilize surface metal raceway. Terminate conduit with plastic bushing. Install maximum two 90 degree equivalent bends between raceway terminations. Minimum conduit sizes unless otherwise indicated:

Cat 6 and 6A Network Cabling	1.25 inch diameter
AV	2 inch diameter
IP Intercom/Clock	1 inch diameter
All Other Systems	0.75 inch diameter
- C. Clock and Speaker Enclosures: Comply with requirements of Section 275313. Unless otherwise indicated, provide 1/2 inch conduit concealed from each backbox to nearest accessible ceiling space of same floor. Terminate conduit with plastic bushing. Provide conduit nipple with bushing for boxes installed in accessible ceiling tiles.
- D. Risers and Horizontal Pathway: Provide conduit for signal pathway between floors and as otherwise indicated. At MDF, IDF's, and equipment head ends, tag or otherwise label with permanent marker each conduit termination to identify its destination.
- E. Install nylon pull cord in each conduit longer than 20 feet. Leave 18 inches of slack minimum

each end. Tag end of pull cord at conduit termination to identify outlet location at other end.

- F. Sleeves: Provide conduit sleeves for installing open signal cables through draft stops and partition walls in attics, crawl spaces, and accessible ceiling spaces. Use specified fire rated sleeves through fire rated construction. Locate and size sleeves per approved shop drawings provided under related sections and as otherwise indicated.
- G. Device Plates: It is the electrical contractor's responsibility to ensure that all line voltage and low voltage system faceplates and visible trim pieces are the same style and finish.
- H. Electronic Door Hardware: Review door frame shop drawings. Conceal cabling within door frames where possible. If framing does not permit concealed installation, provide brushed aluminum raceway. Review rough-in with Architect for all doors prior to installation.

END OF SECTION



## PART 1 GENERAL

### 1.1 SECTION INCLUDES

- A. Electrical Service Requirements.
- B. Telephone Service Requirements.
- C. Wide Area Network Fiber Service Requirements.

### 1.2 REGULATORY REQUIREMENTS AND COORDINATION

- A. Contact and coordinate with Cowlitz County PUD regarding electrical service requirements, including entrance fittings, meter enclosures and socket arrangement, and current transformer provisions. Coordinate with Cowlitz County PUD regarding removal of existing equipment.
- B. Existing telephone service to be extended from existing location to new MDF Room, relocate existing utility equipment. Coordinate with School District personnel and Utility.
- C. Existing fiber service to be extended from existing location to new MDF Room, relocate existing utility equipment. Coordinate with School District personnel and Utility.
- D. Obtain, prepare, and file application forms required by the serving utilities for obtaining temporary and permanent services.
- E. Do not install any equipment or service entrance rough-in prior to contact, coordination, and obtaining all requirements from the applicable serving utilities.
- F. Protect existing utilities during construction.

### 1.3 UTILITY CHARGES

- A. Utility company charges for installing power service shall be paid by the Owner and are not included in the Contract.

## PART 2 PRODUCTS

### 2.1 MATERIALS AND EQUIPMENT

- A. Materials and Equipment: Conform to requirements of the Utility companies.
- B. Raceway: Schedule 40 PVC below grade; rigid galvanized steel for sweeps, risers, and for conduit above grade.
- C. Telephone Terminal: 48" wide x 72" high x 3/4" plywood painted with class A fireproofing, unless otherwise indicated.
- D. Fiber Terminal: 48" wide x 72" high x 3/4" plywood painted with class A fireproofing, unless otherwise indicated.

- E. Utility Raceway: Existing to remain.
- F. Pull Rope: 1/4-inch polypropylene.

### PART 3 EXECUTION

#### 3.1 INSTALLATION, ELECTRICAL SERVICE

- A. Make arrangements with Utility Company to obtain permanent electrical service to the Project. Coordinate and arrange for scheduling of Utility Work.
- B. Installation: Comply with Utility Company rules, regulations, and installation requirements.
- C. Maintain minimum 7.5 inch on center spacing between underground parallel electrical service conduits. Install conduits for electrical service rate above 600 volts with 36 inches minimum cover.
- D. Where utilities share common trench or routing, maintain minimum 12 inch clear separation between power and other utility systems.
- E. Provide meter bases, metering conduit, current transformer (CT) enclosure, and service entrance conduit with pull string. Conductors between CT and transformer to be installed by Utility.
- F. Install current transformers (CT's) furnished by Utility.
- G. Provide excavation, trenching, and backfill for utility company transformer vault and primary service conduits from transformer location to new Main Distribution Equipment location. Provide trench width and depth per Utility requirements. Exact routing of primary service conduits shall be determined by the Utility. Quantity and location of junction and pull vaults shall be determined by the Utility. Obtain written approval from Utility prior to commencing Work.

#### 3.2 INSTALLATION, TELEPHONE SERVICE

- A. Existing to remain and be extended to new location, protect within building and site. Locate underground utilities, pot hole as required to confirm depth.

#### 3.3 INSTALLATION, WIDE AREA NETWORK FIBER SERVICE

- A. Existing to remain and be extended to new location, protect within building and site. Locate underground utilities, pot hole as required to confirm depth.

END OF SECTION

## ELECTRICAL COMMISSIONING

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. The purpose of this section is to describe the commissioning process specific for those sections found in Division 26.

#### 1.2 ADMINISTRATIVE REQUIREMENTS

- A. General Responsibilities: The Contractor's commissioning responsibilities applicable to each of the electrical contractor is as follows (all references apply to commissioned equipment only):
  - 1. In each purchase order or subcontract written, include requirements for submittal data, commissioning documentation, O&M data and training.
  - 2. Attend a commissioning kick-off meeting and other meetings necessary to facilitate the Commissioning process.
  - 3. Contractors shall assist in clarifying the installation, operation, maintenance, and control of commissioned equipment if requested by the Commissioning Authority.
- B. COORDINATION
  - 1. Refer to Section 01 91 00 for a listing of all sections where commissioning requirements are found, for systems to be commissioned and for Pre-verification testing requirements.

#### 1.3 SUBMITTALS

- A. General Submittals: Contractor shall provide to the Commissioning Authority, through established channels, normal cut sheets and shop drawing submittals, and manufacturer's installation and start-up checklists, for all commissioned equipment.
- B. Provide assistance to the Commissioning Authority in preparation of the specific functional performance test procedures specified in Section 019100. Subcontractors shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.

### PART 2 PRODUCTS

Not Used

### PART 3 EXECUTION

#### 3.1 STARTUP

- A. General Requirements:

1. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
- B. Electrical Contractor:
  1. The electrical contractors shall follow the Project start-up plan outlined in 019100. Division 26 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the commissioning authority or Owner.
- 3.2 Pre-Verification Testing (PVT): The Contractor will perform the Pre-verification tests as provided with the Facility Grid app. When all pre-verification testing has been completed, the CA will schedule Functional Performance testing and substantial completion may be issued.
- 3.3 Functional Performance Testing:
  - A. Functional Performance testing is intended to begin upon completion of a system. Functional Performance testing may proceed prior to the completion of systems or sub-systems at the discretion of the Owner's Representative and Commissioning Authority. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all construction checklists and Pre-verification tests as soon as possible.
- 3.4 Deferred Testing
  - A. Assist with seasonal or deferred functional performance testing as needed.
  - B. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.
- 3.5 OPERATIONS AND MAINTENANCE (O&M) MANUALS
  - A. Division 26 shall compile and prepare documentation for all equipment and systems covered in Division 26 and deliver to the Contractor for inclusion in the O&M manuals, according to Division 1. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
  - B. During construction, maintain as built redline drawings for all drawings and final as-built for contractor-generated coordination drawings. Update after completion of commissioning (excluding deferred testing). Prepare redline as-built drawings for all drawings and final as-built for contractor-generated coordination drawings.
  - C. The Commissioning Authority shall receive a copy of the O&M manuals for review and approval.
- 3.6 Training
  - A. The Owner personnel shall be trained on procedures related those listed for Division 26.



1. Provide Training checklists for each session and specification section and/or subject.
2. Prerequisites and Agenda must be complete before training can begin.
  - a. Training shall start with classroom sessions, if necessary, followed by hands on training on each component, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
  - b. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
  - c. The appropriate trade or manufacturer's representative shall provide the instructions on each major component. This person may be the start-up technician for the component, the installing contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific component is required. More than one party may be required to execute the training.
  - d. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
2. Training shall include:
  - a. Use the printed installation, operation and maintenance instruction material included in the O&M manuals.
  - b. Include a review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance; special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shutdown, seasonal changeover and any emergency procedures.
  - c. Discuss relevant health and safety issues and concerns.
  - d. Discuss warranties and guarantees.
  - e. Cover common troubleshooting problems and solutions.
  - f. Explain information included in the O&M manuals and the location of all plans and manuals in the facility.
  - g. Discuss any peculiarities of equipment installation or operation.
  - h. Classroom sessions shall include the use of overhead projections, slides, video and audio taped material as might be appropriate.
  - i. Hands-on training shall include start-up, operation in all modes possible, including manual, shutdown and any emergency procedures and maintenance of all pieces of equipment.

- j. Training shall occur after functional testing is complete, unless approved otherwise by the Owner's Representative and Commissioning Authority.
  - k. Deferred training will follow the same outline as above.
3. Duration of Training: The appropriate contractor shall provide training on each component as required in the main specifications. The electrical contractor shall have the following training responsibilities:
- a. Provide the Owner's Representative and Commissioning Authority with a training plan and training checklists two weeks before the planned training according to the outline described in Division 1.
  - b. Provide designated Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned electrical equipment or system.
  - c. The electrical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls.

### 3.7 DOCUMENTS REQUIRED

- A. The General Contractor will provide the following documentation before Final Acceptance:
- 1. Completed Inspection Forms with approval signatures of all Authority Having Jurisdiction.
  - 2. Approval Signature of Electrical Engineer

END OF SECTION

## PART 1 GENERAL

### 1.1 SCOPE OF WORK

- A. Commissioning of lighting and lighting control systems, electric metering for compliance with the Energy Code and contract documents. Work includes sequencing and scheduling, pre-function checks, functional performance testing, and documentation.
- B. Comply with additional requirements of Section 019100 - Commissioning.

### 1.2 RELATED SECTIONS

- A. Section 019100 - Commissioning.
- B. Section 250800 - Commissioning of Integrated Automation.

### 1.3 DESCRIPTION OF LIGHTING CONTROLS

- A. The lighting system is designed to be in compliance with the 2018 Washington State Non-Residential Energy Code and WAC 246-366—120 Minimum Foot-Candle Intensity for Schools.
  - 1. Daylight harvesting systems shall not automatically reduce light levels below minimum foot candle requirements listed in the WAC when measured 30 inches above the floor.

General Instructional Areas including Libraries	30 FC
Special Instructional Areas – Labs, Art, Shops, Sewing	50 FC
Kitchen Areas including Storage and Prep	30 FC
Non-Instructional Areas including Cafeteria, Corridors, Stairs, Assembly, Toilet Rooms, and Storage	10 FC
Gymnasiums, Locker Rooms and Shower Areas	20 FC
- B. Intent of the Lighting Control Systems:
  - 1. Individual Offices, Classrooms, Conference Rooms or Break Rooms: Lights are to be turned on manually with occupancy sensor control to turn lights off automatically after a period of 30 minutes. Daylight harvesting systems controlling primary and secondary zones will automatically dim fixtures in response to natural light when light levels reach approximately 150% of design (initially 80 FC / 800 lux unless otherwise indicated).
  - 2. Individual Toilet Rooms or Storage Rooms without Daylight: Lights are to be turned on manually with occupancy sensor control to turn lights off automatically after a period of 15 minutes.
  - 3. Means of Egress Corridors and Stairways: Lights are to be turned on manually with low voltage lighting control system to turn lights off automatically on set time schedule. Manual controls to be located as indicated on drawings. Manual override of timeclock scheduled automatic off to be set to a maximum of two hours. Daylight harvesting systems controlling primary and secondary zones will automatically dim fixtures in response to natural light when light levels reach approximately 200% of design (initially 30 FC / 300 lux unless otherwise indicated).
  - 4. Libraries: Lights are to be turned on manually with low voltage lighting control system to turn lights off automatically on set time schedule. Manual controls to be located as indicated on drawings. Manual override of timeclock scheduled automatic off to be set

to a maximum of two hours. Daylight harvesting systems controlling primary and secondary zones will automatically dim fixtures in response to natural light when light levels reach approximately 200% of design (initially 100 FC / 1000 lux unless otherwise indicated).

5. Gymnasiums: Lights are to be turned on manually with low voltage lighting control system to turn lights off automatically on set time schedule. At a minimum fixtures will be capable of multiple light levels to allow for cleaning without turning on all fixtures. Manual controls to be located as indicated on drawings. Manual override of timeclock scheduled automatic off to be set to a maximum of two hours. Daylight harvesting systems controlling primary and secondary zones will automatically dim fixtures in response to natural light when light levels reach approximately 200% of design (initially 120 FC / 1200 lux unless otherwise indicated).
6. Commons: Lights are to be turned on manually with low voltage lighting control system to turn lights off automatically on set time schedule. Manual controls to be located as indicated on drawings. Manual override of timeclock scheduled automatic off to be set to a maximum of two hours. Daylight harvesting systems controlling primary and secondary zones will automatically dim fixtures in response to natural light when light levels reach approximately 150% of design (initially 80 FC / 800 lux unless otherwise indicated).
7. Locker Rooms: Lights are to be turned on manually with low voltage lighting control system to turn lights off automatically on set time schedule. Manual controls to be located as indicated on drawings. Manual override of timeclock scheduled automatic off to be set to a maximum of two hours. Daylight harvesting systems controlling primary and secondary zones will automatically dim fixtures in response to natural light when light levels reach approximately 150% of design (initially 80 FC / 800 lux unless otherwise indicated).
8. Kitchens: Lights are to be turned on manually with low voltage lighting control system to turn lights off automatically on set time schedule. Manual controls to be located as indicated on drawings. Manual override of timeclock scheduled automatic off to be set to a maximum of two hours. Daylight harvesting systems controlling primary and secondary zones will automatically dim fixtures in response to natural light when light levels reach approximately 200% of design (initially 100 FC / 1000 lux unless otherwise indicated).
9. Public Restrooms with More Than One Stall: Lights are to be turned on and off by occupancy sensor with 30 minute time delay set to maximum sensitivity with manual switch to enable occupancy sensor located as indicated on drawings. Daylight harvesting systems controlling primary and secondary zones will automatically dim fixtures in response to natural light when light levels reach approximately 200% of design (initially 50 FC / 500 lux unless otherwise indicated).
10. Electrical Rooms and Mechanical Rooms: Local switch with manual on and manual off.
11. Emergency Egress Lighting: Controls shall be in place to override all automatic dimming and turn fixtures on emergency circuits to full brightness.
12. Exterior Lighting: Combination of time clock, occupancy sensor bi-level control and astronomic time clock input to control lights.

#### 1.4 SUBMITTALS

- A. General: Comply with requirements of Division 01.
- B. Preliminary Commissioning Report: Provide a commissioning plan with narrative

description of activities and the personnel tasked for each, required test equipment, measurable performance criteria, and functions to be tested. The report shall include all functional test documentation, and shall identify uncorrected deficiencies, functional tests that have been deferred, and a proposed date for completion. Maintain onsite a copy of the Preliminary Commissioning Report and make available to the Building Official and Owner.

- C. Commissioning Compliance Checklist (reference figure C408.1.2.1 of the Washington State Energy Code): Prepared and submit after submission of the Preliminary Commissioning Report and at least one week prior to final inspection.
- D. Final Commissioning Report and Closeout Documents: Amend Preliminary Commissioning Report to include commissioning plan revisions, if any, action taken to address deficiencies, and all final documentation of commissioning activities. The final Commissioning Report, Record Documents, and Operations and Maintenance Manuals must be turned over to the Owner within 90 days of the receipt of certificate of occupancy.

## 1.5 QUALIFICATIONS

- A. Commissioning Agent shall be a third party, independent and separate from the company installing the systems to be commissioned.
- B. Commissioning Agent shall have three (3) years experience with commissioning lighting and lighting control systems and be certified by the Building Commissioning Association or the AABC Commissioning Group.

## 1.6 COMMISSIONING TEAM

- A. General Contractor: Shall be responsible to review and verify sub-contractor's commissioning activities, participate in commissioning meetings, maintain and update the schedules, prepare Commissioning Compliance Checklist, and deliver required submittals.
- B. Electrical Contractor: Shall work with General Contractor to establish commissioning schedule, participate in commissioning meetings, arrange for required product manufacturer involvement, perform and document pre-functional checks and functional checks, complete commissioning checklists, prepare Record Documents and Operation & Maintenance Manuals, and provide Owner training.
- C. Product Manufacturer's Representative: Shall provide assistance for installation, programming, startup, troubleshooting, and Owner training.
- D. Design Engineer: Participate in commissioning meetings when requested, review and approve submittals, provide assistance to the Commissioning Agent in understanding design intent.
- E. Commissioning Agent: Prepare and submit preliminary and final Commissioning Reports, furnish commissioning checklists, schedule necessary meetings, witness all functional testing or otherwise perform independent functional testing (spot checking) in 10% or more of spaces and on time control systems, review and approve functional test documentation, Operations and Maintenance Manuals, and record documents, verify function of the installed lighting control systems meet design intent, verify Owner training has occurred, verify that all final submittal documentation is turned over to the Owner, and participate in follow-up review of system operation.

- F. Owner: Participate in commissioning meetings, approve lighting system control sequences and provide time schedules for programming of time controllers, review Preliminary Commissioning Report, participate in training and follow-up review of system operation, receive all closeout documentation.

## 1.7 SEQUENCING AND SCHEDULING

- A. Perform pre-function checks after each system to be commissioned is substantially complete.
- B. Perform functional testing after pre-function checks and room finishes are completed.
- C. Perform Owner training after functional performance testing is complete.
- D. Perform functional performance back check within one year after substantial completion.

## 1.8 COMMISSIONING MEETINGS

- A. All members of the Commissioning Team shall attend and participate in a pre-commissioning conference to be held prior to the Contractor beginning any commissioning work. The conference shall occur after all submittals have been satisfactorily reviewed by the Architect/Engineer and returned to the Contractor, and approximately 30 days prior to pre-function checks, unless otherwise required under Section 019100. The purpose of this conference is to review the commissioning plan, checklists, schedule, requirements for coordination with other trades, and related construction/design issues to allow for efficient and proper commissioning.
- B. Members of the Commissioning Team shall attend and participate in additional commissioning meetings as specified under Section 019100.

## PART 2 PRODUCTS

### 2.1 TEST EQUIPMENT

- A. Test equipment for electrical systems testing shall be provided under Division 26 as necessary for all start-up, testing, adjusting, and commissioning of the electrical equipment.
- B. Light meters and multi-meters shall be digital type calibrated on the manufacturer's recommended intervals with calibration tags affixed to the instrument. In absence of calibration tags, calibration documentation shall be submitted to the Commissioning Agent 30 days prior to use. Documentation shall include description and serial number of instrument, calibration data and date submitted.
- C. Furnish proprietary equipment and additional testing devices and material as needed or recommended by system product manufacturer for startup, programming, and to perform required tests.

## PART 3 EXECUTION

### 3.1 CHECKLISTS

- A. Checklists shall be prepared for each room and automatic time control system. Each checklist shall be completed, dated, certified by the person performing the commissioning activity, and included as part of the preliminary and final commissioning reports.
- B. Checklists in the Appendix of this section may be used for the commissioning work unless approved alternative checklists are provided by the Commissioning Agent.

### 3.2 PRE-FUNCTION CHECKS

- A. Perform pre-function checks using applicable checklist provided. Correct deficiencies discovered in accordance with the applicable contract requirements.
- B. Provide all equipment, materials, services, and labor required to perform the pre-function checks.

### 3.3 FUNCTIONAL PERFORMANCE TESTING

- A. Perform performance tests using applicable checklists provided. Functional performance tests shall begin after all pre-function checks have been completed. Tests shall prove all modes of the sequences of operation, and shall verify all other relevant contract requirements. Tests shall begin with equipment or components and shall progress through subsystems to complete systems. Upon failure of any functional performance test checklist item, the Contractor shall correct all deficiencies in accordance with the applicable contract requirements. The checklist shall then be repeated until it has been completed with no errors.
- B. Provide all equipment, materials, services, and labor required to perform the function checks and follow up spot check activities.
- C. Occupancy Sensor Testing Procedures:
  - 1. Use manual switch to turn lights on.
  - 2. Set sensor for Test mode. Follow product manufacturer recommended checkout/adjust procedure. Set sensor to User mode after completion of testing.
- D. Time Switch and Low Voltage Lighting Control Panel Time Controller Testing Procedures:
  - 1. Set time to turn lights on and verify occurrence.
  - 2. Set time to turn lights off and verify occurrence.
  - 3. In spaces set for “flick warn” feature, set override time to 15 minutes and verify lights flicker as required, manually override lights to stay on and that lights turn off within 15 minutes.
- E. Low Voltage Lighting Control Panel Low Voltage Switch Testing Procedures:
  - 1. Verify that device address descriptions match device type, location description, circuit assignments, and control assignments as shown on approved shop drawings and contract supplemental instructions.
  - 2. Verify each switch controls lights as indicated on Shop Drawing.
  - 3. Where switches are programmed as “on” only, verify lights cannot be manually turned off.
  - 4. Verify switch programming and identification is labeled, matches approved Shop Drawing, and is correctly identified in programming.
- F. Automatic Daylight Control System Testing Procedures:
  - 1. Shine an incandescent or fluorescent light source directly onto the sensor for at least

30-40 seconds. The lights connected to the sensor should begin to dim.

2. If they do not dim, they may already be at the dimmed level because of available daylight. Cover the sensor for 30-40 seconds. The lights should become brighter.
  3. If the lights do not dim or brighten, check the sensor's wiring, verify that it is receiving sufficient voltage, and consult the manufacturer for guidance.
  4. During daylight hours, window coverings may be used in lieu artificial light source for testing.
- G. Electric Meter Testing Procedures:
1. Obtain documentation of factory startup for each customer meter.
  2. Cycle through each meter function and verify value is displayed.
  3. Verify remote monitoring of functions by Owner's energy management system (EMS).

### 3.4 SPOT CHECKING

- A. The Commissioning Agent, Design Engineer, and/or Owner Representative may participate in the commissioning process on a spot-check basis during the commissioning work. Contractor shall arrange mutually agreeable times to demonstrate and assist in performing spot checks. Items found not complete or not as represented by Commissioning Reports shall be corrected at the Contractor's expense, including costs for the Commissioning Agent, Design Engineer, and/or Owner's Representative to re-check the commissioning work.



APPENDIX A

**ROOM CONTROL PRE-FUNCTIONAL CHECKLIST**

**Electrical Contractor to complete and submit checklist prior to scheduling of functional testing.**

Space Description:	Room #:	Date:	
		Complete	N / A
Light fixtures wired and installed		<input type="checkbox"/>	<input type="checkbox"/>
Manual switches installed		<input type="checkbox"/>	<input type="checkbox"/>
Manual switches labeled		<input type="checkbox"/>	<input type="checkbox"/>
Occupancy sensor(s) installed for maximum coverage		<input type="checkbox"/>	<input type="checkbox"/>
Occupancy sensor(s) installed so coverage does not extend into adjacent spaces		<input type="checkbox"/>	<input type="checkbox"/>
Occupancy sensor(s) at least 6 feet from air diffusers		<input type="checkbox"/>	<input type="checkbox"/>
Occupancy sensor initial sensitivity set if not self adapting		<input type="checkbox"/>	<input type="checkbox"/>
Occupancy sensor initial time delay set if not self adapting		<input type="checkbox"/>	<input type="checkbox"/>
Daylight sensor(s) located per manufacturer directions		<input type="checkbox"/>	<input type="checkbox"/>
Daylight sensor(s) aimed per manufacturer directions		<input type="checkbox"/>	<input type="checkbox"/>
Daylight sensor(s) initial calibration set		<input type="checkbox"/>	<input type="checkbox"/>
Daylight sensor furnished programming and calibration device(s) is available		<input type="checkbox"/>	<input type="checkbox"/>
Automatic time switch installed and programmed		<input type="checkbox"/>	<input type="checkbox"/>
Room finishes complete (ceilings, flooring, paint, wall coverings)		<input type="checkbox"/>	<input type="checkbox"/>
Window coverings installed		<input type="checkbox"/>	<input type="checkbox"/>
Horizontal and vertical glazing cleaned		<input type="checkbox"/>	<input type="checkbox"/>
Light shelf installed		<input type="checkbox"/>	<input type="checkbox"/>
Normal power on		<input type="checkbox"/>	<input type="checkbox"/>
Emergency power available		<input type="checkbox"/>	<input type="checkbox"/>
HVAC air balancing completed		<input type="checkbox"/>	<input type="checkbox"/>
Other observations:			
Signatures			
Checks Completed & Submitted By (E):		Verified By (C):	
_____		_____	
Name		Name	
Date		Date	
Reviewed & Accepted By (G):		Reviewed & Accepted By (D):	
_____		_____	
Name		Name	
Date		Date	

**LEGEND:**

N/A – Not Applicable

E – Electrical Contractor

G – General Contractor

C – Commissioning Agent

D – Design Team Representative

APPENDIX A

**ROOM CONTROL FUNCTIONAL CHECKLIST**

Space Description:	Room #:	Date:	
		Complete	N / A
<b>MANUAL CONTROL</b>			
Verify ON/OFF each switch per circuit/zone		<input type="checkbox"/>	<input type="checkbox"/>
Verify manual dim function each switch per circuit/zone		<input type="checkbox"/>	<input type="checkbox"/>
<b>OCCUPANCY SENSOR CONTROL</b>			
Sensor type: <input type="checkbox"/> PIR <input type="checkbox"/> Ultrasonic <input type="checkbox"/> Dual Technology		<input type="checkbox"/>	<input type="checkbox"/>
Sensor ON setting: <input type="checkbox"/> Manual <input type="checkbox"/> Automatic		<input type="checkbox"/>	<input type="checkbox"/>
Verify sensor LEDs function		<input type="checkbox"/>	<input type="checkbox"/>
Verify sensor control function		<input type="checkbox"/>	<input type="checkbox"/>
Verify sensor coverage adequate		<input type="checkbox"/>	<input type="checkbox"/>
Verify sensor coverage does not extend into adjacent spaces		<input type="checkbox"/>	<input type="checkbox"/>
Time delay setting: <input type="checkbox"/> Manual <input type="checkbox"/> Self Adapting		<input type="checkbox"/>	<input type="checkbox"/>
Verify sensor time delay function		<input type="checkbox"/>	<input type="checkbox"/>
Indicated final time delay setting if not self adapting: _____ Minutes		<input type="checkbox"/>	<input type="checkbox"/>
<b>TIME SWITCH CONTROL</b>			
Verify lighting control function		<input type="checkbox"/>	<input type="checkbox"/>
Record relay panel circuit: Panel: _____ Circuit No.: _____		<input type="checkbox"/>	<input type="checkbox"/>
Record time switch control group: _____		<input type="checkbox"/>	<input type="checkbox"/>
Record time switch circuit: _____		<input type="checkbox"/>	<input type="checkbox"/>
<b>AUTOMATIC DAYLIGHT CONTROL</b>			
Sensor type: <input type="checkbox"/> Open Loop <input type="checkbox"/> Closed Loop <input type="checkbox"/> Hybrid		<input type="checkbox"/>	<input type="checkbox"/>
Verify primary and secondary zone response		<input type="checkbox"/>	<input type="checkbox"/>
Verify lights outside of daylight zones do not dim		<input type="checkbox"/>	<input type="checkbox"/>
Verify emergency lights are full on upon loss of normal power		<input type="checkbox"/>	<input type="checkbox"/>
Record foot candle level with window coverings full open: _____ FC		<input type="checkbox"/>	<input type="checkbox"/>
Record foot candle level with window coverings 1/2 open: _____ FC		<input type="checkbox"/>	<input type="checkbox"/>
Record foot candle level with window coverings full closed: _____ FC		<input type="checkbox"/>	<input type="checkbox"/>
Other observations:			
Signatures			
Checks Completed & Submitted By (E): _____ Name Date	Verified By (C): _____ Name Date		
Reviewed & Accepted By (G): _____ Name Date	Reviewed & Accepted By (D): _____ Name Date		

**LEGEND:**

N/A – Not Applicable

E – Electrical Contractor

G – General Contractor

C – Commissioning Agent

D – Design Team Representative

APPENDIX A

**AUTOMATIC TIME SWITCH/CONTROLLER FUNCTIONAL CHECKLIST**

Lighting Control Panel Designation:		Date:	
		Complete	N / A
Time switch daily and holiday schedules programmed		<input type="checkbox"/>	<input type="checkbox"/>
Furnished field programming equipment is available		<input type="checkbox"/>	<input type="checkbox"/>
Program schedule sheets by control group and switched circuit are available		<input type="checkbox"/>	<input type="checkbox"/>
Time switch relays labeled		<input type="checkbox"/>	<input type="checkbox"/>
Relays function as scheduled		<input type="checkbox"/>	<input type="checkbox"/>
Flick warning functions as programmed		<input type="checkbox"/>	<input type="checkbox"/>
Local switches function as scheduled		<input type="checkbox"/>	<input type="checkbox"/>
Master switches function as scheduled		<input type="checkbox"/>	<input type="checkbox"/>
Manual override switches function as scheduled (2 hour maximum override)		<input type="checkbox"/>	<input type="checkbox"/>
Remote switch enable/disable feature functions as scheduled		<input type="checkbox"/>	<input type="checkbox"/>
Exterior building light circuit(s) function as scheduled		<input type="checkbox"/>	<input type="checkbox"/>
Exterior site lighting circuit(s) function as scheduled		<input type="checkbox"/>	<input type="checkbox"/>
Exterior sign lighting circuit(s) function as scheduled		<input type="checkbox"/>	<input type="checkbox"/>
Verify remote outdoor photosensor control function		<input type="checkbox"/>	<input type="checkbox"/>
Time switch backup power functions on loss of power		<input type="checkbox"/>	<input type="checkbox"/>
Other observations:			
<b>Signatures</b>			
Checks Completed & Submitted By (E):		Verified By (C):	
_____		_____	
Name		Name	
Date		Date	
Reviewed & Accepted By (G):		Reviewed & Accepted By (D):	
_____		_____	
Name		Name	
Date		Date	

**LEGEND:**

N/A – Not Applicable

E – Electrical Contractor

G – General Contractor

C – Commissioning Agent

D – Design Team Representative

END OF SECTION



## PART 1 GENERAL

### 1.1 SECTION INCLUDES

- A. Manual Controls.
- B. Occupancy Sensors.
- C. Time Switches.
- D. Low Voltage Control Panels.
- E. Daylight Sensors.
- F. Room Controllers.
- G. Emergency Transfer Devices.
- H. Factory Start-Up Requirements.

### 1.2 RELATED SECTIONS

- A. Section 255000 - Integrated Automation Facility Controls.
- B. Section 260800 - Commissioning of Lighting Systems.
- C. Section 265000 - Lighting Fixtures.

### 1.3 PREPARATION

- A. Prior to preparation of submittals, review documents and intended products with Engineer to ensure design intent and methods of achieving control requirements documented in Control Matrix.

### 1.4 INTENT

- A. Documents reflect control requirements but are not intended to reflect all features of the installed system and are not shop drawings. Lighting control system manufacturer to provide quantity of components required to achieve control indicated. Placement of all sensors to be based upon approved product literature.

### 1.5 SUBMITTALS

- A. Submit product data for all products and associated components specified under Part 2 of this section.
- B. Submit shop drawings showing control sequence, bill of material, and wiring or schematic diagrams for each type and variance of room lighting control system. Indicate by plan or instruction the best mounting and installation location for each occupancy and daylight sensor. For multi-room and networked control systems include additional shop drawings of

floor plans that show location of panels, system components, and interconnecting wiring. Wiring diagrams shall clarify field installed from factory installed wiring.

- C. Submit commissioning check list and testing procedures for approval prior to commissioning of automatic lighting control system(s).

## 1.6 OPERATION AND MAINTENANCE DATA

- A. Include submittal data, as-built shop drawings, installation and operating instructions, commissioning and test reports, and warranties that exceed one year in Operations and Maintenance Manuals.
- B. Submit Record Drawings of complete control system.
- C. Identify location of room controllers and UL 924 devices installed above accessible ceiling spaces with label on ceiling grid below.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Line Voltage Photocells: General Electric, Intermatic, Tork.
- B. Low Voltage Control Panels, Sensors and Switches: nLight, Douglas, Crestron.
- C. Digital Room Controllers, Sensors, and Wall Stations: nLight, Douglas, Crestron.

### 2.2 MANUAL CONTROLS

- A. Line Voltage Switches: Provide as specified under Section 260500 for wiring devices.
- B. Digital Wall Stations: Low voltage, local network, manual switch station with feed thru RJ45 ports, suitable for use with decora style wall plates. Provide On/Off, On/Off/Dim, and/or multi-pushbutton On/Off/Scene/Dim switch stations as indicated. Color: Match wiring devices specified under Section 260500.
- C. Switch Plates: Match material and finish of device plates specified in Section 260500.

### 2.3 OCCUPANCY SENSORS

- A. Room Sensors:
  - 1. Dual technology (ultrasonic/passive infrared) 24VDC occupancy detector, adjustable sensitivity and time delay, manual override, LED motion indicator, compatible with fluorescent electronic ballasts. Rated area coverage shall conform to manufacturer's recommendation for complete room coverage without gaps, using single or multiple sensors as required. Sensors may be wall or ceiling mounted type. Exception: In restrooms and toilets with privacy partitions or showers, provide ultrasonic type without passive infrared feature.
  - 2. Provide low temperature sensors (-4 degree F/-20 degree C) where installed in unheated spaces and in refrigerated spaces. Provide high humidity sensors where installed in damp locations, refrigerated spaces, and adjacent to shower stalls.

3. Wire Guard: Provide in public restrooms, gymnasiums, locker rooms, and similar areas where sensor may be subject to abuse.
- B. Transformer/Relay Pack: 120/277 volt control interface providing NEC class 2 input/output to occupancy sensor(s) and automatic line voltage switch control. Relay contacts shall be isolated, normally open, rated 20 amperes for ballast loads and 1 HP. Provide auxiliary isolated dry contact set to allow for air temperature control (ATC) interface with the occupancy sensor control system; a slave relay may be provided for this purpose.
- C. Wall Switch Sensors:
  1. Passive infrared occupancy sensor, automatic OFF, manual ON/OFF, continuous self adapting sensitivity and time delay, LED motion indicator, compatible with magnetic ballast, electronic ballast, and motor loads, 170 degree minimum field of view. Minimum load rating shall be 600 VA and 1/6 HP at 120 volts and 1000 VA and 1/3 HP at 277 volts. Minimum rated area coverage shall be 900 square feet.
  2. Provide low temperature sensors (-4 degree F/-20 degree C) where installed outdoors, in unheated spaces, and in refrigerated spaces. Provide high humidity sensors where installed in damp locations, refrigerated spaces, and adjacent to shower stalls.
  3. Two Level Switching: Where indicated, provide wall switch sensor with independent dual switching control, user selectable for control of one or two switch legs to provide two levels of room illumination.
  4. Finish: Match wiring devices and plates specified under Section 260500.
- D. Outdoor Sensors: Digital passive infrared (PIR) occupancy sensor, outdoor rated (water tight, -41 to +160 degree F), 360 degree coverage, line voltage On/Off control, 0-10VDC output for dimming, integrated photo sensor, suitable for control of fluorescent, HID, and LED light fixtures, suitable for low and high mounting up to 30 feet above grade, with chase nipple for mounting to outlet box, light fixture, or pole, housing color as selected.

## 2.4 LOW VOLTAGE CONTROL PANELS

- A. Transformers: ANSI/NFPA 70; Class 2 energy limited, 120/277: 15-24 volt, sized for load.
- B. Low Voltage Relays: Mechanical or magnetic latching remote control relays rated 20 amperes at 120/277 volts and suitable for HID lighting. Shall have isolated pilot contacts where required.
- C. Master Controllers: Solid state device allowing group control of more than 3 relays by a momentary and/or maintained contact input from manual switch, photo controller, time controller, or time switch. Installed configuration shall have 20% minimum spare relay capacity. Separate modules may be used for momentary and maintained contact switch control. Include programmable enable/disable of any relay function, and flick warn option with off sweep 2 hour override enabled from local or master switch control during 5 minute warning period. Provide with RS485 networking between controls panels within a building. Provide RS232 port and ethernet interface module and associated software for local and remote PC programming, control, and troubleshooting. Provide modem for offsite factory trouble shooting and programming over a standard telephone connection when this support service available from the system manufacturer.
- D. Photo/Time Controllers: Programmable solid state 365 day astronomic time/photo controller, membrane key pad entry with LCD graphic display, 8 time/photo control programmable

outputs, remote photo sensor input, indefinite program and 72 hour minimum time backup on power loss, 600 events per week with week day and holiday scheduling. Any output can be time, astronomic, photo or combination controlled.

- E. Photo Controllers: Solid state device for operating relays and/or auxiliary contacts to control remote master controllers using a remote low voltage photo sensor. An override input shall allow a remote switch or time clock to enable or disable the photo control function.
- F. Relay Control Cabinets: NEMA ICS6 Type 1; shop fabricated and wired sheet metal box with screw on flush cover, side hinged flush locking door, and painted enamel finish. Assembly shall include labeled terminal blocks, line voltage - low voltage separation barriers, mounting provisions for 20% or more additional relay and associated transformer capacity, and removable circuit index card inside protective pocket on inside of front cover. Key all relay cabinets alike. Furnish two keys. Cabinets shall be flush mounted where indicated.
- G. Flush Switch Cabinets: NEMA ICS6 Type 1; shop fabricated sheet metal box with screw on flush cover, side hinged flush locking door, and painted enamel finish. Keys shall match relay cabinets. Size cabinets to accommodate switch layouts indicated.
- H. Remote Time Controllers: Programmable solid state 365 day, 600 events per week with week day and holiday scheduling, provided under Division 25, Integrated Automation. Provide master controller that accepts both remote momentary and maintained timed inputs. Allow for 8 time control groups minimum.

## 2.5 DAYLIGHT SENSORS

- A. Indoor Digital Daylight Sensors: Multi-zone photo sensor with RJ45 network connection, infrared (IR) transceiver for calibration using a handheld remote programmer, and suitable for semi-flush ceiling mount or for surface mounting in skylight wells. Sensor measures room daylight contribution and communicates with a compatible room controller to automatically dim or switch up to three separate zones of lighting, raising and lowering light fixture illumination in response to available daylight.
- B. Low Voltage Photo Sensors, Outdoors: Weather proof, water tight sensor head suitable for outdoor mounting to an outlet box, auto ranging 1 to 10,000 FC, + or - 5%, compatible with control panel controller for off-day/on-night operation of outdoor light fixtures.
- C. Line Voltage Photocell: Weatherproof, off-day/on-night, 2000 watt tungsten rated, SPST with time delay, adjustable 2-50 footcandles.
- D. Line Voltage Photocell, Flush Mounted: Weatherproof, off-day/on-night, button type, thermal relay, 1000 watt, SPST, with stainless steel cover plate and gasket.

## 2.6 DIGITAL ROOM CONTROLLERS

- A. General: UL listed low voltage network lighting and power controller, 120/277 volt, 20 ampere rated, three (3) on/off relay outputs, four (4) minimum RJ45 digital input/outputs.
- B. Dimming: Where manual and/or automatic daylight control is indicated, provide three (3) 0-10Volt DC Class 2 dimming control outputs. Controls shall be configured to completely shut off all controlled lights in the control zone.



- C. On/Off Receptacle Load Control: Where automatic switch control of receptacles is indicated, provide a UL listed low voltage network 20 ampere plug load rated standalone controller and/or wireless transmitter in combination with approved wireless receptacles.
- D. Sensors, Devices, and Accessories: Provide compatible sensors, wall stations, interface device, and cabling for a complete control system.
- E. Emergency Lighting: Controllers with dimming control shall be programmed or otherwise designed to ensure 100% full light output of controlled dimmable emergency lights upon loss of normal power.
- F. Provide hand held wireless configuration device for remote programming of system sensor, control, and dimming functions. Furnish two (2) hand held devices.
- G. Provide required software and PC USB interface device for programming and managing the digital lighting control system using a personal computer.

## 2.7 EMERGENCY TRANSFER DEVICES

- A. Integral with Light Fixture: Emergency transfer devices installed in light fixtures are specified under Section 265000, Light Fixtures.
- B. Remote Emergency Lighting Transfer Relay: UL 924, 120/277 volt, 20 amp rated, integral test switch, LED power status indication, fail safe emergency power ON upon loss of normal power.
- C. Integral with Digital Room Controller: UL 924, 120/277 Volt, 3 amps minimum; provide emergency relay and control to automatically power ON designated emergency light fixture(s) at full brightness upon loss of normal power.

## 2.8 MATERIALS

- A. Low Voltage Wire: UL Type CL2, NEC Class 2 or better; multi-conductor, stranded copper cable, #20 AWG minimum, color coded.
- B. RS 485 Communications and Digital Control: UL type CMR, Category 5 extended frequency (350MHz), 24 AWG solid copper, 4-pair unshielded twisted pair, jacket overall, color coded. Cable installed below grade shall have a water blocking core and be suitable for wet locations in conduit.
- C. Conduit and Outlet Boxes: As specified under Section 260500.
- D. Cable Supports: Molded nylon clamps, heavy duty nylon ties, or galvanized steel bridle rings; sized to match cables supported. Tyton, Brady, Burndy, or Thomas & Betts manufacture.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Install lighting controls in accordance with manufacturer's instructions and approved shop

drawings. Provide programming, setup, and calibration for complete operation of each control system.

- B. Install low voltage wiring in conduit except cable may be installed without conduit above accessible ceilings. Install open cable parallel and perpendicular to building lines; support cable from structure at intervals not to exceed 4.5 feet on center. Do not splice open cable.
- C. Provide labeling on ceiling tile to identify location of components installed above suspended acoustic ceilings.
- D. Provide permanent engraved nameplates at lighting control stations in Main Office, Library, Gym, Commons, Music Platform and other locations indicated on drawings.

### 3.2 OCCUPANCY SENSORS

- A. Room Sensors: Provide number and location required for complete coverage within room (including toilet and shower stalls) and to minimize false activation thru open doors as recommended by manufacturer. Ceiling mounted sensors shall not be used above 12 feet. Provide additional transformer/relays or room controllers as required where multiple branch circuits are controlled.
- B. On/Off Operation: Wall switches and occupancy sensors shall be wired or otherwise programmed to provide manual on, manual off, and automatic sensor off control of room lighting unless otherwise indicated.
- C. Time Delay: Set manual time delay for automatic off at 30 minutes unless otherwise directed or indicated.

### 3.3 TIME CONTROLS

- A. Provide initial and final programming and testing, scheduled at the convenience of the Owner. Arrange for an Owner representative to be present for each programming session. Coordinate time schedules and programming with Division 25 Contractor. Start up control sequence shall be as scheduled on drawings. Final control sequence shall be as directed by Owner.

### 3.4 LOW VOLTAGE CONTROL PANELS

- A. Provide typewritten circuit index in each relay cabinet identifying relay numbers, line voltage, circuit numbers, loads controlled, and master/local/special sensor switch control information.
- B. Arrange with Division 271001 contractor to provide Ethernet connections.

### 3.5 DAYLIGHT SENSORS

- A. Locate daylight sensors per plan and/or instructions shown on approved shop drawing.
- B. Provide calibration of daylight sensing controls after substantial completion. Calibrate indoor daylight sensors to lower fixture illumination when daylight zone ambient illumination is above 80FC unless otherwise indicated.

### 3.6 DIGITAL ROOM CONTROLLERS

- A. Areas with Accessible Ceiling Space: Locate controller above ceiling within 6 feet of first lighting outlet serving lights to be controlled unless otherwise indicated. Low voltage wiring between sensor and relay may be installed without conduit.
- B. Coordinate with Division 25 contractor to identify auxiliary relay contacts provided for air temperature control (ATC) interface.

### 3.7 FACTORY STARTUP

- A. General: Field start-up, testing, and adjustment for low voltage control panels and for digital room control systems shall be performed under the supervision of a factory trained manufacturer's representative.
- B. Low Voltage Control Panels: Include programming, calibration, and testing, as part of commissioning specified under Section 260800. Allow separate site visits for initial and final programming. Start up control sequence shall be as scheduled on drawings. Final control sequence shall be as directed by Owner. Arrange for an Owner representative to be present for each programming session.
- C. Digital Room Control Systems: Include initial programming, calibration, and testing, as part of commissioning specified under Section 260800.

### 3.8 COMMISSIONING

- A. Comply with requirements of Section 019100 and Section 260800, Commissioning of Lighting Systems for commissioning of lighting controls as required under Section C408 of the Washington State Energy Code.
- B. Provide all tools, equipment, materials, services, and labor required to test lighting control system in each space per manufacturer's installation instructions. Verify settings, coverage, and operation. Correct deficiencies, replace malfunctioning devices, and retest as required. Submit test reports indicating compliance with specifications and manufacturer's installation requirements.

### 3.9 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate operation and maintenance of system to Owner's personnel prior to contract closeout. Allow one site visit and two hours of total instruction scheduled at convenience of Owner prior to occupancy. Within 6 months to one year of substantial completion, provide second training session scheduled at convenience of Owner.
- B. Use operation and maintenance manuals as basis of instruction, reviewing contents of manual with personnel in detail.

END OF SECTION



## PART 1 GENERAL

### 1.1 SECTION INCLUDES

- A. Switchboards.
- B. Panelboards and Circuit Breakers.
- C. Disconnect Switches.
- D. Fuses.
- E. Motor Controllers.
- F. Contactors.
- G. Dry Type Transformers.
- H. Busway.
- I. Enclosed Circuit Breakers.
- J. Nameplates.
- K. Compression Lugs.
- L. Short Circuit, Protective Device Coordination, and Arc Flash Hazard Study.

### 1.2 RELATED SECTIONS

- A. Concrete for Equipment Pads: Comply with Division 03 - Concrete.
- B. Commissioning of Electrical Energy Metering: Comply with Division 01.

### 1.3 SUBMITTALS

- A. Submit product data for switchboards, panelboards, circuit breakers, motor controllers, contactors, dry type transformers, busway, and enclosed circuit breakers. Dry type transformer submittal must indicate compliance with minimum efficiency requirements specified.
- B. Submit shop drawings for switchboards, panelboards, busway, and dry type transformers. Include installation requirements for anchoring and bracing meeting requirements of the International Building Code for Seismic Design Category F.
- C. Coordinate dimensions of equipment with site and project space dimensions to verify equipment will fit, conform to indicated layout, and meet NEC and manufacturer clearance requirements.
- D. Submit reports for tests required under Part 3 of this section. Submit manufacturer's

performance testing instructions and signed written performance test records for equipment ground fault protection systems.

- E. Submit product data and shop drawings for service switchboard to serving utility for review and approval in addition to Architect/Engineer submittal requirements.
- F. Submit short circuit, protective device coordination, and arc flash hazard study.

#### 1.4 OPERATION AND MAINTENANCE DATA

- A. Include data for switchboards, panelboards, circuit breakers, motor controllers, transformers, fuses, contactors, busway, studies, and tests in Operation & Maintenance Manuals.

#### 1.5 SPARE PARTS

- A. Fuses: Furnish to Owner 3 spare fuses of each type and rating installed.
- B. Fuse Pullers: Furnish 2 fuse pullers to the Owner.

#### 1.6 SHORT CIRCUIT, PROTECTIVE DEVICE COORDINATION, AND ARC FLASH HAZARD STUDY

- A. Provide an engineering analysis and report with one line distribution and impedance diagrams, calculations, results, conclusions, and recommendations. Study to include symmetrical and asymmetrical short circuit current calculations, overcurrent protective device time/current coordination curves, trip settings for each main and distribution device, arc flash hazard analysis, and arc flash labeling information. Calculations shall be based on source impedance, X/R ratios, and motor contribution.
- B. Overcurrent protective devices installed on the NEC 700 distribution system shall selectively coordinate with supply side overcurrent protective devices to 0.1 seconds.
- C. Where arc flash hazard/risk category classifications are calculated to exceed hazard category 1, they shall be identified in the Arch flash study along with distribution design recommendations for reducing hazard/risk to 1. Final report shall address Owner approved system changes.
- D. Study and report shall be prepared, stamped, and signed by a professional engineer licensed in the state of Washington and submitted by the equipment manufacturer.

### PART 2 PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Switchboards, Panelboards, Circuit Breakers and Disconnects: Square 'D', Siemens, Cutler-Hammer.
- B. Fusible Branch Circuit Panelboards: Cooper Bussmann, Eaton.
- C. Motor Controllers and Contactors: Allen-Bradley, Square 'D', General Electric, Furnas, Cutler-Hammer.

- D. Fuses: Bussman and Littelfuse.
- E. Dry Type Transformers: Square 'D', General Electric, Siemens, Cutler-Hammer, Tierney.
- F. Busway: Square 'D', General Electric, Siemens, Cutler-Hammer.

## 2.2 SWITCHBOARDS

- A. Switchboards: NEMA PB2; factory assembled, dead front, front accessible, metal-enclosed, free standing, service entrance label. Distribution section devices shall be group mounted.
- B. Electrical Ratings, Configuration, Special Features: As shown on project drawings. The indicated ampere interrupting capacity (AIC) shown on the project drawings is the full RMS symmetrical equipment short circuit rating of bussing and of all overcurrent devices installed. Series rating between overcurrent devices within the switchboard and with load side distribution panelboards is not approved. Series rating with load side lighting and appliance panelboards, load centers, and enclosed circuit breakers shall be provided when indicated on the project drawings.
- C. Switchboard Dimensions: 90 inch nominal height excluding base channels, lifting members, and pull boxes; length and depth not to exceed dimensions as scaled on drawings. Align sections so that back of complete structure may be placed flush against wall.
- D. Finish: Manufacturer's standard enamel over rust inhibitor on exterior surfaces; minimum one coat corrosion-resisting paint or zinc coating on interior surfaces.
- E. Main Overcurrent Protective Device(s): UL 489; molded case circuit breaker with thermal magnetic trip or solid state trip unit with 8X adjustable short-time delay and fixed instantaneous override, 100% rated, fixed mounted, single handle common pole operation, AIC rating greater than available symmetrical short circuit amperes. Provide ground fault protection where indicated.
- F. Fusible Switches: NEMA KS 1; quick make, quick break, handle lockable in OFF position, Class J fuse provisions unless otherwise required for short circuit protection of circuit breakers. Fuses must comply with NEC 240.86 series rating requirements for load side circuit breakers that are not rated for the available fault current.
- G. Fusible Switches, 800 Amperes and Larger: Bolted pressure contact type, Class L fuse provisions.
- H. Circuit Breakers: UL 489; molded case, thermal magnetic trip, AIC rating greater than available symmetrical short circuit amperes. Multi-pole breakers shall be single handle with common pole operation. Circuit breakers rated or otherwise adjustable to 1000 amperes and larger shall have an arc energy reducing maintenance switch with electronic trip and status indication to reduce clearing time per NEC 240.87.
- I. Circuit Breakers for Selective Coordination: UL 489; molded case, solid state trip unit, AIC rating greater than available symmetrical short circuit amperes. Distribution breakers must selectively coordinate with branch circuit breakers of load side lighting and appliance panelboards, load centers, and enclosed circuit breakers. Multi-pole breakers shall be single handle with common pole operation. Circuit breakers rated or otherwise adjustable to 1000 amperes and larger shall include an arc energy reducing maintenance switch with status

indication to reduce clearing time per NEC 240.87.

- J. Bussing: Aluminum with full copper neutral. Provide ground bus.
- K. Future Provisions: Provide spaces fully equipped for future devices with bussing, device supports, and bus connections. Include provisions for extension of bussing when future distribution section is indicated.
- L. Where surge protective device (SPD) is indicated, coordinate requirements with Section 264300.
- M. Switchboard Instrumentation (Microprocessor Based): UL 1244, ANSI C37.90; digital multi-function metering with peak demand, monitoring, and control device, ANSI C12.16 revenue accuracy, panel mounted, with alpha-numeric LED and/or LCD displays.
  - 1. Metering Functions - displayed value (% accuracy): AC phase current (1%), AC phase voltage (1%) phase-phase and phase to neutral, watts (2%), VAR's (2%), power factor (4%), watt demand (2%) with 5, 10, 15, or 30 minute selected interval, watt hours (2%), and frequency (0.5%). Demand functions shall have zero reset feature.
  - 2. Protective Functions: Phase loss, phase reversal, under voltage, and over voltage. Functions shall have adjustable settings and include adjustable time delay feature for abnormal voltage conditions. Provide separate Form C (SPDT) trip and alarm output contacts.
  - 3. Instrument Transformers: ANSI C57.13; current and potential transformers as required. Provide multi-ratio transformers when indicated. Voltage input shall be fused and include a disconnecting means.
  - 4. Remote Monitoring: Include RS232 data output port.
  - 5. Power Loss: Retain all pre-set parameters, accumulated watt hours, and watt demand without battery back-up.
- N. Utility Metering: Include provisions for utility company transformer metering. Comply with Utility Company requirements.
- O. Outdoor Switchboards: Provide NEMA ICS 6 Type 3R, non walk-in enclosure with roof sloping downward toward rear, pad locking doors, and stainless steel hardware. Provide a NEMA 5-20R convenience receptacle and thermostatically controlled space heater(s) in switchboard sections with adequate wattage to prevent the accumulation of moisture. Power for space heaters and receptacle shall be obtained from a control power transformer within the switchboard. All devices, instrumentation, and accessories shall be suitable for the environmental conditions associated with outdoor switchgear.

### 2.3 POWER DISTRIBUTION PANELBOARDS

- A. Panelboards: UL 67, NEMA PB 1; circuit breaker type with provision for branch breakers as indicated, suitable for use as service equipment.
- B. Electrical Ratings, Switch Arrangement, Special Features: As indicated on drawings. Indicated ampere interrupting capacity (AIC) is the full rms symmetrical integrated equipment short circuit rating of bussing and of overcurrent devices without series rating.
- C. Cabinet: ICS 6; Type 1 for dry locations, Type 3R for damp or outdoor locations; surface mounted, with gutter space for metering current sensors shown on one line diagram and



specified under Division 25. Coordinate maximum dimensions with room layout shown on plans.

- D. Finish: Manufacturer's standard enamel over rust inhibitor.
- E. Circuit Directory: Index card under plastic with metal frame holder on each branch switch.
- F. Main Overcurrent Protective Device(s): UL 489; molded case circuit breaker with thermal magnetic trip or solid state trip unit with 8X adjustable short-time delay and fixed instantaneous override, 100% rated, fixed mounted, single handle common pole operation, AIC rating greater than available symmetrical short circuit amperes. Provide ground fault protection where indicated.
- G. Circuit Breakers: UL 489; molded case, thermal magnetic trip, AIC rating greater than available symmetrical short circuit amperes at the panelboard. Multi-pole breakers shall be single handle with common pole operation. Circuit breakers rated or otherwise adjustable to 1000 amperes and larger shall have arc energy reducing maintenance switching with electronic trip and status indication to reduce clearing time per NEC 240.87.
- H. Circuit Breakers for Selective Coordination: UL 489; molded case, solid state trip unit, AIC rating greater than available symmetrical short circuit amperes. Distribution breakers must selectively coordinate with branch circuit breakers of load side lighting and appliance panelboards, load centers, and enclosed circuit breakers current. Multi-pole breakers shall be single handle with common pole operation. Circuit breakers rated or otherwise adjustable to 1000 amperes and larger shall include an arc energy reducing maintenance switch with status indication to reduce clearing time per NEC 240.87.
- I. Bussing: Aluminum with full neutral and ground bus. Provide separate isolated ground bus.
- J. Future Provisions: Provide fully equipped spaces for future devices with bussing, device supports, and bus connections.
- K. Where surge protective device (SPD) is indicated, coordinate requirements with Section 264300.

## 2.4 BRANCH CIRCUIT PANELBOARDS

- A. Panelboards: UL 67, NEMA PB 1; bolt-on circuit breaker type.
- B. Electrical Ratings, Circuit Breaker Arrangement, Special Features: As indicated on drawings. Indicated ampere interrupting capacity (AIC) is the rms symmetrical integrated equipment short circuit rating of the complete assembly. Indicated AIC rating shall be based upon manufacture listed series rating with the panelboard main device or the line side overcurrent protective device, as applicable, unless otherwise indicated.
- C. Cabinet: Concealed trim clamps, concealed hinge door-in-door (one door over interior and one which exposes gutter) with flush locks all keyed alike, 6" deep x 20" wide. Provide two keys for each panelboard furnished.
- D. Finish: Manufacturer's standard enamel over rust inhibitor for exposed surfaces; galvanized steel for recessed boxes.

- E. Circuit Directory: Index card under plastic with metal framed holder on inside door.
- F. Circuit Breakers: UL 489; molded case, thermal magnetic trip. Multi-pole breakers shall be single handle with common pole operation.
  - 1. Provide type SWD circuit breakers for lighting circuits.
  - 2. Provide type HACR circuit breakers for air conditioning equipment, refrigeration equipment, and surge protection devices (SPD).
  - 3. Provide approved manufacturer handle ties between single pole circuit breakers serving branch circuits sharing a common neutral (disconnecting means for multiwire branch circuits).
  - 4. Provide approved manufacturer handle padlock attachment on circuit breakers serving branch circuits for permanently connected appliances without local disconnecting means and where otherwise indicated.
  - 5. Provide combination-type arc-fault circuit interrupter protection (AFCI) circuit breakers for branch circuits where indicated.
  - 6. Provide ground fault circuit interrupter protection (GFCI) circuit breakers for branch circuits where indicated.
  - 7. Provide ground fault equipment protection (GFEP) circuit breakers for pipe heat trace and for deicing and snow melting equipment.
  - 8. Circuit breakers used as mains (back-fed) shall be suitable for the purpose and shall include an auxiliary fastener listed and approved by the panelboard manufacturer where plug-in type device is used.
- G. Bussing: Aluminum with full neutral and ground bus. Provide separate ground bus isolated from cabinet where isolated grounding requirements are indicated.
- H. Where surge protective device (SPD) is indicated, coordinate requirements with Section 264300.
- I. Where fusing is required to comply with selective coordination requirements of NEC 700 and 701, provide lighting and appliance panelboard that includes UL listed, special purpose, low peak branch circuit fuses with Class J performance in series with each branch circuit breaker or disconnect. Fuses shall be IP20 finger-safe with neon open fuse indication, single and multi-pole as scheduled. Cooper Bussmann QSCP, Eaton PRL1aF or 2aF, or approved.
- J. Provide flush mounted panelboards with bullnose trim where full recessed depth is not available.

## 2.5 ENCLOSED CIRCUIT BREAKERS

- A. Circuit Breakers: UL 489; molded case, thermal magnetic trip, AIC rating greater than available symmetrical short circuit amperes. Distribution circuit breakers must be series rated with load side overcurrent devices. Provide circuit breaker electronic trip unit where indicated to include 8X adjustable short-time delay and fixed instantaneous override. Multi-pole breakers shall be single handle with common pole operation.
- B. Electrical Ratings, Configuration, and Special Features: As shown on drawings. The indicated ampere interrupting capacity (AIC) shown on the drawings is the full rms symmetrical equipment short circuit rating of bussing and of all overcurrent devices installed.
- C. Enclosures: NEMA ICS6; Type 1 for dry locations, Type 3R for damp or outdoor, with pad

locking provisions, and suitable for use as service equipment. Include neutral and/or ground kits as required.

## 2.6 DISCONNECT SWITCHES

- A. Safety Switches: NEMA KS 1; heavy duty, quick make, quick break, handle with lock out / tag out provisions. Provide rating, number of poles, and fusing required for load served.
- B. Safety Switches for Variable Frequency Drives (VFD): Safety switches installed on the load side of VFD controllers shall include an interlock to disable controller operation when the safety switch handle is operated to the open position.
- C. Toggle Switches for Small Motors and Appliances: NEMA WD 1; horsepower rated 20 ampere general use snap switch with lock-out attachment.
- D. Elevator Switches: Enclosed fused switch and shunt trip assembly complying with NEC 620 and WAC 296-96 (ANSI 17.1) requirements for elevator power supply. Switch assembly shall include Class J power fuses sized for elevator load, locking handle operator, provisions for remote source control power circuit, fire alarm initiating device interface relay, keyed test switch, pilot light (ON), and mechanical interlock auxiliary contact for emergency automatic recall. Bussman PS series power module switch or equal.
- E. Switch Enclosures: NEMA ICS 6; Type 1 for dry locations, Type 3R for damp or outdoor locations.

## 2.7 FUSES

- A. Approved Fuses, 600 Amperes and Less, for Branch Circuits and Power Distribution:
  - 1. ANSI/UL 198C Class J low peak with time delay unless otherwise indicated except ANSI/UL 198E Class RK5 may be used in safety switches for protection of motors and transformers.
  - 2. For protection of circuit breakers: Fuses must comply with NEC 240.86 series rating requirements for load side circuit breakers that are not rated for the available fault current. Coordinate series rating requirements with published manufacturer's listings for circuit breakers installed.
- B. Approved Fuses, Over 600 Amperes, for Branch Circuits and Power Distribution:
  - 1. ANSI/UL 198C Class L low peak with time delay unless otherwise indicated.
  - 2. For protection of circuit breakers: Fuses must comply with NEC 240.86 series rating requirements for load side circuit breakers that are not rated for the available fault current. Coordinate series rating requirements with published manufacturer's listings for circuit breakers installed.

## 2.8 MOTOR CONTROLLERS

- A. Manual Motor Starters: NEMA ICS 2; AC general purpose Class A manually operated full-voltage controller for fractional horsepower induction motors, with thermal overload unit, green neon pilot light, and toggle operator.
- B. Magnetic Motor Starters: NEMA ICS 2; full voltage non-reversing (FVNR) type, hand reset solid state overload relay with phase loss protection, green 20,000 hour "ON" pilot light, one normally open and one normally closed auxiliary contacts, fused 120 volt control

transformer, 120 volt operating coil; additional features as indicated. Provide cover mounted "Hand-Off-Auto" selector switch unless operator station is indicated.

- C Two Speed Motor Starters: Provide consequent pole or separate winding starter to match requirements of motor provided. Verify motor type prior to ordering. Provide pilot lights for each speed. Other features and starter options shall comply with requirements for magnetic motor starters specified above.
- D Combination Motor Starters: Combine Magnetic Motor Starter and fused disconnect switch with Class R fuse provisions in common enclosure.
- E Fire Alarm Shutdown: Provide magnetic starters with auxiliary control relay for fire alarm shutdown interface where indicated.
- F Operator Stations: NEMA ICS 2; heavy duty oil tight, operator and legend plate indicated.
- G Enclosures: NEMA ICS 6; Type 1 for dry locations, Type 3R for damp or outdoor locations.
- H Enclosure Finishes: Manufacturer's standard enamel over rust inhibitor on all interior and exterior surfaces.

## 2.9 CONTACTORS

- A General Purpose Contactors: NEMA ICS 2; electrically or mechanically held, 100% continuous rating for lighting, resistance, and motor loads, 120 volt control coil fused control circuit. Contact rating and number of poles as indicated on drawings.
- B Emergency Stop Station (Kill Switch): NEMA ICS 2; red 50mm mushroom head pushbutton, push- pull maintained operation with normally closed contact rated 10 amps at 300 volts (minimum) and yellow device plate, flush mounted. Furnish with EMERGENCY STOP labeling engraved on mushroom head or device plate. Square D Siemens, Cutler-Hammer, or approved. Provide quantity of three (3) keys.
- C Remote Operator Station: NEMA ICS 2; key operated two or three position momentary selector switch with contacts rated 10 amps at 300 volts (minimum), flush mounted in finished spaces. Furnish with legend plate or engraving on device plate to indicate function(s). Provide as key operated station where indicated. Square D, Siemens, Cutler-Hammer, or approved.
- D Enclosures: NEMA ICS 6; Type 1 for dry locations, Type 3R for damp or outdoor locations.

## 2.10 DRY TYPE DISTRIBUTION TRANSFORMERS

- A Two Winding Transformers: ANSI/NEMA ST 20, NEMA TP-1 Class 1 compliant; general purpose, air cooled; ratings as shown on drawings. Transformers shall meet the minimum efficiency requirements of Washington State Energy Code (WSEC).
- B Insulation System and Average Temperature Rise: 220 degree C insulation, 150 degree C rise above 40 degree C ambient.
- C Primary Winding Taps: Six (6) 2-1/2% taps, 2 above and 4 below normal.

- D. Sound Levels: Not to exceed ANSI/NEMA ST 20 standards. Shall not exceed 35 dB where "Ultra-Quiet" is indicated on drawings.
- E. Isolation Transformers: Provide electrostatic shielding between windings with separate insulated grounding connection.
- F. Isolate core and coil from enclosure using vibration absorbing mounts.
- G. Install weather shields on transformers installed in indoor locations common with water piping and/or fire sprinklers.

## 2.11 NAMEPLATES AND LABELS

- A. Nameplates: Engraved three-layer laminated plastic, white letters on black background, affixed with stainless steel screws, adhesive acceptable in dry locations. Use black letters on yellow background for series combination rating identification. Use white letters on red background for emergency distribution.
- B. Letter Height: 1/2 inch for series combination rating identification. 1/4 inch for switchboards, panelboards, motor control centers, circuit breakers, switches, and disconnecting means; 1/8 inch for motor starters, contactors, time switches, and equipment served.
- C. Arc Flash Hazard Warning at Service Equipment Rated 1200 Amps and Larger: ANSI Z535.4; Self adhesive vinyl label factory installed by the equipment manufacturer to read WARNING, Electrical Arc Flash Hazard, Appropriate PPE Required, and informational text to indicate system voltage, available fault current at the service overcurrent protective devices, clearing time of service overcurrent protective devices based on the available fault current, and date the label was applied.
- D. Arc Flash Protection Labels: ANSI Z535.4; Self adhesive vinyl label factory installed by the equipment manufacturer with ANSI header to read WARNING or DANGER and informational text to include:  
Electric Arc Flash Hazard.  
Turn off all power before opening.  
Follow all requirements in NFPA 70E for safe work practices and for Personal Protective Equipment.  
Failure to comply can result in death or injury.
- E. Arc Flash Protection Labels for Switchgear, Panelboards, and Motor Control Centers: ANSI Z535.4, NFPA 70E; Self adhesive vinyl labels consisting of arc flash information based on the approved hazard study. Labels shall include Flash Category, Arc Flash Rating (cal/cm<sup>2</sup>), Hazard Boundary, and required Personal Protective Equipment (PPE).

## 2.12 COMPRESSION LUGS (ALUMINUM CONDUCTOR)

- A. Where aluminum conductor is substituted for copper conductor under Section 260500, compression lugs shall be provided in lieu of mechanical lugs for terminating conductors.

## PART 3 EXECUTION

### 3.1 SWITCHBOARDS

- A. Install in accordance with manufacturer's instructions and NEMA PB 2.1.
- B. Seismic Restraint: Comply with requirements of the International Building Code (IBC). Obtain anchoring plans from equipment manufacturer indicating size and location of anchors suitable for Seismic Design Category F. Secure floor mounted equipment to concrete floor or pad with corrosion proof 1/2 inch -13 SAE Grade 5 wedge anchors having a minimum embedded depth of 5 inches unless otherwise approved or recommended by manufacturer.
- C. Provide initial programming and set up for microprocessor based switchboard instrumentation. Coordinate with Owner to verify requirements for User selected programming inputs.

### 3.2 PANELBOARDS

- A. Install in accordance with NEMA PB 1.1.
- B. Height: 78 inches maximum measured from finish floor to top of enclosure; 78 inches maximum measured from finish floor to highest device handle for panelboards over 66 inches high.
- C. Provide typewritten circuit directory for each panelboard listing load description for each circuit. Use final room names and numbers as verified with the Owner.
- D. Stub 3 empty 3/4-inch conduits to accessible location above ceiling and / or below floor from each recessed panelboard.
- E. Fire Rated Construction: Recessed rough-in cans that penetrate fire rated wall assemblies shall comply with requirements of Section 260500. Verify location of fire rated assemblies with Architectural plans prior to rough in.

### 3.3 FUSES

- A. Install fuses in fusible switches.
- B. Size fuses for motor loads at 150% of nameplate full load amperes; size fuses for air conditioning and refrigeration equipment at maximum recommended nameplate rating.

### 3.4 MOTOR CONTROLLERS

- A. Adjust solid state overload relay to match installed motor characteristics and ambient conditions.

### 3.5 DRY TYPE TRANSFORMERS INDOORS

- A. Connect raceway to transformer case using flexible conduit.
- B. Mounting: Floor, wall, or trapeze mount as required. Mount transformers on 1/2 inch minimum oil resistant neoprene vibration isolating pads with cross-ribbed or waffle design and located at each anchor point.

- C. Seismic Restraint: Comply with requirements of the International Building Code (IBC). Obtain required anchoring plans from equipment manufacturer indicating size and location of anchors suitable for Seismic Design Category F. Provide seismic bracing for trapeze mounted equipment. Secure floor mounted equipment to concrete floor or pad with corrosion proof 1/2 inch -13 SAE Grade 5 wedge anchors having a minimum embedded depth of 5 inches unless otherwise approved or recommended by manufacturer.
- D. Disconnecting Means: Comply with NEC 540.14 and as otherwise shown on plans.

### 3.6 NAMEPLATES AND LABELS

- A. Switchboards, Panelboards: Provide nameplate to identify equipment designation, voltage, and source of supply for each, e.g. Panel A, 208/120V, Fed from Panel M. Provide arc flash protection label. Provide series combination rating nameplate where such rating is applicable.
- B. Individual Circuit Breakers, Switches, and Motor Starters Installed in Switchboards, Distribution Panelboards Without Circuit Index: Provide nameplate to identify circuit number and load served.
- C. Motor Starters and Contactors: Provide nameplate to identify load served. May be deleted when load is immediately adjacent and obvious as determined by Architect/Engineer. Provide arc flash protection label.
- D. Individual Enclosed Circuit Breakers, Safety Switches, and Disconnecting Means: Provide nameplate to identify load served and circuit source and circuit number.
- E. Equipment Served: Provide nameplate to identify equipment designation corresponding with nameplate of serving overcurrent device, disconnect switch, or controller. Coordinate with Architect/Engineer to assign numbers when not designated in equipment schedules.
- F. Emergency-Stop Pushbutton: Engraved three-layer laminated plastic, white letters on red background, affixed with stainless steel screws, adhesive acceptable in dry locations. Letter height 1/2 inch to read: "EMERGENCY POWER OFF".
- G. Nameplate and Label Location: Secure to equipment fronts, except recessed panelboards in finished locations secure nameplates and labels to inside face of door.
- H. Service Equipment: Provide label identifying short circuit rating indicated along with date of construction documents.

### 3.7 EQUIPMENT PADS

- A. Switchboards, Transformers - Indoors: Provide concrete equipment (housekeeping) pads, 3-1/2 inches high and 4 inches larger than the footprint of the equipment.

### 3.8 TESTS

- A. Motors and Compressors: Record all nameplate data. Measure actual voltage and running amperes for each phase. Record manufacturer and catalog number of overload thermal units installed.

- B. Dry Type Transformers: Measure primary and secondary voltages after loads are connected and systems are energized. Adjust taps for -1% to +2% of rated secondary voltage.
- C. Equipment Ground Fault Protection Systems: Test prior to being placed into service to verify proper installation and operation of the system as determined by the equipment manufacturer's published instructions. Set pick up for 300 amps and time delay for zero (instantaneous) unless otherwise indicated or directed. Record test results.
- D. Outdoor Dry Transformer Ground Electrode System: ANSI/IEEE 81; measure and record ohmic value by performing fall of potential tests using a ground testing megger. Tests shall be performed with the ground electrode system disconnected/isolated from neutral and with the test current probe located at least 100 feet from the nearest ground system electrode.

### 3.9 COMMISSIONING OF ELECTRICAL ENERGY METERING

- A. Comply with requirements of Section 019100 for commissioning of electrical energy metering as required under Sections C408 and C409 of the Washington State Energy Code.

END OF SECTION



## PART 1 GENERAL

### 1.1 SECTION INCLUDES

- A. Surge Protective Devices (SPD's) for electrical distribution equipment.

### 1.2 SUBMITTALS

- A. Submit product data for all items specified under Part 2 of this Section. Include product installation requirements. Include test data demonstrating compliance with specified performance and peak surge withstand ratings.

### 1.3 OPERATION AND MAINTENANCE DATA

- A. Include data for each device type in Operation and Maintenance Manuals.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Integral SPD: Distribution equipment manufacturer's standard products that meet or exceed the minimum requirements of this specification.
- B. Remote SPD: Standard products of the following manufacturers that meet or exceed the minimum requirements of this specification: Innovative Technologies, Joslyn TPS series, Eaton SPD series.

### 2.2 SPD PRODUCT DESIGN

- A. General: UL 1449, 3rd Edition, Type 2 Devices; MOV hybrid circuit design with EMI/RFI noise rejection filter. For wye configured systems provide line to neutral (L-N), line to ground (L-G), and neutral to ground (N-G) suppression. For delta configured systems provide line to line (L-L) and line to ground suppression.
- B. Diagnostics: LED circuit status indication for each phase. Provide the following additional diagnostics: Audible alarm; Form C contacts for remote alarm; Transient counter.
- C. Enclosure (Remote Devices): NEMA ICS 6; Type 12 or type 4X, unless otherwise indicated. Provide flush trim plate for recess mounting at flush mounted panelboards.
- D. Overcurrent Protection: Comply with UL 1449 standard. Coordinate requirements with distribution equipment supplier. Size protection based on wire size of the SPD conductor leads using RK5 fusing or high inrush rated circuit breaker.
- E. Disconnecting Means: Provide a disconnecting means for each switchboard and panelboard SPD regardless of whether it is integral or remote mounted. Coordinate requirements with distribution equipment supplier.
- F. Product Warranty: 10 year minimum.

### 2.3 SPD ELECTRICAL REQUIREMENTS (MINIMUM)

- A. Voltage Rating: Conform to nameplate of distribution equipment.
- B. Ampere Interrupting Capacity (AIC) Rating: Meet or exceed rating of highest rated overcurrent device in the distribution equipment.
- C. UL 1449 3rd Edition Voltage Protection Rating (VPR):
- | System Volts  | L-N<br>(Normal Mode) | N-G<br>(Common Mode) | L-L        |
|---------------|----------------------|----------------------|------------|
| 120 to Ground | 700 volts            | 700 volts            | 700 Volts  |
| 277 to Ground | 1200 volts           | 1200 volts           | 1200 Volts |
- D. UL 1449 VPR Voltage Let Through:
- | System Volts    | L-N  | L-G  | L-L  | N-G  |
|-----------------|------|------|------|------|
| 480/277 Wye     | 1100 | 1100 | 1900 | 1100 |
| 208/120 Wye     | 700  | 700  | 1000 | 700  |
| 120/240 1-Phase | 700  | 700  | 1000 | 700  |
- E. Peak Surge Withstand Rating per Phase (8 x 20 microsecond impulse wave form):
- |                                      |              |
|--------------------------------------|--------------|
| Service Entrance                     | 160,000 Amps |
| Distribution Switchboards and Panels | 65,000 Amps  |
| Branch Circuit Panelboards           | 40,000 Amps  |
- F. Noise Attenuation: 55 dB minimum at 100 kHz using MIL-STD-220A insertion loss test method.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Provide SPD where indicated.
- B. Provide factory mounted SPD integral with distribution equipment except remote mounted SPD may be used for panelboard construction.
- C. Remote Mounted SPD Installation Requirements:
1. Provide SPD next (close nipped) to equipment enclosure near panelboard overcurrent device provided for the purpose. Wiring leads for remote device shall be as short and straight as possible, but in no case shall exceed 12 inches in length.
  2. Comply with manufacturer's recommendations for overcurrent protection.
  3. Provide additional equipment grounding terminal in panel for SPD ground connection where required to comply with maximum lead length specified.
  4. Provide recessed mounting with flush trim plate where SPD is installed at flush mounted panelboards. Obtain rough-in inspection by the Architect/Engineer prior to cover of recessed installation.

END OF SECTION

## PART 1 GENERAL

### 1.1 SECTION INCLUDES

- A. Interior Luminaires and Accessories.
- B. Exterior Luminaires and Accessories.
- C. Lamps.
- D. Ballasts and LED Drivers.
- E. Poles and Concrete Bases.
- F. Emergency Lighting Equipment.

### 1.2 RELATED SECTIONS

- A. Concrete for Bases: Comply with Division 03 - Concrete.

### 1.3 COORDINATION

- A. Confirm luminaire type, mounting, and recessed depth is compatible with ceiling system prior to ordering. Coordinate with architectural reflected ceiling plans, sections, and details.
- B. Determine final luminaire locations according to architectural reflected ceiling plans and elevations. In spaces open to structure, coordinate final luminaire locations and mounting heights with ductwork, piping, and structural members and submit final plan to Architect/Engineer for approval.
- C. Coordinate dimensions and mounting of under-cabinet and other casework lighting with the cabinet and/or casework product vendor(s) prior to ordering light fixtures.

### 1.4 SUBMITTALS

- A. Submit product data for all items specified under Part 2 of this section and scheduled on the drawings. Include in submittal and in Operations and Maintenance Manual a coversheet listing each fixture type with corresponding LED/lamp and driver/ballast data.
- B. Submit shop drawings for Emergency Lighting System UPS equipment.

### 1.5 OPERATION AND MAINTENANCE DATA AND TRAINING

- A. Submit all data in Operation and Maintenance Manuals.
- B. Provide onsite training on driver and LED board replacement for each type of luminaire installed.
- C. Lighting Inverter: Include instructions for normal operation, routine maintenance requirements, service manuals and testing procedures in Operation and Maintenance Manual.

Provide onsite Owner training.

- D. Include documentation from system start up.

## 1.6 WARRANTY

- A. LED Luminaires and Fixture Ballasts: Provide five year comprehensive warranty.
- B. Lighting Inverters: Provide two year extended warranty with factory start up and onsite service.

## 1.7 EXTRA STOCK

- A. Lighting Inverter: Provide extra stock of filter material, quantity for a complete filter replacement for all installed units.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Luminaires and Accessories: Identified in Fixture Schedule.
- B. Emergency Transfer Relays: LVS.
- C. UPS Central Power Supply: Chloride, Crucial Power, Lithonia, Sure-Lites.

### 2.2 LED LUMINAIRES

- A. Indoor luminaires shall comply with following requirements unless otherwise scheduled on the drawings: UL listed, Reduction of Hazardous Substance (ROHS) compliant, 3500K color temperature, 80 CRI minimum, listed for 25 degree C minimum ambient operation, integral driver, integral surge, open circuit, short circuit, and overload protection, L70 at 50,000 hours or better per IESNA LM-80. Provide dimmable driver for low voltage 0-10 volt control to 10% of lumen output except dimming drivers that have daylight responsive control shall dim to completely OFF.
- B. Outdoor luminaires shall comply with following requirements unless otherwise scheduled on the drawings: UL listed, Reduction of Hazardous Substance (ROHS) compliant, IP66 rated, 3000K color temperature, 70 CRI minimum, listed for -20 degree C to 40 degree C ambient or better operation, integral driver, integral surge, open circuit, short circuit, and overload protection, rated L70 at 50,000 hours or better per IESNA LM-80. Provide dimmable driver suitable for 0-10 volt control.
- C. Recessed LED luminaires shall have drivers, modules, and reflectors accessible, serviceable, and replaceable from below the ceiling.

### 2.3 FIXTURE WHIPS

- A. 3/8 inch flexible conduit or approved MC cable assembly with circuit and equipment ground conductors; 72 inch maximum length.

- B. Where fixtures are provided with pre-installed whips, verify wiring arrangement, termination location, and installation clearances prior to ordering.

## 2.4 FIXTURE ACCESSORIES

- A. Provide necessary hangers, brackets, plates, anchors, and other mounting accessories required by construction features and ceiling conditions. Comply with requirements of Section 260500 - Basic Materials and Methods.
- B. Pendants: Provide single pipe stem type with self-aligning swivel hanger and canopy and suitable for sloped ceilings, stem length as required.
- C. Allow sufficient length for pendants, cables, chains, conduit, or rods as specified to install hanging fixtures at 8 feet above finished floor or 36 inches below the ceiling, whichever is lower, unless otherwise indicated in the construction documents.
- D. Wireguards: Provide wireguards for all surface mounted and industrial fixtures installed in Gymnasiums and Multi-Purpose Rooms.

## 2.5 LIGHTING POLES

- A. Wind Load Rating: 100 mph with luminaires and brackets installed.
- B. Anchor Bolts: As recommended by pole manufacturer. Provide template, flat washers, lock washers, and hex nuts for each pole.

## 2.6 EMERGENCY LIGHTING SYSTEM INVERTER

- A. UL924 and NEC Article 700; Central uninterruptible power supply (UPS) for emergency lighting applications using any combination of fluorescent, incandescent, HID, or LED lighting, magnetic ballasts, electronic ballasts, and electronic LED drivers, ANSI/IEEE C62.41 Category A & B surge compliant. Provide rating and input/output voltage configuration as indicated.
- B. Batteries: 10 year rated sealed lead calcium batteries installed within a NEMA 1 cabinet. Provide full light output for 90 minutes.
- C. Accessories: Input circuit breaker, maintenance by-pass, battery disconnect, output circuit breaker(s), self-diagnostics and alarms, automatic battery recharge, remote computer interface with software, factory start-up. Provide instructions for seismic anchoring to comply with requirements of the IBC for seismic design category F.

## 2.7 LIGHTING FIXTURE SCHEDULE

- A. See Drawings.

# PART 3 EXECUTION

## 3.1 INSTALLATION

- A. Provide LED modules/lamps in luminaires provided under this Section.

- B. Provide wiring, installation, and lamps for lighting fixtures furnished under other Sections or by Owner, including fixtures furnished as part of hoods and equipment (e.g. range hoods, kitchen hoods, fume hoods, and walk-in HVAC equipment). Incandescent lamps shall be maximum listed wattage of fixture except when smaller wattage is indicated.
- C. Set lighting fixtures plumb, square, and level; measure mounting heights to center of fixture for wall mounted and to bottom of fixture for pendant hung.
- D. Support lighting fixtures from building structural members; provide metal channels or additional blocking and framing as required for fixture support between structural members or to avoid interference from mechanical pipes and ducts. Conceal supports within building construction in finished spaces.
- E. Recessed and surface mounted lighting fixtures weighing less than 56 lbs (25.4 kg) may be supported from metal ceiling suspension systems when auxiliary support from structural members using two #12 AWG wire hangers at diagonal corners are provided (hangers may be slack). Fixtures weighing 56 lbs or more must be supported directly from the structure by approved hangers.
- F. Light fixtures hung below suspended ceilings by pendants, cables, chains, conduit, rods, or other means shall be supported from structure above using #9 AWG wire hanger or alternate support approved by Inspection Authorities.
- G. Securely fasten recessed and surface fixtures in place; provide seismic clips (one each corner) for lay-in fixtures; attach surface fixtures tight to ceilings and walls, and secure fluorescent fixtures within 12 inches of each end.
- H. Mounting height for wall mounted fixtures and for hanging fixtures supported by pendants, cable, chain, conduit, rods, or other means shall be determined by the architect/engineer during construction unless otherwise indicated in the construction documents.
- I. Install suspended fixtures so that no obstruction is located within the swing range. Pendants, rods, chains, or cables 48 inches and longer shall be braced to prevent swaying. In finished spaces, use stainless steel aircraft cable for sway bracing. Single stem fixtures shall be braced with cables installed 120 degrees apart. Fixtures and fixture assemblies with two or more supports shall be braced with two cables separated 120 degrees apart and attached to the suspension yoke or bracket located at each end of the fixture or assembly (4 cables total). Single stem fixtures shall be braced with stainless steel aircraft cable stretched taut across the room and attached to fixture stem using a suitable stainless steel shackle and cable clamp.
- J. Prior to substantial completion and before testing and operating manual or automatic fluorescent dimming systems, operate fluorescent lamps at full brightness for the minimum hours recommended by the lamp manufacture to meet burn-in requirements.

### 3.2 FIXTURE FAILURES

- A. Replace luminaires which have failed drivers or LED boards at completion of work.

### 3.3 ADJUSTING AND CLEANING

- A. Align and tighten luminaires and clean reflectors, lenses and diffusers at completion of work. Clean paint splatters, dirt, and debris from installed luminaires.

- B. Make final aiming adjustment of directional luminaires as directed by Architect/Engineer at completion of work.

### 3.4 EMERGENCY LIGHTING EQUIPMENT

- A. Exit, Self-Contained Emergency, Night lights: Connect ahead of switch control on local lighting circuit.

### 3.5 FIRE RATED CONSTRUCTION

- A. Recessed Luminaires: Provide field fabricated fire resistive shell acceptable to Fire Marshal and conforming to requirements of UL assembly rating for ceiling installed. Allow clearances around fixture for adequate ventilation per fixture manufacturers recommendations and UL listing.

### 3.6 THERMAL AND SOUND INSULATION

- A. Coordinate with General Contractor to ensure provisions are made to support insulation materials minimum of 3 inches clear of recessed lighting fixtures that are not IC rated.

### 3.7 CONCRETE BASES

- A. General: Provide concrete bases for anchor base poles and for pathway lights.
- B. Pole Bases: Size and construction as indicated. Install anchors using template obtained from pole manufacturer. Install poles on bases plumb; provide double nuts or shims for adjustment. Grout around pole bases.
- C. Bollard Bases: 12 inches square x 36 inches deep, flush with hard surface finish grade except in landscape or unfinished areas set 2-inch above final grade. Provide 1/2-inch chamfer on all exposed edges.

### 3.8 TRAINING

- A. Coordinate with Architect to arrange onsite training for luminaire and lighting inverters. Allow 20 minutes per each type of installed luminaire to review driver and LED board replacement. Allow four hours of factory training for the lighting inverters.

END OF SECTION





## PART 1 GENERAL

### 1.1 SCOPE

- A. Stage lighting and dimmer control system consisting of wiring devices, lighting instruments, and complete DMX dimmer control system utilizing color changing LED instruments.

### 1.2 RELATED SECTIONS

- A. Section 260500 - Basic Materials and Methods.

### 1.3 COORDINATION

- A. Determine final luminaire and support locations according to architectural reflected ceiling plans and elevations. In spaces open to structure, coordinate final luminaire locations and mounting heights with ductwork, piping, and structural members and submit final plan to Architect/Engineer for approval.

### 1.4 SUBMITTALS

- A. Submit product data for all items specified under Part 2 of this section and scheduled on the drawings. Include in submittal and in Operations and Maintenance Manual a coversheet listing each fixture type with corresponding LED/lamp and driver/ballast data.

### 1.5 OPERATION AND MAINTENANCE DATA AND TRAINING

- A. Submit all data in Operation and Maintenance Manuals.
- B. Provide onsite training on luminaire replacement.
- C. Include documentation from system start up.

### 1.6 WARRANTY

- A. LED Luminaires and Controllers: Provide five year comprehensive warranty.

### 1.7 EXTRA STOCK

- A. Provide two additional instruments of each type installed.

## PART 2 PRODUCTS

### 2.1 PIPE

- A. Black steel pipe 1-1/2" diameter with end caps, pipe clamps, fasteners, and mounting hardware. Lengths as shown.

### 2.2 CONNECTOR STRIPS

- A. Prewired heavy gauge steel wireway with twist lock receptacles, terminal box, pipe baton brackets, assembly hanger brackets, and accessories. Stagecraft Industries or equal.
  - 1. Wireway: 2 inch x 4 inch minimum with removable cover and standard 6 inch on center knockout spacing.
  - 2. Receptacles: Flush twist lock 20 amp NEMA grounded 120 volt.
  - 3. Mounting Hardware: Include hanger brackets, pipe baton brackets, 1-1/2 inch diameter pipe for mounting lighting instruments, 3/8 inch minimum steel cable hangers with attachment thimbles.
  - 4. Circuit Identification: Engraved laminated plastic, black letters on white or yellow background, 2 inch number height.
  - 5. Finish: Black.
  - 6. Supply: Ceiling mounted junction box, multiconductor SO supply cable, Kellums strain relief each end.
  - 7. Quantities: See Drawings

## 2.3 LIGHTING INSTRUMENTS

- A. TRA - Par Lights (Quantity 12 Instruments): DMX controlled, Full Color (RGBAL) PAR LED with interchangeable lenses, provide with wide, narrow and medium lenses, C-clamp, wire leads with NEMA 5-15P, and plug safety chain, rated for 50,000 hours. Chauvet Ovation P-56F.
- B. TRB - Ellipsoidal Spotlights (Quantity 12 Instruments): DMX controlled, Full Color (RGBAL) ERS LED with interchangeable lenses, provide with wide and narrow lenses, C-clamp, wire leads with NEMA 5-15P, and plug safety chain, rated for 50,000 hours. Chauvet Ovation P-56F.
- C. Wireguard: Custom design for protection of spotlights with mounting hardware.
- D. Color Media: Furnish a starter package of 6 GamColor color media (pale lavender, dark sky blue, primary blue, fire red, light amber, and bright pink).

## 2.4 DIMMING SYSTEM

- A. DMX Control System with 8-relay panel complete with DMX 8-port merger, power supplies, output jacks and cables, nLight Fresco DXT system with Fresco LMP1 lighting management panel.
- B. Control Unit: Desktop theatrical control panel, with multi-touch display capable of reading QR codes, with Smart Tablet interface and built in effects generator. ChamSys QuickQ10.
- C. Wall Mount Control Station: LCD Touchscreen, capable of 72 channels and 36 scenes; nLight Fresco FSC Architectural Lighting Control.

## PART 3 EXECUTION

- 3.1 Install equipment per manufacturer's recommendations. Focus and aim as recommended by manufacturer.
- 3.2 Provide necessary supports to secure pipe to structure. Furnish detail for approval.

- 3.3 All stage lighting circuits to have separate neutral for each hot conductor, grounding per code. No common neutrals.
- 3.4 Schedule for dimming system factory representative to energize system and provide initial programming of dimming system “scenes”.
- 3.5 Provide training of system using manual as basis of instruction. Allow for one two-hour session to be scheduled at Owner’s convenience.

END OF SECTION



**DIVISION 27**  
**COMMUNICATIONS**



## PART 1 GENERAL

### 1.1 SUMMARY

- A. The purpose of this section is to describe the commissioning process specific for those sections found in Division 27.

### 1.2 ADMINISTRATIVE REQUIREMENTS

- A. General Responsibilities: The Contractor's commissioning responsibilities applicable to each of the communication contractor, and audio/visual contractors are as follows:
  - 1. In each purchase order or subcontract written, include requirements for submittal data, commissioning documentation, O&M data and training.
  - 2. Attend a commissioning kick-off meeting and other meetings necessary to facilitate the Commissioning process.
  - 3. Contractors shall assist in clarifying the installation, operation, maintenance, and control of commissioned equipment if requested by the Commissioning Authority.

### 1.3 COORDINATION

- A. Refer to Section 019100 for a listing of all sections where commissioning requirements are found, for systems to be commissioned and for functional testing requirements.

### 1.4 SUBMITTALS

- A. General Submittals: Contractor shall provide to the Commissioning Authority, through established channels, normal cut sheets and shop drawing submittals for all commissioned equipment.
- B. Provide assistance to the Commissioning Authority in preparation of the specific functional performance test procedures specified in Section 019100. Subcontractors shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.

## PART 2 PRODUCTS (Not Used)

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Installation Checklists: The Contractor shall complete the checklist(s) provided with the Facility Grid app.
  - 1. The completion of these checklists does not limit the Contractor's responsibilities for quality control and scheduling as indicated elsewhere in the documents, nor does this checklist include all submittal, inspection, or quality assurance requirements for the work of this Section.

2. Complete the installation checklists for each component and each system to be commissioned with the Facility Grid app and updated at a minimum of once per week.
  - a. The field technician or installer should complete the updates that will be logged by Facility Grid.
  - b. The installer should be aware of the importance of proper installation and that verification of the installation of components will be on going through out construction by the Commissioning Authority.
  - c. The checklists are available for review by the Construction team and Commissioning Authority at any time by logging in to Facility Grid.

### 3.2 START-UP ACTIVITIES

- A. General Requirements: Develop a project start-up plan using manufacturer's start-up procedures and the installation checklists for all commissioned components. Submit to Commissioning Authority for review and approval 14 days prior to startup. Refer to Division 01 91 00 for further details on the start-up plan.
  1. Notify the Owner's Representative and Commissioning Authority, when communication system testing will occur. Be responsible to notify the Owner's Representative and Commissioning Authority, ahead of time, when commissioning activities not yet performed or not yet scheduled will delay construction.
  2. Coordinate schedule of start-up plan with the HVAC mechanical, electrical and controls contractors. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the Commissioning Authority or Owner.
  3. During the startup and initial checkout process, execute the portions of the installation checklists for all commissioned components.
  4. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the Architect and Commissioning Authority.
  5. Provide skilled technicians to execute starting of components. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem solving.

- 3.3 Pre-Verification Testing (PVT): The Contractor will perform the Pre-verification tests as provided with the Facility Grid app. The PVT's will be done on all equipment and systems outlined in Division 01 91 00. When all pre-verification testing has been completed, the CA will schedule Functional Performance testing and substantial completion may be issued.

### 3.4 CLOSEOUT ACTIVITIES

- A. Training: The Owner personnel shall be trained on procedures listed in 1.1A above.
  1. Provide results of all manufacturer recommended tests, conductivity tests, and correction sheets for systems installed in this Division.
- B. Operation and Maintenance Manuals: The approved complete manuals must be on site prior to training.
  1. For additional O and M related requirements, review Division 1.
- C. Training: The Owner personnel shall be trained on procedures related to the list in 1.1A above.
  1. For additional training related requirements, review Division 1.



### 3.5 DOCUMENTS REQUIRED

A. The General Contractor will provide the following documentation before Final Acceptance:

1. Completed Inspection Forms with approval signatures of all Authority Having Jurisdiction.
2. Approval Signature of Electrical Engineer
3. Provide test results of Audio/Video Conductivity. Use Manufacturer's test forms.
4. Provide tests results for Public Address and Intercom System. Use Manufacturer's test forms.

END OF SECTION



## PART 1 GENERAL

### 1.1 SECTION INCLUDES

- A. Cable and accessories for local area telecommunications network.
- B. Cable for all internet protocol (IP) based audio and video systems.
- C. Station Outlets for local area telecommunications network.
- D. Cross-Connect Components for local area telecommunications network.
- E. Equipment Mounting for all internet protocol (IP) based audio and video systems.
- F. System Design for local area telecommunications network.
- G. Uninterruptible Power Supplies for local area telecommunications network.

### 1.2 RELATED SECTIONS

- A. Section 260100 - Electrical General Requirements.
- B. Section 260500 - Basic Materials and Methods.
- C. Section 260526 - Grounding and Bonding.
- D. Section 260530 - Low Voltage Electrical Systems Pathways.
- E. Section 275123 - Integrated Electronic Communications and Clock Network.
- F. Section 282300 - Closed Circuit Television System.

### 1.3 REGULATORY REQUIREMENTS

- A. Conform to requirements of the latest revisions of the following standards:

TIA/EIA-569A	Commercial Building Standard for Telecommunications Pathways and Spaces
TIA/EIA-568B.1, 2, 3	Commercial Building Telecommunication Standards
TIA/EIA-455-61	FOTP-61, Measurement of Fiber or Cable Attenuation Using an OTDR
TIA/EIA-606	Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
TIA/EIA-607	Commercial Building Grounding and Bonding Requirements for Telecommunications

### 1.4 LOCAL AREA NETWORK SYSTEM DESCRIPTION

- A. Provide design and installation of horizontal structured cabling system consisting of unshielded twisted pair (UTP) horizontal station wiring with fiber optic backbone for voice and data networks. Horizontal fiber to be used for devices located more than 250-feet from a

telecommunications closet.

- B. Horizontal Station Cabling System (wireless access points): Conform to TIA/EIA Category 6A channel rated requirements. Terminate each station jack via a dedicated cable to a patch panel at the nearest Distribution Frame or wiring closet located on same floor unless otherwise indicated.
- C. Horizontal Station Cabling System (wall stations, CCTV, intercom system): Conform to TIA/EIA Category 6 channel rated requirements. Terminate each station jack via a dedicated cable to a POE+ patch panel at the nearest Distribution Frame or wiring closet located on same floor unless otherwise indicated.
- D. Horizontal Fiber Cabling System (site CCTV and signage): Provide multi-mode outdoor rated fiber optic cable to a dedicated fiber patch panel at the nearest Distribution Frame.
- E. Fiber Optic Backbone: Provide single-mode fiber optic cable from each Intermediate Distribution Frame (IDF) to the MDF. Each fiber cable shall be terminated at a fiber patch panel each end.
- F. Coordinate with Kelso School District wide area network fiber installer to bring services into the building.

#### 1.5 CABLING INSTALLATION FOR OTHER IP BASED SYSTEMS

- A. Install unshielded twisted pair (UTP) wiring for intercom/clock and closed circuit video recording devices (Sections 275123 and 282300). Provide a unique color cable for each system.
- B. Install patch panels and other accessories furnished by Sections 275123 and 282300 in MDF and IDF racks.
- C. Fiber Optic Backbone: One pair of the multi-strand fiber optic cable specified for the local area network shall be used for intercom/clock and one pair shall be used for closed circuit video recording. Clearly identify use on the fiber optic patch panel.

#### 1.6 COORDINATION

- A. Review shop drawings and product submittals for all IP based systems prior to the beginning of the building rough-in period. Include time for a minimum of one meeting to review requirements with line voltage contractor and Section 275123 and 282300 contractors.

#### 1.7 SUBMITTALS

- A. Submit product data for all items specified under Part 2 of this section.
- B. Submit terminal labeling plan and typical classroom layout prior to submission of shop drawings for approval.
- C. Verify room numbers with architect and use final numbers for station labeling and record documents as identified during construction.
- D. Submit shop drawings showing floor plans with room numbers, station outlet locations,

horizontal station cable routing, backbone cable routing, and alpha numeric identification of terminals and jacks. Include elevation plans showing layout of cross-connect and wire management hardware. Show location and size of conduit sleeves for open cable routing.

- E. Submit documentation for tests required under Part 3 of this section.

#### 1.8 OPERATION AND MAINTENANCE DATA

- A. Include data and extended warranty information for complete PDS in Operation and Maintenance Manual.
- B. Include cable certification test results for each UTP and Fiber Optic cable. Provide (2) CD's with complete set of As-built drawings and test results.

#### 1.9 AS-BUILT RECORD DRAWINGS

- A. Record drawings to reflect final room numbers and station numbers as determined during construction.
- B. Document routing of all cabling and update riser diagrams.
- C. Include elevations of all racks showing all installed components.
- D. Provide half-size laminated set to be left on site.

#### 1.10 QUALIFICATIONS

- A. Company: Contractor specializing in the design, installation, and testing of high speed data and voice network systems for a minimum of five years.
- B. Installers: Trained and experienced technicians of the company, certified by the product manufacturer and by Building Industry Consulting Service International (BICSI) for the PDS cabling, hardware, and accessories being installed, shall perform the work.
- C. The contractor must have on staff at least 1 Registered Communications Distribution Designer (RCDD), in good standing through the Building Industry Consulting Service International (BICSI).

#### 1.11 WARRANTY

- A. The structured cabling system shall be covered by the manufactures Application Assurance and Extended Warranty, for a period of no less than 25 years.
- B. This warranty shall cover all telecommunications structured cabling materials supplied in this specification including copper and fiber optic connectivity, racks, etc.
- C. The specialty contractor performing this work must be certified and trained by the manufacture for the system which it is to install, prior to the bid date and provide certification documentation upon request.

- D. Provide warranty certificate, issued by the manufacture to the owner, with the project close out documentation.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURER

- A. UTP Cable: Hitachi, CommScope Systimax, AMP, Superior Essex.
- B. UTP Station Outlets and Cross-Connect Components: CommScope Systimax, AMP, Ortronics.
- C. Fiber Optic Cable, Equipment, and Accessories: Ortronics, AMP or Hitachi other approved under the PDS warranty certification.
- D. Equipment Racks and Cabinets: Chatsworth Products, Great Lakes.
- E. Uninterruptible Power Supplies: Rack Mount Minuteman ED3000RM2U or approved equal.

### 2.2 CABLE

- A. Station Cable - Wall Stations, Classroom AV stations, Ceiling Mount Projectors, Interior and building mounted CCTV and Intercom System: UL type CMR, TIA/EIA Category 6, 24 AWG solid copper, 4-pair unshielded twisted pair, riser rated, color coded to indicate purpose (blue = wall stations, yellow = CCTV, white = intercom, orange = other). Cable installed outdoors or below slab on grade shall have a water block core and be rated for outside plant and inside plant installation.
- B. Station Cable: UL type CMR, TIA/EIA Category 6A 24 AWG solid copper, 4-pair unshielded twisted pair, color coded jacket overall, riser rated. Cable installed outdoors or below slab on grade shall have a water blocking core and suitable for installation below grade in conduit. Cable installed outdoors or below slab on grade shall have a water block core and rated for outside plant and inside plant installation when installed in conduit.
- C. Station Cable, Horizontal Fiber: Indoor/Outdoor riser rated 4-strand multi-mode fiber.
- D. Trunk Cable (Telephone Backbone): UL Type CMR, TIA/EIA Category 6 24 AWG solid copper, multiple unshielded twisted pairs, color coded, jacket overall. Cable installed outdoors or below slab on grade shall be gel filled and suitable for installation below grade in conduit.
- E. Single-Mode Riser Rated Fiber Optic Cable (Data Backbone): UL listed OFNR twelve (12) strand single-mode OM3, high performance laser core, 10 GB certified for 300 meters at 850nm, indoor/outdoor rated, loose buffer.

### 2.3 CABLE ACCESSORIES

- A. Cable Support: Extra wide base J hooks, with plenum rated tie wraps. Caddy cable cat system or equal. Staples, straps, bridle rings, and similar supports are prohibited.
- B. Fiber Protection, Inside Plant: Non-metallic corrugated flexible raceway, 1 inch minimum

diameter, orange color, UL listed for use with OFNR fiber cable. Carlon Riser-Gard or equal.

- C. Fiber Protection, Outside Plant: Non-metallic corrugated flexible raceway, 1 inch diameter, orange color, UL listed for use as an innerduct within conduit systems.
- D. Wire Management, Backboards: Provide open "D" style wire rings for horizontal and vertical cable management, including strain relief, bend radius, and cable routing.
- E. UTP Voice Cable Circuit Protection, Outside Plant: UL 497, solid-state, fused, press to fit cross-connect block protectors with automatic reset and ground bar attachment. ITW Linx UltraLinx series protector or equal. Provide for each circuit pair.
- F. UTP Data Cable Circuit Protection, Outside Plant: UL 497, solid state modular protector. Provide rack mounted patch panel configuration for bundles or pathways that exceed 6 cables. ITW Linx or equal. Provide for protection for each cable.

## 2.4 STATION OUTLETS

- A. Outlet Jacks: TIA/EIA-Category 6 or 6A to match cable type specified for application, T568B RJ45, 8-position/8-conductor, keyed modular jack.
- B. Faceplates: Thermoplastic with identification strip top and bottom; 3 module/6 port capacity; color to match wiring devices. Provide blank modules for unused plate opening.
- C. Floor Box Outlets: Standard duplex mounting strap with modular snap-in outlet jacks. Provide blank insert where ever jack is not installed.
- D. Outlets in Two-Piece Surface Metal Raceway: Decorator (rectangular) style duplex mounting strap with modular snap-in outlet jacks. Provide blank insert where ever jack is not installed.
- E. Biscuit Jack: 2-Port surface mount box with 2-outlet jacks, ivory. Manufacturer to match outlets.

## 2.5 CROSS-CONNECT COMPONENTS

- A. Terminating Blocks: AT&T 110 series connecting blocks with stand-off brackets, bridging clips, cable troughs, and distribution rings as required for cable management. Provide labeling strips for conductor assignment identification.
- B. Telephone Cross Connect: TIA/EIA Category 5, printed circuit board patch panels, multi-port modular construction with RJ45 8-position jacks, AT&T 110 connector system, T568A wiring, identification strips, 19 inch rack mounting, unless otherwise indicated. Provide sufficient panels and quantity of ports equal to at least 40% of the number of installed stations jacks.
- C. Station Outlet Cross Connect: TIA/EIA Category 6 or 6A to match cable type specified for application, printed circuit board patch panels, 6-port modular construction with RJ45 keyed 8-position jacks, 110 type connector system, universal T568A/B wired for T568B, identification strips, and 19 inch rack mounting, unless otherwise indicated. Provide sufficient panels and quantity of ports equal to the number of terminated stations cables plus 20%.

- D. Intercom/Clock System Cross Connect: PoE+ TIA/EIA Category 6 printed circuit board patch panels, 6-port modular construction with RJ45 keyed 8-position jacks, 110 type connector system, universal T568A/B wired for T568B, identification strips, and 19 inch rack mounting, unless otherwise indicated. Provide sufficient panels and quantity of ports equal to the number of terminated stations cables plus 20%.
- E. Fiber Cross Connect: Twelve (12) port LC style panel installed in locking protective cabinet with provisions for fiber storage, fiber routing, and connector identification; 19 inch rack mounting, unless otherwise indicated.
- F. Patch Cords: Patch Cords, Category 6: UL type CM, 4-pair cable with RJ45 plug each end, length not to exceed 4 meters, quantity equal to number of Category 6 cables installed. Verify length with shop drawing of rack elevations prior to ordering. Color to match installed cable, color-coded to indicate purpose.
- G. Fiber Optic Connectors: Single-mode LC style. Quick cure epoxy adhesive. Bayonet style coupling with multi-mode ceramic or glass-in-ceramic ferrule, keyed for repeatable performance.
- H. Single-Mode Fiber Patch Cords: Preassembled single fiber, ULTRA grade jumper cord with connectors each end, length 3 meters. Provide one patch cord for each terminated/assigned fiber patch panel port plus 10%, with ST to LC connectors as required (verify with Owner).
- I. Patch Cords, Category 6A: UL type CM, 4-pair cable with RJ45 plug each end, length not to exceed 4 meters, quantity equal to number of Category 6A cables installed. Verify length with shop drawing of rack elevations prior to ordering. Color: Green.

## 2.6 EQUIPMENT MOUNTING

- A. Equipment Racks, Floor: Aluminum self supporting frame designed for open rack mounting of telecommunications equipment, base anchor design, pre-drilled EIA mounting holes, 19 inches wide by 84 inches high unless otherwise indicated. Provide four equipment shelves with mounting hardware. Finish: black.
- B. Equipment Racks, Wall: Steel or aluminum one piece wall bracket with hinged swing out panel mount feature, 19 inches wide by 6 inch nominal deep.
- C. Equipment Cabinets, Floor: Free standing, removable side panels, hinged steel vented rear door with lock, hinged steel front with lock, 24 inch by 24 inch by 84 inch unless otherwise indicated with EIA provisions for rack mounted 19 inch wide equipment, integral ventilation blower and 8 outlet (minimum) plug strip, and floor levelers. Furnish with four equipment shelves and mounting hardware. Locks shall be keyed to match branch circuit panelboards. Finish: grey or black enamel.
- D. Equipment Cabinets, Wall: Wall mounted, vented side panels, hinged steel door with lock, 48H x 21W x 20D inch minimum, hinged swing out panel mounting frame with EIA provisions for rack mounted 19 inch wide equipment. Provide with integral 250 CFM minimum ventilation fan and two equipment shelves and mounting hardware. Locks shall be keyed to match branch circuit panelboards. Finish: grey or black enamel.
- E. Wire Management, Equipment Racks: Provide vertical wire management channels each side of equipment racks for strain relief; bend radius, and cable routing. At each patch panel



provide rear mounted strain relief bar for station cable routing and front mounted wire management rings or cable trough for patch cords.

- F. Power Supplies: Rack mounted, 120 VAC, line interactive, uninterruptible power supply (UPS) with surge protection and filtering, (6) NEMA 5-15R receptacle outlets (minimum), USB connectivity, status display for On Line/On Battery/Replace Battery/Overload, and low battery/on battery alarms. VA rating indicated. APC Smart UPS SUA series or approved.
- G. Plug Strips: Rack mounted, 120 VAC power strip, with (8) NEMA 5-15R rear mounted 90 degree receptacle outlets, power switch, UL 1449 surge protective device, and 20 amp 6-foot cord & plug input.

### PART 3 EXECUTION

#### 3.1 PREPARATION

- A. Provide location and size of conduit sleeves for routing open cables thru fire rated construction, draft stops, and partition walls in attics, crawl spaces, and accessible ceiling spaces. Size sleeves with 25% minimum space capacity. Indicate on shop drawings for coordination with Section 260530. Review requirements in person with line voltage electrical contractor prior to building rough-in.
- B. Review intercom/clock shop drawings prior to rough-in. Review CCTV camera locations with Owner prior to rough-in. Allow for intercom speaker relocation up to 20-lineal feet. Allow for relocation of CCTV cameras up to 50-lineal feet.

#### 3.2 INSTALLATION - GENERAL

- A. Comply with product manufacturer installation instructions. Conform to requirements of TIA/EIA- 568-B and TIA/EIA-569 for the specified Category.
- B. Unless otherwise indicated, provide one cable drop per jack.
- C. Label station outlets sequentially using the following alpha/numeric identification plan unless otherwise directed: IDF# - Room# - Outlet# -Jack (A, B, . . .). In each room start with first outlet by main entrance door and continue clockwise around room. Label station cable at each end with a permanent cable marker to match the corresponding terminal number. Label each station jack using polyester film adhesive pre-labeled markers to indicate corresponding terminal number. Use final room names and numbers identified by Owner. Provide permanent station label on ceiling grid for all wireless access point Biscuit Jack locations and on all CCTV biscuit jacks. Label for CCTV biscuit jacks to be minimum 1/2" letters.
- D. Label voice cross-connect terminals sequentially using an approved numeric or alpha-numeric plan submitted for approval.
- E. Conceal wiring in suspended ceiling spaces, attic spaces, crawl spaces, and in wall construction. Utilize conduit rough-in specified in Section 260530 and shown on drawings. Install cable in neat parallel runs within cable trays and down to cross-connect hardware without rolls, twists, or loops.
- F. Install cables continuous without splicing. Install open cable above accessible ceilings,

parallel and perpendicular to building lines. Bundle cables with nylon tie wraps and support cable in tray, conduit sleeves, or from structure using specified J hooks at intervals not to exceed 4-1/2 feet. Maximum number of cables per bundle shall be 48.

- G. Provide cable slack to meet TIA/EIA standards, minimum.
- H. Seal conduit sleeves thru fire rated construction using silicone foam system, Chase-Foam CTC PR-855, 3M CP 25, or Dow Corning RTV.
- I. Maintain a minimum 6 inch separation from parallel power wiring. Do not share bore or knock out holes thru wall studs and other structural members with power wiring.
- J. Secure floor mounted equipment racks with four (4) 5/8 inch diameter anchor bolts, one near each corner of floor base. Use lead expansion anchors in concrete floors.
- K. Coordinate with line voltage electrical contractor to ensure grounding of all exposed non-current carrying metallic parts of the communications system.
- L. Provide fiber optic cable within protective non-metallic raceway system. Install raceway to within 18 inches of fiber termination.
- M. Equipment Cabinets: Provide equipment cabinets for IDF and MDF racks located in attic spaces and where otherwise indicated.
- N. Provide required telecommunication wiring between fire alarm transmitter and telephone service demarcation point. Verify requirements with fire alarm system provider. Allow for (2) RJ31 jacks with dedicated Category 5 or better station cable terminated at a shared headend cross connect block reserved for analog telephone service interface.
- O. Provide required telecommunication wiring between intrusion alarm transmitter and telephone service demarcation point. Verify requirements with intrusion alarm system provider. Allow for (2) RJ31 jacks with dedicated Category 5 or better station cable terminated at a shared headend cross connect block reserved for analog telephone service interface.
- P. Provide required telecommunication wiring between Owner provided emergency alert system and telephone system.
- Q. Provide UL497 primary circuit protection at building entrance and building exit for all outside plant copper telecommunication cabling.

### 3.3 INSTALLATION – INTERCOM/CLOCK SYSTEMS

- A. Comply with product manufacturer installation instructions. Conform to requirements of TIA/EIA- 568-B and TIA/EIA-569 for the specified Category.
- B. Wiring:
  - 1. Provide dedicated Category 6 cable to each speaker or combination clock speaker location except as follows:
    - a. Outdoor speakers may share same cable homerun.
    - b. Speakers in hallways, corridors, restrooms, and toilets may share same cable homerun.

- c. More than one speaker in common room or space may share same cable homerun.
  2. Conceal wiring in suspended ceiling spaces, attic spaces, crawl spaces, and new wall construction.
  3. Utilize conduit rough-in specified in Section 260530 and shown on drawings. Install cable in neat parallel runs within cable trays and down to terminal hardware without rolls, twists, or loops.
  4. Consistently color code wiring throughout per Shop Drawings. Do not splice conductors. Terminate conductors at terminals of equipment and devices. Install patch panel and other rack mounted equipment furnished by Sections 275313 and 275123.
  5. Support cable at intervals not exceeding 4-1/2 feet.
  6. Segregate and bundle wiring separate from the other signal systems except intercom wiring provided under Section 275313 may share same cable or wiring bundle.
- C. Prior to connection of any terminal equipment, all intercom cables shall be tested for continuity. All defective cabling is to be replaced prior to device hook-up. Testing results to be reviewed by Section 275123 installer and corrections to be performed by Section 271001.
- D. Coordinate with line voltage electrical contractor to ensure grounding of all exposed non-current carrying metallic parts of the communications system.
- E. Fire Rated Construction: Conform to requirements of Section 260100. See Architectural plans for location of rated walls and ceilings.

### 3.4 INSTALLATION – CLOSED CIRCUIT VIDEO CAMERAS

- A. Comply with product manufacturer installation instructions. Conform to requirements of TIA/EIA- 568-B and TIA/EIA-569 for the specified Category.
- B. Wiring:
1. Provide dedicated Category 6 cable to each camera location shown, terminate in Biscuit Jack if above ceiling or in wall jack. Where cable distance exceed 100 meters, furnish PoE extender.
  2. Provide dedicated camera Category 6 patch panels in MDF and IDF racks.
  3. Conceal wiring in suspended ceiling spaces, attic spaces, crawl spaces, and new wall construction.
  4. Utilize conduit rough-in specified in Section 260530 and shown on drawings. Install cable in neat parallel runs within cable trays and down to terminal hardware without rolls, twists, or loops.
  5. Consistently color code wiring throughout per Shop Drawings. Do not splice conductors. Terminate conductors at terminals of equipment and devices.
  6. Support cable at intervals not exceeding 4-1/2 feet.
  7. Segregate and bundle wiring separate from the other signal systems.
- C. Prior to connection of any terminal equipment, all cables shall be tested for continuity. All defective cabling is to be replaced prior to device hook-up. Testing results to be reviewed by Owner's CCTV camera installer and Information Technologies Department and corrections to be performed by Section 271001.
- D. Coordinate with line voltage electrical contractor to ensure grounding of all exposed non-current carrying metallic parts of the communications system.

### 3.5 TESTING

#### A. UTP Cabling:

1. Test station drops for specification compliance at completion of work. Correct deficiencies by replacing terminations, components, or cable as required.
2. Perform continuity test on each wire/pair prior to cover. Verify no open circuits, short circuits, or accidental grounds exist.
3. PDS shall be certified to meet or exceed the specifications as set forth in TIA/EIA TSB40 and TIA/EIA 606-A for specified Category compliance. Certifications shall include the following parameters for each pair of each cable installed:
  - a. Wire Map (pin to pin connectivity)
  - b. Length (in feet)
  - c. Attenuation to Crosstalk Ratio (ACR)
  - d. DC Loop Resistance
  - e. Ambient Noise
  - f. Near-End Crosstalk (NEXT)
  - g. Equal-Level Far-End Crosstalk (ELFEXT)
  - h. Return Loss (RL)
4. Use test equipment such as the Ideal LANTEK 6 or approved equal to measure all essential cable parameters specified by TIA/EIA and UL thru Category 6. Provide a written record of these tests.
5. Correct malfunctions when detected and proceed with testing. Record test results on a "UTP Cable Test Results" form showing frequency tested and PASS/FAIL results.

#### B. Fiber Optic Cabling:

1. OTDR Acceptance Tests: Test fiber optic cable for continuity, normalized fiber loss, and overall length verification, using an Optical Time Domain Reflectometer (OTDR). Attenuation measurements in dB/km shall be performed for each multi-mode fiber at 850 nm and 1300 nm wavelengths. Perform tests of cable after cable is installed and before connectorizing. Attenuation of multimode fibers shall be no greater than 3.0 dB/km at 850 nm and no greater than 1.0 dB/km at 1300 nm. Installed cables with any damaged fibers shall be removed and replaced at Contractor expense.
2. Visual Inspection Reports: Visual inspection of each field installed fiber optic connector shall be documented to include report on end face quality, polish, and informational comments.
3. Optical Loss Tests: Fibers shall be loss tested in both directions at 850 nm and 1300 nm wavelengths after connectorization. Acceptable attenuation shall be any value less than the fiber attenuation plus 0.5 dB per multimode fiber connector.
4. Use test equipment such as the Ideal FIBERTEK or approved equal to measure all essential parameters specified. Provide a written record of these tests.
5. Correct malfunctions when detected and proceed with testing. Record test results on a "Fiber Optic Cable Test Results" form showing PASS/FAIL results.

#### C. All testing shall be in compliance with the manufactures requirements for project certification, both copper and fiber optic.

### 3.6 DOCUMENTATION

- #### A. Documentation includes the following and shall be delivered to the Architect/Engineer within 20 working days after the wiring is completed.
1. Certification documents and test results.

2. Record drawings.
3. Permanent ID record at each MDF and IDF location.
4. Cable color code chart indicating color and purpose at each MDF and IDF location.  
Coordinate with building energy management system contractor to ensure that each system has a unique color.

END OF SECTION



## PART 1 GENERAL

### 1.1 SECTION INCLUDES

- A. Audio Switchers.
- B. Amplifiers.
- C. A/V Control Stations.
- D. Microphones.
- E. Speakers.
- F. Audio Video Outlets and Associated Cabling.
- G. Accessories.

### 1.2 RELATED SECTIONS

- A. Section 260100 - Electrical General Requirements.
- B. Section 260500 - Basic Materials and Methods.
- C. Section 260526 - Grounding and Bonding.
- D. Section 260530 - Low-Voltage Electrical Systems Pathway.
- E. Section 271001 – Telecommunications Premises Wiring.
- F. Section 275123 – Integrated Electronics Communications and Clock Network.

### 1.3 SYSTEM DESCRIPTION

- A. Standalone room audio-video sound amplification system and component pre-wire in rooms indicated. Provide all accessories, cables and components required for complete sound reinforcement system with audio-video control feature and interface to Rauland Telecenter U intercom system. Coordinate with Division 27 10 01 for local area network connection at each enclosure.

### 1.4 SUBMITTALS

- A. Submit product data for all items specified under Part 2 of this section.
- B. Submit shop drawings to include floor plans showing location of all equipment and devices. Indicate size, type, quantity, and routing of interconnecting wiring on floor plans. Show location and size of conduit sleeves for open cable routing.

### 1.5 OPERATION AND MAINTENANCE DATA

- A. Include data for complete system in Operation and Maintenance Manuals. Include manufacturer general information guide book for the system and actual options furnished.

## 1.6 QUALIFICATIONS

- A. Installers: Trained, experienced, and licensed technicians of company having minimum three years experience in the installation of AV systems and certified to install the FrontRow system shall perform the work.
- B. Authorized factory representative of the system being installed shall supervise installation, programming, testing, and adjustment of the system. Approved Sub-Contractor: Troxell.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Hardware: FrontRow.
- B. Cable: CommScope, Belden, Berk-Tek, West Penn, Black Box, TecNec.
- C. USB Outlets: Atlona

### 2.2 STANDARD CLASSROOM SYSTEM

- A. FrontRow Trio ceiling mounted system with integral speakers and electronics. With 8-button touchpad selector switch with Bluetooth connectivity, input station and output connectors. With wireless microphone. With interface to intercom system.
- B. USB Connectivity between teacher station and projector.
- C. Faceplates: FrontRow plates to match District Standard.

### 2.3 USB CABLING SYSTEM

- A. Outlets: Passive USB
- B. Cabling: Premium USB cable with overall jacket.
- C. Faceplate: To match device.

### 2.4 HDMI CABLING SYSTEM

- A. Outlets: Modular HDMI female to female coupler.
- B. Cabling: High speed HDMI 26/24 AWG, 13.2 Gbps cable, male to male gold plated connectors, UL listed for in-wall Class 2 installation.

### 2.5 MATERIALS

- A. Conductors for 120 Volt Circuits: Building wire as specified in Section 260500.



- B. Conductors for Sound and Control Circuits: Color coded, multi conductor copper cable with overall foil shield and PVC jacket as recommended by manufacturer. Speaker cables shall include twisted pair conductors. Conductor size shall be as recommended by system manufacturer. Provide speaker and RS-232 communication wiring as required for complete system.
- C. Raceway: Comply with requirements of Section 270528.
- D. Cable Supports: Molded nylon clamps, heavy duty nylon ties, or galvanized steel bridle rings; size to match cables supported.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

- A. Review reflected ceiling plans for coordination with other trades in placing speakers. Locate infrared receiver at ceiling projector location.
- B. Comply with product manufacturers' installation instructions and requirements.
- C. Wiring:
  - 1. Conceal wiring in suspended ceiling spaces and new wall construction.
  - 2. Utilize conduit rough-in specified in Section 270528 and shown on drawings. Exposed wiring is not permitted.
  - 3. Cable installation shall comply with NEC 300-4 where installed through studs, joists, rafters, and similar structural members.
  - 4. Secure cable by straps or similar fittings so designed and installed as not to damage the cable, at intervals not exceeding 4.5 feet.
  - 5. Install cabling without splices, sharp bends, or physical distortions. Segregate and bundle wiring separate from the other signal systems.
  - 6. Protect cables with plastic bushing through device plates and outlet boxes.
  - 7. Terminate conductors at terminals of equipment and devices.

#### 3.2 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate operation, programming, and maintenance of system to Owner's personnel prior to Contract Close-Out. Allow two site visits scheduled at convenience of Owner, and 4 hours of total instruction.
- B. Use operation and maintenance manuals as basis of instruction. Review contents of manual with personnel in detail to explain all aspects of operation, programming and maintenance.

END OF SECTION



## PART 1 GENERAL

### 1.1 GENERAL REQUIREMENTS

- A. The work described by this specification includes the furnishing of all material, equipment, labor to install, and the performing of all testing necessary for the installation of a high-quality sound reinforcement system and video system complete and in proper operating condition as indicated on the drawings and/or described herein. The audio-visual system contractor shall demonstrate that the system meets the specifications to the satisfaction of the owner. The contractor shall have the responsibility for meeting the requirements of this specification. The work shall be in accordance with all provisions of the general condition and any supplementary special conditions.
- B. All major components shall be furnished and installed by a factory-authorized distributor.
- C. The AV system contractor and manufacturer shall have furnished and installed similar systems continuously for no less than five years.
- D. The contractor shall furnish and install all materials, even though not specifically mentioned herein, which are necessary for the proper integration of the system so that the system shall perform the functions listed herein in compliance with all the specified requirements.
- E. The AV system contractor shall guarantee availability of 24-hour local service by factory-trained personnel of the equipment manufacturer. The distributor shall have available stock of the manufacturer's standard parts.
- F. To qualify as a bidder, the electronics contractor shall hold the necessary licenses as issued by the State of Washington for an electrical contractor. Installation shall be made by a licensed and bonded contractor holding a valid Washington State Electrical Contractor's License. All work covered by this specification is to be performed by a holder of a current State of Washington Journeyman Electrical Certificate or Specialty Electrician for low energy systems.

### 1.2 SCOPE OF WORK

- A. Work within Auxiliary Gymnasium 061 is a complete system to be included in Base Bid. Work within Gymnasium 145 is a complete system to be included under Alternate Bid. Work within Cafeteria 012 is limited to installation of salvaged equipment with new faceplates, cabling and connectors and is to be included in Base Bid.
- B. New sound systems shall provide clear natural sound uniformly distributed throughout the designated listening areas. The system shall be bi-amplified to increase apparent loudness and reduce intermodulation distortion. The system shall consist of constant directivity mid and high frequency horns and cone transducer low frequency sections. The low frequency cross over point, of the main speaker cluster, is to be kept at or below 500Hz to maintain speech range pattern control and to enhance naturalness in lower speaking voices and music.
- C. The video system shall include a motorized retractable projection screen and large venue WUXGA 4K/60p signal input video projector with lens shift and zoom lens as required for location within space with operating software. Each projector to be mounted in a ceiling

mount retractable projector lift.

- D. A handheld, wireless infra-red remote control system for functional presets and level control is to be provided. The IR remote system shall provide, at a minimum the following user functions:
  - 1. Master volume control.
  - 2. Auxiliary source level control.
  - 3. Speaker muting.
  - 4. Equalization preset selection for music or speech.
  - 5. Presets for 4 user defined applications of the above parameters.
- E. Compliance with the Americans with Disabilities Act shall be accomplished through the installation of radio frequency broadcast, hearing assistance system for each space with transmitter and quantity of receivers as required, sized per maximum number of occupants.
  - 1. Main Gymnasium 145: 1058 occupants.
  - 2. Auxiliary Gymnasium 061: 641 occupants.

### 1.3 RELATED SECTIONS

- A. Section 260100 - Electrical General Requirements.
- B. Section 260500 - Basic Materials and Methods.
- C. Section 260526 - Grounding and Bonding.
- D. Section 260530 - Low-Voltage Electrical Systems Pathway.
- E. Section 271001 – Telecommunications Premises Wiring.

### 1.4 SUBMITTALS

- A. Computer Design: Provide computer aided design drawings and documentation clearly indicating proposed design. At a minimum the documentation shall show mounting and initial aiming of the speaker array, predicted results for coverage contours (isobars), predicted interference or shadowing, power analysis of speaker cluster and % Alcon's. All computer line drawings shall be printed using a pen plotter or laser printer for clarity.
- B. Provide clearly identified, complete catalog cuts of all major components including backboxes, cables and connection.
- C. Provide shop drawings showing engineering details of equipment interconnection including point to point wiring, gain or losses between components in dBm, switching configurations, color codes and connector pin configurations, matching networks and pads, rack elevations and equipment layout, speaker arrays with proposed mounting and aiming. Proposed wire routing, rough-in and installation information.

### 1.5 OPERATION AND MAINTENANCE MANUALS

- A. Provide PDF version and 3 complete bound O&M manuals describing maintenance and operation of the system. Include descriptions and service data on all component parts. Manual shall also include the following:
  - 1. Warranty statement indicating effective dates.

2. Complete engineering data on all systems furnished including point to point wiring diagrams of the system in its "as built condition".
3. Step by step instructions on operational procedures, including power up and power down sequences, special operational guidelines and standard preventative maintenance procedures. One copy shall be permanently affixed to equipment rack.

## PART 2 EQUIPMENT

### 2.1 DIGITAL SIGNAL PROCESSOR

- A. The digital signal processor shall provide 8 input channels and, by adding 8-channel expansion modules, may be increased to more than 64 input channels. The input pre-amplifiers shall be of discrete transistor design and the inputs will be differentially balanced to insure low noise and low distortion. Input transformers shall be available as an option. Phantom Power shall be selectable on each channel by internal jumpers, with +12 Volts standard and +48 Volts as an option. Trim controls on each channel shall have a 40dB range and rear mounted 30dB Pad switches shall provide a gain adjustment range of 70dB. Each channel shall have a rotary level control.
- B. Input to the channels, stacking input for expansion modules, and output from the mixer shall be provided on XLR connectors. Patch insert points shall be provided for the individual channels and the mixer output section on TRS 1/4" Phone connectors. The mixer shall provide signal and power connections for other Advantage SYSTEM ONE modules, which can provide automatic mixing, gain control, remote control, auxiliary output, and equalization functions to the system.
- C. The mixer shall include internal jumpers on channels 1-7 for Talkover muting of channel 8. The mixer output section shall include two variable notch filters, Treble & Bass equalization, a switchable high-pass filter, an adjustable output limiter, a signal present indicator, a rotary level control, and a balanced transformer isolated output. The expander modules shall include standard input channel features and an electronically balanced output, but not Talkover muting or the additional output section features. An expander module may be used as an independent mixer.
- D. The mixer shall have a Frequency Response of +0/-3dB from 20Hz to 20 kHz at +4dBu. THD shall be less than .08% from 20Hz to 20 kHz at +4dBu. EIN shall be less than -126dBu and output Hum & Noise shall be less than -75dBu from 20Hz to 20 kHz at nominal level. Power Consumption shall be less than 15 Watts. Dimensions shall be 1.75 inches (1 rack space) high, 19 inches wide, and 7 inches deep. The mixer and expander shall be UL listed.
- E. Symetrix Radius 12 x 8 Digital Signal Processor with four input Addition.
- F. Symetrix ARC Controller.

### 2.2 DIGITAL REMOTE CONTROL

- A. The digital remote control shall provide audio level and mute functions via infrared, wall-mount, and/or computer control. Internal microprocessors and a non-volatile memory shall provide four channels of digitally controlled VCA, four control voltages, five memorized set-ups, four logic outputs, and a serial port.

- B. Each channel of internal VCA shall provide both input and output on a single TRS 1/4" phone jack. Each channel shall also provide a patch insert point on a TRS 1/4" phone jack, for connection of additional signal processing devices. Four independent control voltages shall be provided, on rear panel screw terminals, for controlling Advantage RCII modules, other external VCA devices, or most standard lighting dimmers. Each control voltage shall be variable from 0 to +10 Volts, and may be used to control multiple VCAs. The digital remote control shall provide signal and power connections for Advantage SYSTEM ONE modules, which can provide mic/line mixing, automatic gating, gain control, auxiliary output, and equalization functions to the system.
- C. The digital remote control shall provide an internal infrared receiver, with hand-held infrared transmitters, external infrared receivers, and wall-mount control panels available as options. Rear panel screw terminals shall provide connection for up to three external infrared receivers and/or wall-mount control panels, which can be wired up to 2000 feet from the system. Infrared transmitters shall operate within 30 feet of infrared receivers. A 9-pin subminiature-D connector shall provide both an RS-232 serial port for computer control and four logic outputs for controlling external switching circuits. Front panel indicators shall display status of the four logic outputs. Remote control shall be available from up to five locations.
- D. The digital remote control shall provide four user presets, which are stored in a non-volatile memory along with the existing settings. Each preset shall include all level and mute settings for future recall. Presets may be recalled and changed via remote control. A front panel switch shall allow the user to store new or edited presets. Front panel indicators shall display which preset has been recalled, and indicate if any editing of the preset has occurred.
- E. The digital remote control shall allow re-configuration of the remote control commands for advanced applications. Re-configuration shall allow custom commands such as "stereo strapping", "multi-tasking", and "user lock-out" to be created. Re-configuration shall also allow changes in logic output operation. The digital remote control shall have a Frequency Response of +0/-0.5dB from 20Hz to 20 kHz at +4dBu. Total Harmonic Distortion shall be less than 0.04% from 20Hz to 20 kHz at +4dBu. Hum & Noise shall be less than -90dBu from 20Hz to 20 kHz at unity gain. Power Consumption shall be less than 15 Watts. Dimensions shall be 1.75 inches high (1 rack space), 19 inches wide, and 4 inches deep. Weight shall be 4.5 lbs.

## 2.3 EQUALIZERS

- A. The equalizers shall have two channels. Each channel shall have 28 one-third octave frequency bands at the preferred ISO center frequencies between 31.5 Hz and 16 kHz inclusively, and a master gain control. The gain of each frequency band and the master shall be programmable in 1 dB steps from -12 dB to +12 dB. There shall be no internal or external user gain controls, or other front panel controls. The equalizer shall be microprocessor controlled and programmable only from an external means.
- B. Each channel shall have a 3-pole (18 dB/octave) high pass filter with software-selectable corner frequencies. The corner frequencies of said filter shall be <10 Hz (OFF state), 40 Hz, 50 Hz, 63 Hz, 80 Hz, 100 Hz, 125 Hz, and 160 Hz. There shall also be a 3-pole (18 dB/c~ave) low pass filter for each channel with software-selectable corner frequencies. These frequencies shall be 5 kHz, 6.3 kHz, 8 kHz, 10 kHz, 12.5 kHz, 16 kHz, and >50 kHz (OFF state). The inputs and outputs of the equalizer shall be electronically-balanced with

provisions for the inclusion of optional input and output signal isolation transformers.

- C. The equalizer shall meet the following performance criteria. Maximum input level: at least 6.16 V rms. Input impedance: at least 15 k $\Omega$ . Maximum output power level: at least +18 dBm. Output noise: <-85 dBm A-wtd. (all gains at unity). Dynamic range: at least 105 dB. THD: <0.015% (all gains at unity). IMD (SMPTE 4:1): < 0.015% (all gains at unity). The equalizer shall be operable from a 120 V ac, 60 Hz supply.

## 2.4 POWER AMPLIFIERS

- A. The power amplifiers shall be a solid-state dual-channel model employing multi-mode (AB+B) grounded bridge output circuitry.
- B. The outputs shall be switchable as dual (stereo), bridged mono or parallel-mono modes of operation. The bridged-mono mode shall bridge the outputs to provide increased output voltage. The parallel-mono mode shall parallel the outputs to provide increased output current.
- C. The outputs shall also be capable of directly driving a "constant voltage" 70-V line without the use of "step-up" transformers. Each channel shall be independently switchable to this 70-V mode or to a nominal low-impedance mode. The output impedance of each channel shall be less than 10 milliohms in series with less than 2 micro henries in dual mode in dual mode.
- D. The amplifier shall contain protection circuitry which limits the drive level placed on the output devices before their known safe operating area is exceeded. This protection circuitry shall simulate the junction temperature of the output devices in order to predict how close they are to their safe operating limits. The amplifier shall be safe when driving any kind of load-even reactive ones. The power requirements shall be 120 VAC at 60 Hz. At idle, the amplifier shall draw 60 watts or less. With a continuous 1 kHz output of 75 watts (1/3 power) into 4 ohms (both channels driven in dual mode), as many as 6.63 amperes shall be drawn from the AC power source. Similarly, at 225 watts (full power) as many as 10.5 amperes shall be drawn from the AC power source.
- E. The amplifier chassis shall be constructed of steel and shall be designed for flow-through ventilation. It shall include a variable-speed on-demand cooling fan. The amplifier shall be finished with black splatter-coat paint and shall have a Lexan overlay on the front panel.
- F. The dimensions of the amplifier shall allow for 19 inch (48.3 cm) EIA standard (RS-310-B) rack mounting. The amplifier shall be 7 inches (17.8 cm) tall, 16 inches (40.6 cm) deep behind the rack-mounting surface, and 0.5 Inches (1.3 cm~) in front of the rack-mounting surface.
- G. QSC RMX2450a Power Amplifier.

## 2.5 HEARING ASSISTANCE SYSTEM

- A. The hearing assistance system shall be an FM band RF broadcast type complete with transmitter, co-axial antenna and pocket receivers. Provide complete with rack mounted installation kit. Williams Sound PPA-BBS-FM
- B. Main Speakers: The main speakers shall be a 2 way type with 15" low frequency speaker and combination long throw / short throw constant directivity horn with 1" compression

driver. Frequency response shall be from 50 Hz to 20 kHz. Power handling shall be 250 watts, axial sensitivity shall be 100.0 dB @ 1 meter. Directivity factor shall be at least 14.

- C. Listen LT-800-216-01 Assisted Listening System.
- D. Provide quantity as required for seating capacity.

## 2.6 A.C. POWER CONDITIONER

- A. The A.C. power conditioner shall provide a high voltage surge and transient suppressor combined with a high frequency noise / radio frequency interference (RFI) filter in a circuit breaker protected system. Rack mountable with eight switched outlets in the rear of the unit, providing a maximum load of 1200 watts and 10 amps. The front panel of the A.C. power conditioner shall include separate switches for the AC outlets and lights, and a status light indicating when power is applied to the rear outlets. Power conditioner shall come equipped with a 10 amp circuit breaker, heavy-duty 3-wire line cord.
- B. FURMAN SOUND Model PL-8.

## 2.7 EQUIPMENT RACK

- A. The sectional wall mounting equipment rack shall be constructed of 16 gauge CRS throughout. Hinges shall be bolted and not welded for strength. Rear section shall be of one piece construction with electric welding at all seams. Rear section shall have 1 1/2" (13mm)-3/4" (19mm) double knockouts at the top and bottom. Center section shall be secured with screw type locking rods and alignment pins. Panel mounting rails shall be tapped for 10-32 screws. Front door shall be 2" (51mm) deep and of one piece construction. All joints shall be electric welded. A cylinder lock shall be mounted on front door.
- B. Middle Atlantic Series or equal.

## 2.8 MICROPHONES

- A. Dynamic cardioid Noise-canceling microphone. The frequency response shall be 200 - 4,000 Hz, output impedance 150 ohms, output level -57 dB with 0db equaling 1 mW/10 dynes/cm (2) at 150 ohms.
- B. The microphone case shall be cyclac and pressure-cast zinc, and include a pressure-cast table stand integral with the microphone case. A DPDT switch shall be provided, one section of which shall normally short-circuit the transducer when switch is in "off" position and remove short-circuit in the "on" position. A second section of the switch shall be provided with the capability to function either in an electronic switching mode or for operation of external relay. A locking feature shall be provided by means of which switch may be locked in "on" position. A 7' black plastic two-conductor shielded cable equipped with a three-pin XLR type connector shall be furnished. Finish of the integral stand and microphone shall be non-reflecting grey. Net weight shall be 822 g (1lb, 13 oz).
- C. Shure SM58 handheld microphones, quantity of four (2 for each Gymnasium space).

## 2.9 WIRELESS MICROPHONE SYSTEMS

- A. The Wireless microphone systems shall consist of true diversity receivers and handheld and



lavalier type transmitters. The frequency range of operation shall be from UHF signal. Signal to noise ratio shall be greater than 105 dB. Receiver outputs shall be switchable from mic to line levels and shall have LED indications of audio level, squelch and diversity status. Average transmitter battery life shall be approximately 10hrs. The handheld transmitter shall have a neodymium type microphone element. Receivers shall be rack mounted; provide complete with antennae.

- B. Shure BLX288/PG48 dual handheld wireless microphone system.

## 2.10 MICROPHONE STANDS

- A. The floor stand shall be a general purpose stand, with grip-action clutch; low profile textured charcoal base, adjustable from 34" to 65" high; chrome plated, seamless upright steel tubing with 5/8" threads for microphone or microphone holder, and self-leveling shock absorbing pads on base.
- B. The microphone floor stand shall be ATLAS MS-12C Provide four.
- C. The desk stand shall be a general purpose stand, non-adjustable 4" high chrome tube, 6" diameter cast iron charcoal base, weight: 2 lbs. The microphone desk stand shall be ATLAS DS-5. Provide one.

## 2.11 MICROPHONE EXTENSION CABLES

- A. Microphone extension cables shall be provided. The cables shall be made of flexible rubber jacketed cable equal to BELDEN #8424, #20 gage with braid shield. Provide male XLR type connector on one end equal to SWITCHCRAFT A3M, and female XLR type connector on other end equal to SWITCHCRAFT A3F. Provide quantities and lengths as given below:
  - 1. Provide two 25 foot extensions.
  - 2. Provide one 50 foot extension.

## 2.12 INPUT JACKS

- A. Microphone input jacks shall be located as shown on the plans. Three pin female XLR type on stainless steel plate. The connector shall be riveted into place on the backing plate. Line input jacks shall be located as shown on plans. 1/4" female chassis mounted to, and electrically isolated from, stainless steel plate. Custom.

## 2.13 PROJECTOR

- A. Large venue WUXGA 4K/60p signal input video projector with lens shift and zoom lens as required for location within space with operating software. Nominal 16,000 lumens. Minimum 20,000 hours to 50% light output. Panasonic PT-MZ16KL or equal.

## 2.14 PROJECTOR LIFT

- A. Auxiliary Gym 061: Draper SLX with 21-foot extension capability with white environmental airspace enclosure and universal mounting bracket with Draper LVC-S with locking cover, keyed to District Standard.
- B. Main Gym 145: Draper SLX with 21-foot extension capability with white ceiling finish kit and universal mounting bracket with Draper LVC-S with locking cover, keyed to District

Standard.

## 2.15 PROJECTION SCREEN

- A. Auxiliary Gym 061: Wall mount motorized tensioned projection screen,, steel housing, 226" diagonal, 120" x 192" with filler section to suspend viewing region 8-feet, with control station. Da-Lite Cosmpolitan or equal.
- B. Main Gym 145: Ceiling mount motorized tensioned projection screen, recessed housing, 226" diagonal, 120" x 192" with filler section to suspend viewing region 8-feet, with control station. Da-Lite Cosmpolitan or equal.

## 2.14 LABELS

- A. All outlets shall be identified with engraved phenolic labels permanently and securely affixed to the device plate. All controls in the main equipment cabinet and on the remote control panel will be correspondingly labeled.

## 2.15 MISCELLANEOUS

- A. Relays, panels, power supplies, transformers, and any other equipment and cabling necessary for a complete operating system.

# PART 3 EXECUTION

## 3.1 INSTALLATION

- A. Equipment shall be completely installed, tested, adjusted and operating properly under the terms of this specification:
  - 1. Provide an engineered speaker cluster support system to mount all speaker devices. Mounting shall be made in such a manner as to allow for +/- 10 degrees horizontal and vertical adjustment of devices from proposed aiming and 6" of roll adjustment. Structure shall be capable of supporting the devices to a load safety factor of three. The engineer may require confirmation of structural integrity by a certified structural engineer. Such costs shall be born by the contractor.
  - 2. All wiring shall be in metal raceways. Separate conduit runs shall be provided for microphone lines, speaker lines and A.C. power. Wire shall be #14 X 2 stranded with overall jacket for lows, #16 X 2 stranded with overall jacket for highs or 70 Volt lines, #20 X 2 stranded with overall shield and jacket for microphone and line levels, #22 X 4 solid with overall jacket for remote control lines. Equal to WEST PENN numbers: 226, 225, 292, 240.
  - 3. Installation is to be performed under the supervision of a qualified project technician. This technician shall be factory trained in the proper installation of the proposed equipment, shall approve and sign all documents and shop drawings attesting to compliance, and shall be present for final adjustment and training of the owners forces. All appropriate local electrical codes for installation of these systems shall be met.
  - 4. All A.C. voltage lines shall be three wire with a coded #14 green ground wire. Sound system shall be on a dedicated A.C. circuit. Electrical contractor is to provide earth grounding to the sound cabinets via building safety ground. All grounding shall be done so that no more than 25 ohms of resistance to ground is maintained.
  - 5. Component, interconnection and cable shield grounds are to be installed so that the

system is free of ground loops, hum, noise, instability and crosstalk.

6. Equipment shall be installed in equipment rack. Equipment and installation shall be of a design to eliminate shock hazard to the operators. All equipment for a complete finished system shall be supplied even if not expressly mentioned in these specifications.

### 3.2 TESTING

- A. The AV contractor shall perform tests and adjustments of the completed system. A complete report for the system showing all parameters of each procedure, measured results, calculations, graphs and interpretations shall be supplied to the engineer.
- B. Laboratory quality test equipment shall be used by the AV contractor to perform all required tests and measurements.
- C. Only standardized test procedures shall be used for equalization, measurement of impedances, adjusting electrical levels, adjusting sound levels, minimizing hum, polarity measurements, time alignments, etc.
- D. The following tests shall be performed on the system and the results shall be included in the operations and maintenance manuals for permanent record:
  1. Each speaker line shall be tested for total speaker load impedance. Line impedances shall be measured at 100Hz, 400Hz, 1000Hz, 4000Hz, and 10,000Hz. Total load impedance connected to an amplifier shall not be less than the rated output load impedance of the power amplifiers.
  2. The orientation and relative power levels to the various speakers shall be adjusted for the most uniform direct sound coverage of the listening area as determined by acoustical measurements and listening tests.
  3. Equalization shall be performed, using test equipment, to provide adjustment of the system so that the system is free of regeneration (feedback) with a frequency response of +3dB over the specified frequency response range. Listening tests shall be performed with the system microphones and program material. Adjustments shall be made for the most natural sound under normal usage conditions. The system shall be free of any buzzes, rattles or operational anomalies.
  4. The total system shall be installed from microphone to loudspeakers in absolute polarity. A positive pressure on the microphone shall produce a positive pressure from all loudspeakers.
  5. Provide TEF testing and documentation to demonstrate system results for; frequency response, phase response, energy over time and RASTI speech intelligibility. TEF documentation shall be submitted in hard copy format and on floppy disk.

### 3.3 ACOUSTICAL TESTING

- A. After all electronic equipment specified herein is fully installed at the jobsite and the speakers are fully installed, the system shall be equalized and acoustically tested by the sound contractor utilizing the Time Delay Spectrometry (TDS) testing technique. Personnel, test equipment, complete report, and signing shall be as described under Testing and Equalization.
- B. The loudspeakers shall be oriented and sound levels set to provide an even distribution of the Direct Sound Field frequency response of 250 to 10,000 Hz throughout the seating area.

- C. An Energy Frequency Curve (EFC) will be made of the Direct Sound from 20 to 20,000 Hz.
- D. Provide equalization to attain Direct Sound frequency response, that is within +3 dB from 100 to 10,000 Hz with a 6 dB roll off below 80 Hz and above 12,500 Hz, at any seat in the audience covered by the loudspeakers.
- E. The system shall deliver a minimum of 85 dB average program level with additional 10 dB peaking margin to any seat in the audience at distortion level below 1% THD over the specified frequency range.

### 3.4 TRAINING

- A. Instruct the Owner in proper operation and routine maintenance of the system.
- B. A complete technical manual with servicing instructions shall become part of the permanent owners operations and maintenance manual. It shall include at a minimum:
  - 1. Manufacturer's owner's manuals on major components, including schematics and parts lists.
  - 2. Complete as built drawings showing internal wiring of all equipment assemblies, wiring between equipment assemblies, running sheets showing color codes and terminal connections of all equipment assemblies and junction boxes.
  - 3. Tap connections of all speaker transformers and power amplifier outputs.
  - 4. Designations and settings of all equalizers, etc. installed in the system.
  - 5. Name, address and telephone number of the installing contractors service organization.

### 3.5 DOCUMENTATION

- A. Documentation of test shall be provided to the engineer and shall consist of the following:
  - 1. The test results as listed under Electronic System Testing.
  - 2. The test results as listed under Acoustical Testing.
  - 3. The unequalized house curves of the frequency response made with the measuring microphone.
  - 4. The equalized house curve made with the measuring microphone.
  - 5. The level settings for each electronic component.
  - 6. List of personnel and test equipment used.
  - 7. Qualifications of personnel (formal training and experience).

### 3.6 GUARANTEE AND SERVICE

- A. A one-year warranty covering all components, equipment, and workmanship shall be submitted in writing. This warranty will begin on the final acceptance date or substantial completion (whichever occurs last).
- B. Should any trouble develop within this one year period from the date of acceptance of the work due to inferior or faulty material and/or workmanship, or should it be discovered that the work is not in accordance with the contract, the contractor shall promptly make all required corrections without cost to the owner.

### 3.7 MAINTENANCE AND OPERATING MANUALS AND INSTRUCTIONS

- A. The contractor shall provide three copies of an operating and servicing manual to the owner.

- B. Each operating and servicing manual shall include all information necessary for the proper servicing of the system. Included shall be an instruction and maintenance manual for each piece of equipment.
- C. Each manual shall be bound. The complete title of each manual shall be visible on the front cover of the book.
- D. After the system is totally installed (or when directed) and in proper operating condition as approved by the architect, the contractor shall provide a simplified instruction sheet and instruction sessions as necessary to describe and demonstrate the entire system to the owner's staff. These sessions will total approximately four hours of instruction.

END OF SECTION



## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

- A. The drawings and general provisions of the Contract Documents apply to this Section.

### 1.2 RELATED SECTIONS

- A. Section 260100 - Electrical General Requirements.
- B. Section 260500 - Basic Materials and Methods.
- C. Section 260526 - Grounding and Bonding.
- D. Section 260530 - Low-Voltage Electrical Systems Pathway.
- E. Section 271001 - Telecommunications Premises Wiring.

### 1.3 SUMMARY

- A. This section includes a fully operational IP platform for a district-wide internal and school Critical Communications Solution, incorporating school safety notifications and general communications including but not limited to the following:
  - 1. The platform shall provide complete internal communications and employ state of the art IP Technology including the minimum functions listed.
    - a. Two-way internal intercommunications between staff locations and classrooms.
    - b. Scheduled bell events.
    - c. Emergency announcements that will override any pre-programmed audio, assuring that all Emergency/Lockdown etc., are heard at each speaker location.
    - d. Capability of prerecording emergency announcements that can be activated by a Soft Key on an administrative console, panic button, dial string, mobile app, or web browser.
    - e. Atomic Time Synchronization with Class Change Tones utilizing multiple, programmable schedules for each zone.
    - f. District-wide, Emergency, Group, All School and Zone live voice paging.
    - g. District-wide, Emergency, group, All School and Zone visual messaging.
    - h. District-wide, Emergency, Group, All School and Zone paging for pre-recorded audio – tones, music and voice.
    - i. Single sign on web-based user interface for multi-school functionality.
  - 2. Any authorized administrator shall be able to call from outside the school into any classroom, zone, or entire school directly via the School District supplied SIP enabled Telephone Network. This shall allow remote monitoring, call-in annunciation, and two-way conversation from outside the facility as well as paging into the system. (Compliance with NEMA Standard SB-40 for emergency communications in K-12 Schools).
  - 3. Automated message strings shall be manually initiated from a single-button access on the console, on a SIP connected telephone, panic button, mobile app, from the web-based user interface or via interface with third party systems.
  - 4. Paging and two-way intercom features shall be accessible from any system console or SIP connected telephone for each campus.

5. Each single campus installation shall be locally survivable for intercom, paging, bells, and emergencies such as lockdown, even when the district connection is unavailable.
6. This specification establishes a minimum level of quality, features, and performance for individual components as well as the integrated system.
7. Systems that do not comply with the feature-sets highlighted in this Specification will not be considered.
8. Included in the emergency procedures is the ability to send specific messages and or instructions. These features can be added to the emergency sequences.
9. The ability to require an access code to initiate or clear an emergency from the administrative console.
10. An app that can run on either Android or Apple phones. This app will give the user the ability to initiate one of 18 emergency procedures programmed into the app. This app will also allow you to view all classrooms check in status. This process will update during the emergency to make sure all information is current.
11. The ability to allow the fire alarm system to signal an active fire alarm to TCU. This will allow supplemental visual and audio messaging from Telecenter U. Telecenter U can be programmed to change system state, dependent on the active emergency. Both fire and emergency will be displayed on the administrative console and mobile application.

#### 1.4 DEFINITION OF TERMS

- A. Installer(s): Shall refer to the person, persons, or company who or which contracts to perform the work specified herein.

#### 1.5 SUBMITTALS

- A. Product data for each component.
- B. Shop Drawings: Prior to proceeding with the work: Provide detailed equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, location of each field connection, and a complete schedule of all equipment and materials with associated manufacturer's cuts sheets which are to be used.
  1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring. Identify terminals to facilitate installation, operation, and maintenance. Include a single-line diagram showing cabling interconnection of components and levels throughout system and impedances.
  2. Artwork drawings and lists indicating proposed nameplate nomenclature and arrangements for control panels and plug panels prior to fabrication reflecting equipment used.
  3. Each drawing shall have a descriptive title and all sub-parts of each drawing shall be labeled. All drawings shall have the name and locations of the project, Systems Contractor's name in the title block.
  4. Details and descriptions of any other aspect of the system, which must differ from the contract documents due to field conditions or equipment, furnished.
- C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements. Include record of final matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.



- D. Maintenance Data: For equipment to be included in maintenance manuals specified in Division 01.
  - 1. Record of Owners equipment-programming option decisions.
    - a. All instructions necessary for proper operation and manufacturer's instructions.
    - b. "Proof of Performance" information.
    - c. Manufacturer's maintenance information.
    - d. Copies of non-proprietary computer programs and system set up disks documenting all programmable features of the installed system.
- E. Record Drawings: Prior to final acceptance, provide complete set of drawings in PDF format indicating all cable numbers and construction details in accordance with the actual system installation. Revise all shop drawings to represent actual installation conditions and final room names and numbers. These Record Drawings will be used during "Final Acceptance Testing".
- F. System Training: Submit the following information describing the training programs and system trainers as outlined in paragraph 1.6 of this specification and in accordance with Division 1 specifications.
  - 1. Include with the submittal a preliminary staff development training program in outline form for review and approval by the owner's representative.
  - 2. Include with the submittal a current copy of trainer's needs assessment form which will be reviewed with the owner's designated representative for the system's preliminary system programming and configuration.
  - 3. Include with the submittal copies of all documentation used to identify for the owner those participants attending and completing the training programs.
- G. A copy of the manufacturer's standard statement of warranty proving all equipment provided for the school communications network is covered with the required **five-year** warranty shall be included with the project submittal. This statement of warranty shall be provided on the manufacturer's stationary.

#### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced Installer who is an authorized representative of equipment manufacturer for both installation and maintenance of equipment required for this Section.
  - 1. Technically capable and factory trained service personnel at a local service facility to provide routine and emergency service for all products used in this project.
- B. Any Contractor, who intends to bid on this work and does not meet the requirements of the "Quality Assurance" paragraph(s), shall employ the services of an "Installer" who does meet the requirements and who shall provide the equipment, make all connections and continuously supervise the installation. A subcontractor so employed as the "Installer" must be acceptable to the Architect/Engineer. The "Installer" shall be identified within thirty (30) days of notification to proceed for acceptance by the Architect/Engineer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- D. Comply with NFPA 70.

- E. Comply with NEMA Standard SB-40 for Emergency Communications in K-12 schools.
- F. Comply with UL 60950.

#### 1.7 IN-SERVICE TRAINING

- A. The contractor shall provide and implement a complete and comprehensive staff training program for all administrators, facility staff members, and teachers. This mandatory training program will provide school staff a complete understanding of how to utilize and properly operate all functions.
- B. The training program shall be implemented by a staff member/trainer employed by the contractor. The trainer must be factory certified to provide training on their product.
- C. All staff development training is to be coordinated through the owner's designated representative. As training sessions are completed, the trainer will provide the school's administrative staff and school district's staff a document listing all the staff and faculty members who attended, received, and completed the training program.

#### 1.8 WARRANTY

- A. Provide a **manufacturer's five-year warranty** of the school communications network equipment against defects in material and workmanship. This warranty will cover all electronic system components. Additional warranties cover clocks, speakers, and call in switches. If any defects are found within the warranty period, the defective equipment shall be replaced at no cost (equipment only); a one-year warranty shall be provided for labor.
- B. A copy of the manufacturer's standard statement of warranty proving all equipment provided for the school communications network is covered with the required five-year warranty shall be included with the project submittal. This statement of warranty shall be provided on the manufacturer's stationary. The standard five-year warranty is an important element in establishing a standard in quality. Manufacturers who circumvent the five-year warranty by offering special "extended warranties" that are not part of their normal published warranty will not be accepted.
- C. Contractor shall respond, excluding weekends and holidays, within 24 hours to any warranty service calls. If equipment cannot be repaired within 24 hours of service visit, the contractor shall provide "loaner" equipment to the facility at no charge.
- D. Make available a service contract offering continuing factory authorized service of the system after the initial warranty period.

#### 1.9 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide the following system:
  - 1. Telecenter manufactured by Rauland
    - a. Authorized Rauland Distributor contact:  
**Name GB Manchester**  
**Address 1 6000 NE 88<sup>th</sup> St.**  
**Address 2 Vancouver, WA 98665**  
**Contact: Laci Rowland**  
**Email: laci.r@gbmanchester.com**

## PART 2 - PRODUCTS

### 2.1 SYSTEM REQUIREMENTS

- A. The platform shall utilize state of the art IP Technology for Emergency automation, Call-in Notification, School Safety Paging and Evacuation tones, Class Change Tones utilizing multiple, programmable schedules for each zone, two-way hands-free everyday internal communications and paging, visual messaging, and program distribution. The system shall be easy to learn and operate. All standard programming shall be web-based, district-wide and user friendly to allow the system administrator the ability to easily program system features.
- B. Provide complete and satisfactorily operating district/school communications and district/school safety as described herein, using materials and equipment of types, sizes, ratings, and performances as indicated. Use materials and equipment that comply with referenced standards and manufacturers' standard design and construction, in accordance with published product information. Coordinate the features of all materials and equipment so they form an integrated system, with components and interconnections matched for optimum performance of specified functions.
- C. The platform shall be a single electronic system consisting of a minimum of 10 audio channels for each campus, (classroom) IP Speaker Modules and call switches, IP Zone Modules connecting corridor speakers, inside and outside horns, IP Administrative Consoles, SIP enabled PBX integration and district-wide integration for paging, emergency notifications, calendar scheduling and configuration.
- D. Each Classroom shall be provided with a Speaker Module interface, a status light, and a minimum of 5 different call switches, each with their own annunciation path and priority.
- E. Call-ins may automatically annunciate (display of priority and location) to administrative consoles, SIP enabled phones, and outside phones.
- F. Call-ins shall be programmed to automatically change priority and annunciation route based on age of call-in and original priority.
- G. Call-ins may have priority (and annunciation route) changed by user action from a console or SIP enabled phone.
- H. Call-in annunciation route shall include playing pre-recorded audio over speakers, sending a pre-configured email, and activating relays.
- I. The platform shall lend itself to expansion by simple addition of hardware modules.
- J. The platform shall connect directly to an existing, standard protocol WAN/LAN network, without the need for a separate server at each school location. Configuration, including bell schedules, calendars, and emergency sequences can be remotely created, changed, stored and downloaded to the system by an authorized user from a web-based user interface.
- K. The platform shall provide the ability to initiate school safety paging announcements, evacuation tones and take cover tones from any telephone or connected web browser within the facility or outside the facility to any other location within the facility or district.

- L. The platform shall provide the ability to selectively communicate or monitor individual classrooms in emergency situations from any telephone within the facility or outside the facility to any other location within the facility; all communication within the classroom shall be hands-free and will not require any interaction by the classroom user.
- M. The platform shall provide classroom users the ability to confirm that they have safely secured their classrooms during an emergency with a single button press. The front office administrator will receive confirmation that the classroom is safely secured via an administrative console and web-based user interface. The front office administrator can view classrooms that are not safely secured via the administrative console. The front office administrator can view classrooms that are not safely secured via the web-based user interface. The front office administrator shall be able to initiate two-way communication, without a pre-announcement tone, to the classroom during an emergency via the administrative console. Web-based user interface will still identify that a school is in an emergency, even if all classrooms are safely secured. Individual classroom check-in and school emergency status shall be viewed from the web-based user interface, both on-site and remotely.
- N. IP Addressable and POE powered Speaker Modules for individual rooms shall be system programmable and may be assigned any two, three, four, five- or six-digit number as well as name and description. Any extension may be reassigned at any time.
- O. IP-enabled two-way voice communication shall be available from any provided telephone or administrative console through any speaker in a campus. This shall allow hands-free communication to any classroom or any individual loudspeaker unit. A programmable pre-announce tone shall sound immediately before the intercom path is opened and a supervisory tone shall continue to sound at regular intervals when speaker monitoring is active, complying fully with all privacy legislation. Pre announce tone and supervisory tones shall be disabled during designated emergencies automatically.
- P. The platform shall allow users to configure multiple schedules per school, with a minimum of 500 unique events per schedule, and automatic Daylight Savings time correction. Schedules can be programmed to occur once, daily, weekly, monthly, or in any combination of the preceding recurrences. Each school may have a minimum of 20 unique bell schedules, with a minimum of 5 active schedules on any given day for each campus. User shall be able to select from 25 standard included tones as well additional user created and uploaded audio files for class change signaling and messaging. In addition, scheduled events shall include relay actions, email notifications, visual messaging, status lights and paging exclusions as system configuration changes. The platform shall allow control of the bell schedules via the district WAN/LAN without the need for a separate server at each school location. Bell schedules can be remotely created, changed, stored and assigned to calendar days for the local school by an authorized user from a single web-based user interface, without logging into multiple systems.
- Q. The platform shall be able to integrate with an existing PA system or operate as a fully independent IP solution. The platform shall be able to function in combination of said configurations and allow for seamless communication within a school or district-wide, regardless of the type of configuration used. The platform shall be scalable, with the ability to easily add, install, and configure additional equipment to a system.

- R. The platform allows for customization of preprogrammed sequences, used for emergencies, events, and everyday communications. Preprogrammed sequences can be activated from the push of a relay button, soft key of an administrative console, a dial string of a SIP phone, or a web browser configured to the district network. Sequences can be initiated automatically as part of a schedule or on the fly. Preprogrammed sequences can be customized to utilize any combination of audio tones, emails, relays, tone exclusions, swings, delays, duples, SIP phone notifications, and program distribution. Audio tones can include customized audio files and voice messages, recorded in any language. Uploaded audio tones and messages can be preprogrammed to announce repeatedly or individually, as part of a scheduled sequence or on the fly. Each school in a district can have its own customized sequences, and can be activated individually, in groups, or district-wide.
- S. The platform allows for emergencies to be initiated in a drill environment, separate from real emergencies. Drill emergencies can be initiated from panic buttons, consoles, SIP phones, or a web browser.
- T. The platform shall provide status lights that will display the status of individual classrooms and school-wide status, including for emergencies, at the same time. Status lights will be customizable in color and flash rate based on event type and priority.
- U. Visual message boards are available in 2 sizes. Small message boards have 8 by 40 LED display with 3 color LED's. The large message board will have 2 lines with 16 by 80 LED display with 3 color LED's. During idle time the message boards can display date and time. They can also display countdowns for class change or status of an emergency. You will have the ability to change the messages on the fly to display instructions or directions. Status lights can be tied to message boards to give more information as to status of classrooms that checked in or groups of rooms that checked in.
- V. POE zone page amplifier module. This component will give the schools the ability to play audio to drive groups of speakers from a single device. Depending upon configuration you can have 14 or 35 watts of output. The module can be either wall or rack mounted.
- W. First Responders Notification. This feature can be initiated so the status lights do not display the rooms that checked in until the first responders are on site. This will not influence any of the other check-in notifications. The App, console and computers can still display the rooms that checked in.
- X. TCU Emergency Initiation App. This app can be installed on either Android or Apple devices. The app can process up to 18 different emergencies. The app will update in real time rooms that have checked in OK. It can also display a Fire emergency is in effect during an emergency.

## 2.2 EQUIPMENT AND MATERIAL

- A. Server Software:
  - 1. Provides district-wide paging, bell event scheduling, emergency notification and configuration for entire district.
  - 2. Ability to configure system and initiate system features, per school and district-wide via web-based user interface.
  - 3. The software can sync system time to the Atomic Clock Signal or to the school's or district's network time server.

4. The software will provide a web browser to deliver district-wide emergency paging, pre-recorded messages and tones from any authorized computer in the facility or the district. The software must be capable of automatically notifying district personnel via the WAN/LAN of an alarm condition.
5. The software can automatically broadcast emergency instructions via associated system hardware throughout an entire district when an alarm (e.g. lockdown, lockout, security, fire) is initiated via the web-based user interface. The emergency instructions are preprogrammed and require no user intervention. Bell tones can be halted during an emergency. The system provides redundant alarm annunciation over intercom/paging speakers and is not meant to replace primary fire alarm or security systems.
6. The software allows for user-uploaded pre-recorded messages and tones. Software supports the upload of MP3 and WAV file types. User-uploaded pre-recorded messages and tones can be part of emergencies, sequences, and bell schedules.
7. The system shall monitor itself if devices go offline and system actions are not received. Specified users shall receive email notifications when devices go offline. The software shall be able to keep a log and report on system activity within a school or all schools district-wide for a minimum of one year. These reports can be exported to excel spreadsheets.
8. The system shall allow administrators to run reports on all system activities including emergencies, drills, paging, call-ins, check-ins and system trouble on a per school, multi-school and district-wide basis.
9. The system allows programmable end points to be automatically included or excluded for live paging, bell tones, or prerecorded audio, depending on the time or day or day of the week. These inclusions/exclusions can be applied manually or automatically depending on their schedule.
10. The software can automatically send an email, as part of a programmed sequence of events, to district administrators alerting them of an emergency within the district.
11. The software provides the ability to view schools that are in an emergency status, using any web browser on the district's network. The software shall identify the name of the school in an emergency as well the type of emergency that school is in.
12. The software provides the ability to view individual classrooms that are not checked-in during an emergency, using any web browser on the district's network. The software shall identify the name, extension, and description of the classroom that is not checked-in during the emergency.
13. The system has a minimum of 5 customizable emergencies, one of them being an All-Clear – with the ability to return the system from an emergency to normal status. Each emergency shall have a minimum of 500 unique events.
14. As a district-wide communications solution, the system shall be able to provide simultaneous communications to all schools or groups of schools within a district. The system shall allow a user to initiate district-wide communications to individual schools, all schools or groups of schools, from a web-based user interface. The system shall allow a user to initiate prerecorded audio, live paging, or programmed sequences to individual schools, all schools or groups of schools, from the web-based user interface. Programmed sequences shall be customizable per school, and the system shall be able to activate them simultaneously to individual schools, all schools or groups of schools, from the web-based user interface.
15. The communications software must allow upgrade from an individual school system to multiple schools, or an entire school district, using the same web-based user interface. The communications software from an individual school system must be identical in typical user operation to the multiple schools or entire school district communications system software.

16. The system allows for emergencies to be initiated as drills for practice. Drills may include all or some of the associated steps as its corresponding emergency sequence. Drills are recorded in the event history report.
  17. The system provides the ability to export lists of bell schedule steps, emergency sequences, staff directory, users, peripherals, and zone targets.
- B. Campus Controller:
1. Provides call routing for paging and intercom for a single facility.
  2. System shall connect to the district provided Telephone Network via a SIP connection.
  3. Support a flexible numbering plan allowing two, three, four, five, or six-digit extensions.
  4. SIP interface to a district provided Telephone Network shall be capable of allowing connected phones to display classroom call-ins, answer internal intercom call-ins, make pages and change priorities of call-ins in progress.
  5. Direct dialing, two-way amplified voice intercom between any provided telephone or admin console and speaker without the use of a press-to-talk or talk-listen switch.
  6. Ability to upgrade priority level from individual call switch.
  7. The ability to answer intercom call-ins registered at administrative consoles and pre-selected telephones.
  8. The ability to automatically escalate incoming call-ins to an alternate telephone or group of telephones if they remain unanswered for a predetermined amount of time.
  9. The ability to manually upgrade an intercom call-in to an alternate telephone or group of telephones.
  10. The ability for classrooms to “check-in” via push button when they have successfully secured their location during emergency.
  11. Administrative console shall display locations that have not checked in to confirm their secured location and provide hands-free audio monitoring and communication to unsecured locations.
  12. The controller shall not need direct connection to any classroom via home run or distributed wiring. It shall communicate solely through the IP network.
  13. Single button access from any console on the system to distribute emergency announcements within the facility to all or select locations equipped with speakers. Emergency announcements originating from any assigned administrative console shall have priority over all regular system functions.
  14. Ability for administrative consoles and connected phones to selectively monitor audio at any two-way speaker during an emergency.
  15. Stores a minimum of 48 hours’ worth of Bell Event Schedules, all emergency notification sequences as well as facility wide configuration.
  16. System can sync system time to the Atomic Clock Signal or to the school’s or districts network time server.
  17. System’s SIP Interface shall provide:
    - a. Audio paging access from any telephone to any single intercom speaker, zone (group) of intercom/paging speakers, or all speakers/paging horns throughout the entire facility.
    - b. Ability to answer a call-in directed to that SIP extension.
    - c. Ability to upgrade a call-in directed to that SIP extension.
    - d. Single button access from any telephone on the system to initiate alarm signals within the facility to all or select locations equipped with speakers. A minimum of 25 separate distinct alarm signals shall be provided. Alarm signals originating from any assigned administrative telephone shall have priority over all regular system functions.

- e. Ability to initiate a school-wide emergency including lockdown and evacuate sequences.
- f. SIP device shall display call-in information from call in switch. Information will include a minimum of Classroom Name, Number, and Priority Level.
- 18. The system will have the ability to utilize a web browser and a USB microphone connected to the PC to deliver district-wide live emergency paging, pre-recorded messages and tones from any authorized computer in the facility or the district. The system must be capable of automatically notifying district personnel via the WAN of an alarm condition.
- 19. The system will have the ability to utilize a desktop microphone to deliver school-wide live emergency paging and zone paging throughout the facility.
- 20. The system can automatically broadcast emergency instructions throughout an entire campus when an alarm (e.g. lockdown, lockout, security, fire) is tripped or manually activated. The emergency instructions are preprogrammed and require no user intervention. Bell tones can be halted during an emergency. The system provides redundant alarm annunciation over intercom/paging speakers and is not meant to replace primary fire alarm or security systems.
- 21. The system can integrate with emergency weather radios to generate live emergency broadcasts notification throughout a facility.

C. IP Addressable Modules:

- 1. System shall provide multiple IP Addressable Modules for intercom, paging and relay activation.
  - a. All Modules are POE 802.3af compliant.
  - b. All Modules support DHCP.
  - c. All Modules connect to network with a single RJ45 connector.
- 2. IP Addressable Speaker Module:
  - a. Shall interface to school's data network, a classroom speaker, and multiple call switches.
  - b. A minimum of 5 levels of call-in can be placed from an IP Speaker Module. The call-ins are routed to administrative consoles and select SIP connected telephones and can only be cleared from the system once answered. If a call-in is not answered within a preprogrammed time the call-in may reroute to other telephones, consoles, and speakers.
  - c. An option for Privacy call in switches is supported. When the Privacy switch is activated it prevents administrative or classroom telephones from monitoring the specific classroom/location intercom speaker.
  - d. The ability to belong to one or more of a minimum of 100 independent zones for zone paging, program/music distribution zones and class change tone zones; this assignment is a programmable function, changeable by time of day. Each IP Speaker Module's location shall be programmed in software to belong to any combination of software zones. IP Speaker Modules shall be designed to mount near ceiling and wall speakers and in the plenum space.
  - e. Intercom and paging volume adjustable from Software interface.
  - f. Module will support and power a status light that displays individual classroom information including call-ins placed, testing status and emergency check-in status.
- 3. IP Addressable Zone Paging Module:
  - a. Zone Paging Module shall connect multiple speakers for district all page, all page, zone paging, bells, audio events and, emergency notification.
  - b. Zone Paging Modules shall be rack and wall mountable.



- c. Zone Paging Modules shall be able to belong to one or more of 100 independent zones for live paging, bells, pre-recorded audio and emergency notification.
- 4. IP Addressable Aux I/O Module:
  - a. Aux I/O Module shall have two input contacts and two output contacts.
  - b. Input and output contacts are individually addressable.
  - c. Aux I/O Module shall be wall and rack mountable.
  - d. User can program relays to be activated manually, through an event/bell schedule, or during emergency notification.
  - e. Aux I/O Module can perform school lockdown from a single press of a panic button.
- 5. IP Addressable Program Line Input Module:
  - a. Program Line Input Module shall provide line level audio program distribution into system.
  - b. Program Line Input Module shall have a 3.5mm cable jack.
  - c. Program Line Input Module shall be configured via web-based user interface.
  - d. User can configure program distribution to be activated manually or automatically through an event/bell schedule.
  - e. Program Line Input Module will have a system priority level such that emergency communications override program distribution.
- 6. IP Addressable Microphone Input Module:
  - a. The system shall support a minimum of five (5) Microphone Input Modules per school.
  - b. Microphone Input Module shall support dynamic and condenser style microphones.
  - c. Microphone Input Module shall support microphones with or without Push-To-Talk functionality.
  - d. Microphone Input Module shall support configurable paging priorities.
  - e. Microphone Input Module shall provide user feedback for paging activity.
  - f. Microphone Input Module shall have adjustable microphone gain levels.
  - g. Microphone Input Module shall be configurable from the web-based user interface.
  - h. Live pages from the Microphone Input Module can automatically increase audio priority during an emergency.
- D. IP Addressable Administrative Console:
  - 1. A full color screen with 64 soft keys, 3 line select, volume control, push to talk, speakerphone mode and left/right and up/down scrolling.
  - 2. Audio paging access from any Console to any single intercom speaker, zone (group) of intercom/paging speakers, or all speakers/paging horns throughout the entire school.
  - 3. Programmable soft key access from any console on the system to initiate alarm signals within the school to all or select locations equipped with speakers. A minimum of 25 separate distinct alarm signals shall be provided. Alarm signals originating from any assigned administrative console shall have priority over all regular system functions.
  - 4. Programmable soft key access from any console to automatically broadcast page emergency instructions throughout an entire school when an alarm (e.g. lockdown, lockout, security, fire) is tripped or manually activated. The emergency instructions are preprogrammed and require no user intervention. The system provides redundant alarm annunciation over intercom/paging speakers and is not meant to replace primary fire alarm or security systems.
  - 5. Ability to perform intercom to any single IP Addressable Speaker Module.

6. Ability to display 3 call-ins at a time on the screen while other call-ins are annunciating and the ability to scroll to view all call-ins.
  7. Ability to upgrade a call-in via soft key.
  8. Programmable soft key access from any console for activating relays, campus wide.
  9. Ability to maintain, along with controller and other IP Modules system functions, including intercom, bells and paging for the local campus in the event of district-wide connection loss.
  10. Classrooms that have not 'checked-in' during an emergency are listed on the Administrative Console's screen.
  11. The time duration of an emergency is shown on the screen of the administrative console. The check-in timer is shown on the screen of the administrative console.
- E. Audio Paging/Program Amplifiers:
1. Power amplifier(s) shall be provided to provide a minimum of 2 watts of power to all paging speakers, and 15 watts of power to all paging horns.
  2. The maximum load on the paging/program amplifiers shall be 80% of the rated maximum output of the amplifiers.
- F. Normal/Emergency Call Switch – Rauland Dual Level Call In Switch:
1. Normal/Emergency Call Switches indicated on the drawings shall provide the following functions and features:
    - a. One (1) "Normal" call switch that shall activate a distinctive "NORMAL" level call from single button activation. The button shall be clearly marked "NORMAL" and will route the call-in to any one or more Administrative Consoles and/or Marquee Displays for quick and easy response from an Administrative Console.
    - b. One (1) "Emergency" call switch that shall activate a distinctive "EMERGENCY" level call from single button activation. The button shall be red in color and shall be clearly marked "EMERGENCY" and will route the call-in to any one or more Administrative Consoles and/or Displays for quick and easy response from an Administrative Consoles.
- G. Emergency/Check-In Call Switch – Rauland Check-In Call In Switch:
1. Emergency/Check-In Call Switched indicated on the drawings shall provide the following functions and features:
    - a. One (1) "Emergency" call switch that shall activate a distinctive "EMERGENCY" level call from single button activation. The button shall be red in color and shall be clearly marked "EMERGENCY" and will route the call-in to any one or more Administrative Consoles and/or Displays for quick and easy response from an Administrative Consoles.
    - b. One (1) "CHECK-IN" call switch that shall activate a distinctive "CHECK-IN" level call from single button activation. The button shall be blue in color and shall be clearly marked "CHECK-IN" and will route the call-in to any one or more Administrative Consoles. This button will be used for emergency check-ins during school emergencies, notifying the front office of the classroom occupants' safety during an emergency.
- H. Status Light:
1. Status Light will be powered and controlled by an IP Classroom Module.
  2. Status lights will 2 light segments, one for classroom status and one for school status.
  3. Each segment will display specific colors and blink patterns based on status priorities.

4. If you add a visual message board an additional status light can be added and driven on the 1 cat wire delivered to the classroom. Both lights can be used for different notifications inside and outside the room.
- I. Zone Page Amplifier Module:
  1. Depending on configuration the amp output is either 14 or 35 watts output.
  2. Wall or rack mounted as indicated on shop drawing.
  3. Powered with either a wall port or POE+.
- J. Visual Clock/Message Boards:
  1. Can be powered by either POE or POE+ depending on size and features.
  2. Comes in 2 sizes.
  3. Large 2 lines 16 by 80 LED display.
  4. Small 1 line 8 by 40 LED.
  5. 3 color LEDs: Red, Amber and Green.
- K. Equipment Racks:
  1. Furnished by Section 271001.
- L. Interior Ceiling Speakers:
  1. Provide Ceiling Speaker Assembly consisting of 8 Ohm, 8" speaker mounted in a 2 foot by 2 foot, or 2 foot by 1 foot, lay-in baffle, with an integrated back box that covers the full area of the baffle.
  2. The speaker shall be connected by inserting an 8-pin RJ45 terminated CAT 5e or Cat 6 cable.
  3. The speaker shall include provisions to allow attachment of a safety cable if required.
- M. Wall Mounted Horns:
  1. Provide double re-entrant type horn loudspeakers with integral driver. The horn loudspeaker shall be impervious to weather and vandalism. Horn shall be constructed of heavy-duty ABS plastic. Horn loudspeaker drivers shall be rated at 15 watts with a frequency response of 480 Hz to 14 KHz. Sensitivity shall be 106 dB 1 watt, 1 meter. Transformer assembly shall be dual voltage multi-tap type suitable for 25 or 70-volt installations. Dispersion pattern shall be 180 degrees conical. The horn loudspeaker shall be constructed of treated heavy gauge aluminum, with all exposed parts potted and a sealed driver. Wiring terminal shall be fully enclosed. The speaker flange and mounting surface shall have a cork-rubber gasket. The horn loudspeakers finish shall be gray baked on enamel.
  2. The recessed back box shall be of heavy gauge cold-rolled steel, spot welded for stability with a rust-retardant gray primer finish. Acoustically treat the interior to eliminate mechanical resonance. The back box shall be 10-3/4" x 10-3/4" x 6" deep.
  3. The baffle shall be vandal proof, the faceplate constructed of 14-gauge carbon steel with a minimum tensile strength of 55,000 PSI. A lattice grid sub-plate shall deny access to the horn but be acoustically transparent for sound projection. Provide tamper proof, stainless steel mounting hardware. The baffle shall have a mar/scratch baked epoxy rust inhibitive finish.
- N. Uninterruptible Power Supplies (UPS):
  1. UPS equipment provided for this system will include Power Conditioning to smooth current and voltage fluctuations.

2. UPS equipment will be sized in accordance with the system manufacturer's recommendations.
3. Provide an individual UPS for EACH SYSTEM CONTROLLER (Gateway) furnished with the system.
4. Provide additional UPS(s) for protection of all other equipment furnished with the system and housed in the equipment racks.
5. All UPS equipment shall be rack mounted.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine conditions, with the Installer present, for compliance with requirements and other conditions affecting the performance of the School Communications and School Safety Network.
- B. Do not proceed until unsatisfactory conditions have been corrected.
- C. Verify final room names and numbers to be used. Programmed room numbers must match room number signage.

#### 3.2 INSTALLATION

- A. General: Install system in accordance with NFPA 70 and other applicable codes. Install equipment in accordance with manufacturer's written instructions.
- B. Furnish and install all material, devices, components and equipment for a complete operational system.
- C. Impedance and Level Matching: Carefully match input and output impedance's and signal levels at signal interfaces. Provide matching networks where required.
- D. Control Circuit Wiring: Install control circuits in accordance with NFPA 70 and as indicated. Provide number of conductors as recommended by system manufacturer to provide control functions indicated or specified.
- E. All housings are to be located as indicated.
- F. The contractor shall provide necessary transient protection on the AC power feed, all copper station lines leaving or entering the building, and all central office trunks. All protection shall be as recommended by the equipment supplier and referenced to earth ground.
- G. Wiring within Enclosures: Provide adequate length of conductors. Bundle, lace, and train the conductors to terminal points with no excess. Provide and use lacing bars.
- H. Provide physical isolation from speaker-microphone, telephone, line-level wiring, and power wiring. Run in separate raceways, or where exposed or in same enclosure, provide 12-inch minimum separation between conductors to speaker-microphones, telephone wiring and adjacent parallel power. Provide physical separation as recommended by equipment manufacturer for other system conductors.

- I. Identification of Conductors and Cables: Use color coding of conductors and apply wire and cable marking tape to designate wires and cables so all media are identified in coordination with system wiring diagrams.
- J. Weatherproofing: Provide weatherproof enclosures for items to be mounted outdoors or exposed to weather.
- K. Wireguards: Provide wireguards for items located in Locker Rooms, Gymnasium and Auxiliary Gymnasium.

### 3.3 GROUNDING

- A. Provide equipment grounding connections for Integrated Electronic Communications Network systems as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.
- B. Ground equipment, conductor, and cable shields to eliminate shock hazard and to 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.
- C. Provide all necessary transient protection on the AC power feed and on all copper station lines leaving or entering the building. Note in system drawings, the type and location of these protection devices as well as all wiring information.

### 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Provide services of a duly factory authorized service representative for this project location to supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the system.
- B. Inspection: Make observations to verify that units and controls are properly labeled, and interconnecting wires and terminals are identified. Provide a list of final tap settings of paging speaker line matching transformers.
- C. Testing: Rectify deficiencies indicated by tests and completely re-test work affected by such deficiencies at Contractor's expense. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

### 3.5 FINAL ACCEPTANCE TESTING

- A. The Final Acceptance Testing shall be provided to the Owner or the Owners designated representative only. Final acceptance testing to any other trade or service provider for the project will not comply with the requirements of this section.
- B. The contractor will provide a Final Acceptance Test record document signed by both the contractor and the Owner or designated Owner's Representative establishing the "In Warranty" date. The warranty period will not commence until the Final Acceptance Test is completed.
- C. Be prepared to verify the performance of any portion of the installation by demonstration, listening and viewing test, and instrumented measurements. Make additional adjustments

within the scope of work and which are deemed necessary by the Owner because of the acceptance test.

### 3.6 COMMISSIONING

- A. The contractor shall train the Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of the system. This training will be in accordance with the training as outlined in Section 1.6 of these specifications. In addition to the Training Materials provided, the contractor will also furnish Operators Manuals and Users Guides at the time of this training.
- B. Schedule training with Owner through the owner's representative, with at least seven days advance notice.

### 3.7 OCCUPANCY ADJUSTMENTS

- A. The contractor shall provide Occupancy Adjustments in accordance with Section 1.6 of these specifications. A response scenario amenable to both the owner and the contractor will be established and followed for the first year of service.

### 3.8 CLEANING AND PROTECTION

- A. Prior to final acceptance, the contractor shall vacuum and clean all system components and protect them from damage and deterioration. All blank spaces in equipment cabinets will be covered with blank panels. Top and side panels, and all cabinet doors will be installed. All general areas within and around all equipment rack/cabinets in the facility will be swept, vacuumed, and cleaned up. No cabinets will be left unlocked and all cabinet keys will be turned over to the owner or designated owner's representative.

END OF SECTION

## PART 1 GENERAL

### 1.1 SCOPE

- A. Bidder design and installation of distributed antenna system for emergency responder radio coverage system to comply with International Fire Code Section 510 designed in accordance with NFPA 1221 and local AHJ amendments. Include both VHF and UHF signals. Emergency Responder Radio Antenna/Repeater System to include bi-directional amplifiers, donor antenna, distribution network utilizing coaxial cables or fiber, cable tap-offs, directional couplers or splitters and uninterruptible power supply. Include costs for permitting.
- B. Work includes coverage of new construction and the existing Building 1.
- C. Emergency responder refers to Emergency responder refers to the City of Kelso Fire Department and other agencies as designated by the Authority Having Jurisdiction.
- D. Coordinate with fire alarm contractor to provide monitoring by fire alarm system.

### 1.2 REGULATIONS

- A. Codes, regulations and standards referenced in the Section are:
  - 1. NFPA 70 - The National Electrical Code.
  - 2. IFC 2012.
  - 3. NFPA 72 National Fire Alarm Code.
  - 4. FCC 47 CFR Private Land Mobile Radio.
  - 5. 90.219-2007 Services-Use of Signal Boosters.
  - 6. FCC Rules Part 22, Part 90 and Part 101.

### 1.3 DEFINITIONS

- A. Emergency Responder: City of Kelso Fire Department.

### 1.4 SUBMITTALS

- A. Submit preliminary RF survey data with recommendations once building envelope is complete (new addition and new glazing installed).
- B. Submit preliminary survey, product data and shop drawing to the Architect/Engineer and the Authority Having Jurisdiction for review and approval.
- C. Shop Drawings:
  - 1. Floor plan drawings with elevation detail names for each elevation view. Sheet title shall include site name, address, sheet number, floor plan number and north arrow. Include site plan view of the subject buildings and surrounding property to clearly indicate the location and orientation of roof mounted outdoor antennas associated with the proposed system.
  - 2. Include a minimum of (1) building elevation depicting the location of any outdoor antennas associated with the proposed system. Include height of antenna centerline above building, orientation, and location of all external grounding connections.

3. Include a detail plan view of all Telecommunications Spaces housing head-end and/or other consolidated equipment, showing the location of the rack(s) and/or enclosure(s) of the Emergency Responder Radio Antenna/Repeater System equipment.
  4. Include a separate plan view of each interior floor where indoor antenna systems are proposed. Include antenna numbers, coaxial cable routes, and the locations of any other system components including splitters, couplers, filters, amplifiers, etc. All components shall be named or labeled for reference in power budget calculations tables. Overlay approximated coverage radii indicating -95 dBm downlink (base to mobile) signal strength around each proposed indoor coverage antenna. Include results of any previous coverage testing per grid, if available.
  5. Include battery calculations.
- D. Product Data: Submit product data for all items indicating exact product information.
- E. Closeout Documents:
1. Submit as-built drawings indicating location of all components and routing of all cabling.
  2. Provide operations and maintenance data for all components.

## 1.5 QUALITY ASSURANCE

- A. Designer Qualifications: Engage an experienced designer licensed by the FCC to perform work of this Section. Designer to have certification of in-building system training issued by a nationally recognized organization or certificate issued by the manufacturer of the equipment to be installed.

## 1.6 TESTING

- A. Test system in accordance with IFC 510, Acceptance Test Procedures.

## 1.7 SERVICE CONTRACT

- A. Include a 5 year service contract to completely maintain and test the system in accordance with IFC and AHJ requirements.

# PART 2 PRODUCTS

## 2.1 GENERAL PERFORMANCE REQUIREMENTS

- A. Compatibility: All equipment, including but not limited to repeaters, transmitters, receivers, signal boosters, cabling, fiber distributed antenna system, etc., shall not interfere with the existing communication systems utilized by the Public Safety and First Responder agencies.
- B. Power Supplies: Minimum of two (2) independent and reliable power supplies, one primary and one secondary. The primary power source supplied from a dedicated 20 ampere branch circuit and complies with 4.4.1.4 of NFPA 72. The secondary power source, a dedicated battery, capable of operating the in-building radio system for at least 12 hours of 100% system operation and contained in one NEMA 4 or 4X type enclosures. Specify monitoring the integrity of power supplies in accordance with 4.4.7.3 of NFPA 72.
- C. Survivability:



1. Physical Protection: Specify all wiring and fiber optics to be installed in conduit.
2. Fire Performance: Specify all main risers or trunks of the antenna system to be installed with resistance to attack from a fire using one of the following methods:
  - a. A 2-hour fire rated cable or cable system.
  - b. Routing the cable through a 2-hour fire rated enclosure(s) or shaft(s).
  - c. A system configured in a looped design, routed through 1-hour fire rated enclosure(s) or shaft(s). The circuit shall be capable of transmitting and receiving a signal during a single open or non-simultaneous single ground fault on a circuit conductor.
  - d. Performance alternative approved by the authority having jurisdiction.
3. Cabinet: Signal booster and all associated RF filters to be housed in a single, NEMA 4 certified, painted steel weather tight box.
4. Cable: Cable to be rated for fire plenum and riser rating.

## 2.2 SYSTEM COMPONENTS

- A. Signal Strength:
  1. Downlink: Design for a minimum signal strength of -95 dBm to be provided throughout the coverage area.
  2. Uplink: Design for a minimum signal strength of -95 dBm to be received at the local Fire Department Radio System from the coverage area.
  3. Design system such that the donor antenna maintains isolation from the distributed antenna system. Design the donor antenna signal level to be a minimum of 15 dB above the distributed antenna system under all operating conditions.
- B. Supported Frequencies: Design the radio system to support frequencies in the VHF/UHF public safety bands as utilized by the local Fire Department. All in-building radio system shall be compatible with both analog and digital communications simultaneously at the time of installation.
- C. Bidder shall provide parts and equipment list and specifications for all components of the system, including, but not limited to:
  1. Donor Antenna.
  2. Interior DAS Antennas.
  3. Signal Booster.
  4. Coaxial Cable: 2-hour fire rated circuit integrity cable, plenum rated and connectors.
  5. Fiber Optic Cable and connectors.
  6. Bias tee, connectors, terminations, jumpers, and gas tube.
  7. Combining equipment.
  8. Grounding.

## PART 3 EXECUTION

### 3.1 SIGNAL STRENGTH SURVEY

- A. Perform signal strength measurements after Building is enclosed and wall insulation has been installed.

### 3.2 LICENSING

- A. All fees associated with the licensing shall be paid by the Owner.
- B. All testing must be done on frequencies authorized by the FCC.

### 3.3 GROUNDING

- A. Provide grounding of cable shields and equipment per Manufacturer's requirements.
- B. Ground Antenna mast per NFPA 70 NEC requirements, Section 260526, "Grounding and Bonding for Communications Systems" and antenna manufacturer's requirements. Specify grounding blocks and surge protection for outside coaxial cabling. Specify lightning protection system and bonding for antenna mast.

### 3.4 TESTING

- A. Test system in accordance with IFC 510, Acceptance Test Procedures.

### 3.5 LABELING

- A. Provide phenolic nameplates for system amplifier and battery cabinet. Indicate purpose of equipment, circuit number and notice that system is monitored and should only be accessed by trained personnel. Identify radio frequency and channels amplified.
- B. Include additional signage as required by the AHJ.

### 3.6 DEMONSTRATION AND TRAINING

- A. Review system features with Owner's personnel. Allow 4 hours of training to be scheduled at Owner's convenience.

END OF SECTION

## **DIVISION 28**

# **ELECTRONIC SAFETY AND SECURITY**



## PART 1 GENERAL

### 1.1 SUMMARY

- A. The purpose of this section is to describe the commissioning process specific for those sections listed in Division 28.

### 1.2 ADMINISTRATIVE REQUIREMENTS

- A. General Responsibilities: The Contractor's commissioning responsibilities applicable to each of the Contractors for Fire Alarm and Security are as follows:
  - 1. In each purchase order or subcontract written, include requirements for submittal data, commissioning documentation, O&M data and training.
  - 2. Attend a commissioning kick-off meeting and other meetings necessary to facilitate the Commissioning process.
  - 3. Contractors shall assist in clarifying the installation, operation, maintenance, and control of commissioned equipment if requested by the Commissioning Authority.
- B. Coordination  
Refer to Section 019100 for a listing of all sections where commissioning requirements are found, for systems to be commissioned and for Pre-verification testing requirements.

### 1.3 SUBMITTALS

- A. General Submittals: Contractor shall provide to the Commissioning Authority, through established channels, normal cut sheets and shop drawing submittals, and manufacturer's installation, start-up, and testing checklists, for all commissioned equipment.

## PART 2 PRODUCTS (NOT USED)

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Installation Checklists: The Contractor shall complete the checklist(s) provided with and using the Facility Grid app.
  - 1. The completion of these checklists does not limit the Contractor's responsibilities for quality control and scheduling as indicated elsewhere in the documents, nor does this checklist include all submittal, inspection, or quality assurance requirements for the work of this Section.

### 3.2 CLOSEOUT ACTIVITIES

- A. Functional Performance Testing: The Contractor shall complete the tests indicated in this Section with the consultant/AHJ present.
  - 1. Security System: Testing of the Security System will be performed with the A/E consultant present.
  - 2. Fire Alarm System: Testing of the Fire alarm system will be done prior to training and with the Fire Marshall and A/E consultant present.
  - 3. Training: The Owner personnel shall be trained on procedures related to section 1.1A above.

### 3.3 DOCUMENTS REQUIRED

A. The General Contractor will provide the following documentation before Final Acceptance:

1. Completed Inspection Forms with approval signatures of all Authority Having Jurisdiction.
2. Approval Signature of A/E Consultant
3. Copies of Completed Manufacturer Functional Tests

END OF SECTION 28 08 00

## PART 1 GENERAL

### 1.1 SUMMARY

- A. The work consists of providing and installing prescribed systems and equipment, in accordance with the Owner's directives and needs. The Contractor shall design, install, and configure systems to provide the exact function described herein and will be held to the operational criteria. Contractor shall be responsible for providing and installing a complete and fully operational system, with the intended features and capabilities, whether or not all required parts, components, systems or accessories are specified in the construction documents. Contractor shall provide all required parts, components, systems, materials and accessories needed for a complete and working system, without additional cost to the owner. System to be integrated into District S2 NetVRx Enterprise software. Work of this section to be performed by the same contractor that performs Sections 281600 and 282300.
- B. Furnish all labor, materials, tools, equipment, and services for all Access Control Equipment, as indicated, in accord with provisions of Contract Documents. Final terminations and system commissioning to be performed by a factory certified technician. Systems and the respective specification sections which are part of this section include:
- C. Items include but are not limited to the following:
  - 1. Reader Controller.
  - 2. Reader Interface.
  - 3. Access Control and Alarm Monitoring Software.
  - 4. Power Supply.
  - 5. Card Readers.
  - 6. On-line networked locks, wireless and hardwired.
  - 7. Off-line locks controlled by access control and alarm monitoring software.
  - 8. Wiring, switches, and ancillary equipment.
  - 9. Although such work is not specifically indicated, provide and install supplementary or miscellaneous items, appurtenances and devices incidental to, or necessary for, a sound, secure and complete installation.
  - 10. Training on operation and software of the access control system per Section 3.7 of this specification section.
- D. Intent of Access Control Specification:
  - 1. The following specification shall be considered as coordinated with the general conditions, special conditions and the preamble of this and other related sections. It shall be the Security Contractor's responsibility to furnish all necessary systems and equipment, in accordance with the Owner's directives and needs.
  - 2. Where items aren't definitely or correctly specified and are required for completion of the work, a written statement of such omission, error, or other discrepancy shall be sent to the Architect, prior to date specified for receipt of bids for clarification by addendum; or, furnish such items in the type and quality established by this specification, and appropriate to the service intended.
  - 3. Adjustments to the Contract Sum will not be allowed for omissions not clarified prior to bid opening.

### 1.2 QUALITY ASSURANCE

- A. Requirements of Regulatory Agencies:
  - 1. Furnish security equipment to comply with the requirements of laws, codes, ordinances, and regulations of the governmental authorities having jurisdiction where such requirements exceed the requirements of the Specifications.
  - 2. Furnish security equipment to comply with the requirements of American National Standards for Making Buildings and Facilities Accessible to and Usable by Physically Handicapped People (ICC/ANSI A117.1), the governmental authority having jurisdiction and to comply with Americans with Disabilities Act.
- B. System supplier must be certified by the equipment manufacturer, for installing, supporting and servicing the products to be furnished. Certification shall be submitted on the equipment manufacturer's letterhead.
- C. Contractor Qualifications:
  - 1. Company that is trained, authorized, and certified to install the specified products.
  - 2. Company with a minimum of 5 (five) years system design, engineering supervision, and installation experience in the access control industry.
  - 3. The contractor will maintain a fully staffed local office within 75 miles of the work site. The service center will be staffed by factory trained technicians and must be adequately equipped to provide emergency phone service within twenty four (24) hours on a twenty-four (24) hour, 365 days per year basis, whether or not the owner purchases a maintenance contract with the contractor.
  - 4. Within the local service center, the contractor must maintain an inventory of spare parts and other items critical to system operation and as necessary to meet the emergency service requirements.
  - 5. The contractor must have in-house engineering and project management capability consistent with the requirements of this project. The contractor shall provide a project manager who is actively in the project. This person shall be the same individual throughout the course of the project and shall be the person responsible for the scheduling of the system programming, preparation of the Operation and Maintenance Manuals, Training Programs, documentation and system testing, maintenance of Drawings and the coordination of all subcontract labor. The owner reserves the right to approve the contractor's Project Manager.
  - 6. The contractor must abide by and adhere to all Drug Free School Zone laws and participate in a drug-free workplace program.
  - 7. Approved Sub-Contractors: Long Building Technologies, GB Manchester.
- D. Testing Agency: Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Pre-Installation Conference: Prior to installation arrange conference between supplier, and related trades to review materials, procedures, and coordinating related work.
- F. Sequencing: The work shall be performed in the following sequence, unless directed otherwise by owner's representative:
  - 1. Installation of all wiring, conduit and rough-in boxes.
  - 2. Installation of Access Controllers, Modules & Power Supplies.
  - 3. Installation of new field devices and new readers/network locks.
  - 4. Installation of site control & front end equipment.
  - 5. Commissioning of the new system components.



6. End User training.

G. The Authorized Dealer to include 1 year warranty from date of substantial project completion.

### 1.3 SUBMITTALS

A. Submit all product data and shop drawings for review and approval. Shop drawings to include complete wiring diagrams for all components and all device identification. Utilize final room names and numbers as identified during construction for programming purposes.

### 1.4 WARRANTY

A. All work and system components shall be covered by a one (1) year 'in field' warranty against defects in materials and workmanship, commencing with substantial completion of the project, unless otherwise directed by owner or their representative.

B. During system warranty period, system updates are to be made available to owner at no charge to owner.

C. During warranty period, provide twenty-four (24) hour toll-free technical support.

### 1.5 RELATED SECTIONS

A. Section 260100 - Electrical General Requirements.

B. Section 260400 - Existing Electrical Systems.

C. Section 260500 - Basic Materials and Methods.

D. Section 260526 - Grounding and Bonding.

E. Section 260530 - Low-Voltage Electrical Systems Pathway.

F. Section 281600 - Intrusion Alarm System.

G. Section 282300 - Closed Circuit Television System.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

A. Access Control System Hardware/Firmware/Software:

1. S2 NetBox VRx compatible with existing Enterprise software system.

B. Credentials and Readers:

1. Credentials: Owner Provided.

2. Reader, Proximity: Weatherproof wall mounted reader: HID Signo 40NKS-01-00001H (wall mount) or 20NKS-01-00001H (mullion mount).

C. Request-to-Exit Buttons:

1. STI
- D. Door Position Switches/Contacts:
  1. Sentrol
- E. Request-to-Exit Motion Sensors:
  1. Bosch
- F. Electric Horns, Door Alarms, Strobes:
  1. Schlage by Allegion (or approved equal)
- G. Power Supplies:
  1. Altronix or equal.
- H. Pushbutton Release:

## 2.2 SYSTEM CAPABILITIES

- A. Access Control System Software will have the following software components and capabilities:
  1. System Communication:
    - a. The system shall provide a Communication Interface Module (CIM) to issue all database changes to the Reader Controllers. This software module also shall have the ability to gather all the information (transactions) from the Reader Controller and store it in proper history files.
  2. Communication Management:
    - a. The system shall also facilitate a System Processor (SP) that controls the communication between the File Server and the workstations. This application shall be in charge of directing transactions and alarms to proper workstations. This program also shall be capable of sending alarms of e-mail messages to legitimate e-mail accounts.
  3. Access Rights:
    - a. The software shall allow for assignment of the access rights to badge holders. The access right is the combination of what "Areas" the badge holder can go and when the badge holder can go there (time zones). Each badge holder can be allowed multiple "Area" access rights. Each access right shall be allowed to have a different time schedule. The software shall automatically load the proper access rights into each field panel without any operator intervention. There shall be no limits on the number of access rights (who goes where and when) by the system design.
  4. Event Triggers:
    - a. The system shall have the ability to associate output events, i.e. relay activation in relation to system events, i.e. access requests and contact input changes of state.
  5. System Integration:
    - a. The system shall integrate with the building intrusion alarm systems to allow select readers to be disabled until intrusion alarm system is disarmed.
    - b. System to interface with S2 closed circuit television system.
  6. System Security.
  7. Reports.
  8. Cardholder Creation and Management.

9. Badge Layout.
10. Allow multiple credentials per cardholder.
11. Person with Disability (Special Access Privileges).
12. Assigning Area Access.
13. Portrait Capture.
14. Portrait Enhancement.
15. Portrait Exporting.
16. Signature Capture.
17. User Definable Fields.
18. Designing Badge Layouts.
19. Printing Badges.
20. Badge Automation.
21. Export and Import Badge Layouts.
22. Transaction Monitoring.
23. Viewing Previous Transactions.
24. Alarm Processing and Monitoring.
25. Alarm Graphics.
26. Manual and Automatic Overrides.
27. Manual Overrides.
28. Automatic Overrides.
29. Integrated Guest Pass.
30. Guest Pass Locations.
31. Pending Guest Records.
32. Access control Templates.
33. Guest Pass Web Interface option.
34. Report Generation.
35. Scheduled Reports.
36. Elevator Control.
37. System Wide Features:
  - a. Context Sensitive Help.
  - b. Wizards.
  - c. Pull Down Menus.
  - d. Onscreen Help.
  - e. Search and Advanced Find.
  - f. Right Click Options.

## 2.3 SYSTEM PROGRAMMING

- A. The contractor shall furnish and install all hardware, software, devices and components to meet the performance and functional requirements described in these contract documents. Include all items required, whether or not individually specified, to ensure a completely operational integrated Security Protection system. The contractor must complete all database entry (unless directed otherwise by owner or their representative), and provide the owner with training on cardholder entry, as well as all system programming. No additional costs shall be allowed to make the system operational or to meet specifications.

## 2.4 SYSTEM ARCHITECTURE

- A. System Description:
  1. Primary function is to regulate access through specific portals, to allow remote control of identified access points and to control access points through a time schedule.

2. Utilize card technology as its primary access device.
3. Surge Protection Components must be protected from voltage surges originating externally to equipment housing and entering through power, communication, signal, control, or sensing leads. Must also include surge protection for external wiring of each conductor-entry connection to components.
4. Power: Any special power treatment required, such as filtering or spike elimination that may be required for proper operation and protection of the ACS, shall be provided with the system. Step down power supply with battery backup of at least 4 hours.
5. Backup Power: ACS equipment power shall be supplied from a UPS system, which shall be tied to emergency building power circuits. The UPS shall power the equipment including, but not limited to, the Embedded Controller, electronic locks and lock power supplies for a minimum of 4 hours.

## 2.5 SYSTEM CONTROLLER

- A. Software and Server: Genetec or S2 System Enterprise Software, client license must be installed on a computer that meets the minimum requirements.
- B. Access Control and Alarm monitoring software includes:
  1. Transaction and Alarm monitoring / routing.
  2. Cardholder management (includes special access needs).
  3. Unlimited card holder capacity.
  4. Unlimited card reader capacity.
  5. Unlimited alarm capacity.
  6. Unlimited operator capacity.
  7. Manage online and off line locks/readers.
  8. Portrait Capture and card production (printers not included).
  9. Video and Camera control via exacqVision NVR & DVR's.
  10. Guest Pass management and badge creation (printer not included).
  11. Complete Auditing/Reporting capabilities.
  12. Auto scheduling of predefined reports.
  13. Enrollment reader capable.
  14. Elevator Control.
  15. Software Support: Include minimum 5 years of software support to include all system updates.
- C. Server shall be provided by the School District.
- D. Guest Pass Software.
- E. Enrollment Reader.

## 2.6 SYSTEM HARDWARE

- A. Network Devices: S2 Network Node.
- B. Reader Controller: S2 Access Control Application Blade (ACM).
- C. Reader Interface: HID Signo. Wall or mullion mount.
- D. Networked Electronics Locks: Schlage NDE, Schlage LE.
  1. Networked On-line Locks Model's:

- a. Wireless Applications:
  - 1) Communicates to the controller via SMS.
  - 2) Modular design that allows customization without removing it from the door (multi-technology (prox + smart card), multi-technology + keypad, magnetic stripe + keypad, magnetic stripe & keypad only).
  - 3) 900 MHz communication between AD-400 and PIM400.
  - 4) Encrypted transmission.
  - 5) Wireless Lockdown/Unlock feature.
  - 6) Up to 2 year battery life.
  - 7) Credential verification time < 1 second.
  - 8) Communicated to PIM up to 200 ft. with obstructions (normal building construction), up to 1000 ft. clear line of site Networked locks model's.
- b. Hardwired Applications:
  - 1) Communicates to the controller via RS485.
  - 2) Real-time communication between controller and lock.
  - 3) Supports daisy chain or star communications.
  - 4) Modular design that allows customization without removing it from the door (multi-technology (prox + smart card), multi-technology + keypad, magnetic stripe + keypad, magnetic stripe & keypad only).
  - 5) Built in Request-to-exit, Door position, Lock/unlock status, Request-to-enter, Interior cover tamper guard, Deadbolt position.
  - 6) Lockdown/Unlock feature.
  - 7) Field configurable fail safe/fail secure and other capabilities per code.
- 2. Off-line Locks:
  - a. Off-line Applications:
    - 1) Uploads (transactions) and downloads (cardholders, scheduling, time zones, etc.) to system software via Handheld Device (HHD).
    - 2) Up to 2 year battery life.
    - 3) Modular design that allows customization without removing it from the door (multi-technology (prox + smart card), magnetic stripe).

## 2.7 POWER SUPPLIES

- A. Power supplies to have the following features and include battery back-up within each power supply enclosure:
  - 1. LED indicators to show good AC power and DC on.
  - 2. Electronic power limited short circuit protection.
  - 3. Thermal regulator for preventing overheating.
  - 4. Output ON/OFF service switch.
  - 5. No switch over or voltage drop when input power fails.

## PART 3 EXECUTION

### 3.1 COORDINATION

- A. Review installation requirements with all involved trades one month prior to rough-in to ensure all line voltage power, low voltage cabling and door hardware requirements are coordinated.
- B. Review door operation with Architect, Engineer and Owner prior to finalization of shop

drawings.

### 3.2 SYSTEM SOFTWARE

- A. Develop, install, and test software and databases for the complete and proper operation of systems involved. Assign software license to Owner and assign secured IP address to/or supplied by Owner.

### 3.3 SYSTEM PROGRAMMING

- A. The Contractor shall work with the owner to ensure that the new components will be properly programmed into the new and/or existing system.
- B. Coordination required is as follows, unless directed otherwise by owner or their representative:
  - 1. Personal/staff information.
  - 2. Access time for all personal/staff.
  - 3. Definitions of openings for staff access.
  - 4. Holiday definition.
  - 5. Special access privileges.
  - 6. Lock down conditions.

### 3.4 OWNER PERSONNEL TRAINING

- A. On Site Operator training: instruct operating staff in proper operation, including hands-on training:
  - 1. Minimum of four (4), man-hours covering the operations for each system installed.
  - 2. Training sessions shall be provided to supervisors, staff utilizing systems and equipment provided under this section, maintenance personnel and any other personnel designated by the owner. Security Contractor should prepare to provide operator training for up to ten (10) personnel.
  - 3. Provide training sessions on all work shifts, including day, evening and night shifts.
- B. On Site Administrator training: instruct owner-designated security system administrators for each system installed:
  - 1. Minimum of four (4), man-hours of training for each owner-designated individual. Training to cover all administrative and management functions, features and controls for each system.
- C. Refresher training: provide a 90-day refresher training session to operators and administrators:
  - 1. Minimum of four (4) hours of training for each owner-designated Operator and/or Administrator. Training shall cover summaries of all operator and administrator training topics and shall include greater detail on subject areas or operations not yet mastered by operators or administrators.
- D. Review in detail all information in the operations and maintenance manuals for each system provided.
- E. Training courses shall be videotaped for subsequent training use by the Owner.

END OF SECTION

## PART 1 GENERAL

### 1.1 SECTION INCLUDES

- A. Building Intrusion Detection and Alarm System, Bidder Design.

### 1.2 RELATED SECTIONS

- A. Section 260100 - Electrical General Requirements.
- B. Section 260500 - Basic Materials and Methods.
- C. Section 260526 - Grounding and Bonding.
- D. Section 260530 - Low-Voltage Electrical Systems Pathway.
- E. Section 281300 - Electronic Access Control.
- F. Section 282300 - Closed Circuit Television System.

### 1.3 SYSTEM DESCRIPTION

- A. Perimeter Protection: Provide contact devices on all exterior doors.
- B. Space Protection: Provide glass break detection in exterior rooms with windows. See Part 3 of this specification and drawings.
- C. Protective Loops: Connect alarm initiating devices to instant protective loop (zone) except at building entry area designated for system arm/disarm where alarm initiating devices shall be connected to the time delay protective loop.
- D. Alarm:
  - 1. Pre-Alarm: Time programmed audible signal located at remote arm/disarm station and activated by time delay protective loop.
  - 2. Alarm: Silent alarm. System alarm shall result in automatic transmission of a coded digital signal to the receiving station over a designated business telephone line.
- E. Interface to Access Control System: Provide software and physical hardware interface to S2 access control system.

### 1.4 SYSTEM MONITORING

- A. Provide transmission of alarm and trouble signals to a local Central Station designated by the Owner.
- B. Include connection and first year charges for 24 hour Central Station monitoring.

### 1.5 SUBMITTALS

- A. Prior to submitting Shop Drawings, schedule a meeting with Owner and Architect/Engineer

to review proposed system design, products, and system operation and features.

- B. Product Data: Submit product data for all items specified under Part 2 of this section.
- C. Shop Drawings: Submit shop drawings of complete system design. Show building plan with equipment and device locations, interconnecting wiring, and zoning. Indicate wire and cable type, size, and quantities. Wiring diagrams shall indicate wire color coding and termination points for control equipment and each type of device. Include schedules for alarm zone and area zone assignments.

## 1.6 OPERATION AND MAINTENANCE DATA

- A. Include data for complete system in Operation and Maintenance Manuals. Include programming and user manuals and clarify actual configuration, zone configuration, options, and accessories actually installed.
- B. Record Drawing: Provide as-built record drawing indicating installed locations of all components, cable routing and device addresses.

## 1.7 QUALIFICATIONS

- A. Installers: Trained and experienced technicians of company having minimum three years experience in the installation of intrusion alarm detection and systems shall perform the work. The work of this Section to be performed by the same contractor responsible for performing the work of Section 281300, Access Control and Section 282300, Closed Circuit Television Systems.
- B. Authorized factory representative of the system being installed shall supervise installation, testing, and adjustment of the system.
- C. Vendor shall have service staff on 24 hour call, 7 days a week to respond to warranty deficiencies during the warranty period and for future needs after the warranty period expires. Response shall be within 6 hours of notification from Owner to Alarm company.
- D. Approved Sub-Contractors:
  - 1. Long Building Technologies, contact: Jim Jamison – (206)300-1503.
  - 2. GB Manchester, contact: Archie Kangas – (360)816-0484.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Bosch to match School District Standard.

### 2.2 PRODUCTS

- A. Control Panel: Bosch B9512G.
  - 1. Microprocessor based programmable security control panel and communicator with surface wall mounted cabinet. With keypad mounted on or adjacent to control cabinet.
  - 2. System Features (minimum):
    - a. Solid state, multi-zoned, with capacity for 8 zones expandable to 134.



- b. Supervision of initiating and signaling circuits.
  - c. Real time clock and test timer.
  - d. Normal power monitoring, automatic thermal reset breakers.
  - e. Battery pack and charger with capacity to operate the 12 VDC system in standby for 48 hours and 10 minutes of alarm after the 48 hours of standby, battery monitoring and battery charging.
  - f. On-board audible alarm annunciator.
  - g. Programmable relays for indicated interface, input, and output functions. Include two spare relays.
  - h. 500 event log with parallel printer interface module.
  - i. Remote Account Manager to allow access to the stored events by the alarm monitoring agency.
  - j. Supervised walk test switch (trouble signal in test position) to allow one person to walk test the system.
  - k. Supervised terminals, digital autodialer, telephone cables (for two lines) and two RJ telephone jacks for connection to an approved monitoring agency via telephone line.
  - l. Customizable control function, custom command center text, programmable command menu, programmable user authority.
  - m. Ports to connect keypads, zone expanders, and other accessories.
- B. Break Glass Detectors: Microprocessor-controlled digital signal processing, high energy/low pulse detection, high/low sensitivity settings, digital RFI/EMI filtering, 25' minimum range, compatible with alarm control system.
- C. Contacts (Window & Door): Recessed 3/8" diameter magnetic wide gap SPST, with 12" minimum leads for concealed installation. Provide light or dark color to match architectural finish. Provide 1/4" diameter where construction does not permit 3/8" diameter. Contacts installed in steel frames shall be suitable for the application.
- D. Digital Communicator: Supervised four channel electronic coded digital transmitter complete with battery backup and phone cable with plug for connection to RJ31X phone jack. Communication may be an integral part of the alarm control panel or separate equipment.
- E. Key Pad: Bosch B920.

## 2.3 MATERIALS

- A. Conductors:
- 1. 120 Volt Circuits: As specified in Section 260500 for 600 volt.
  - 2. 12 Volt DC Circuits: 22-gauge minimum, color coded, multi-conductor copper cable with overall foil shield and PVC jacket. Wire size shall be increased as required to meet voltage drop and circuit resistance characteristics of the system.
  - 3. Outside plant cable shall be UL listed for the purpose.
- B. Boxes, Conduit, Raceway, Device Plates: Comply with section 260500.

## PART 3 EXECUTION

### 3.1 PREPARATION

- A. Arrange with Owner's telephone system installer to provide two phone lines terminated at the coded transmitter with required telephone jacks.

### 3.2 INSTALLATION

- A. Equipment and Devices:
  - 1. Install, adjust, and test per manufacturer's instructions.
  - 2. Provide initial programming of alarm to make system operational. Variable and optional software features shall be programmed as directed by the Owner. Provide final programming using final names and room numbers; coordinate with Owner and make system adjustments requested.
  - 3. Alarm system control, remote arm/disarm key station(s), and access control shall be located as indicated. Alarm initiating devices shall be installed and located as required to provide intrusion protection specified.
  - 4. Install all detectors away from false alarm causing conditions. Aim and adjust detectors to give proper operation and coverage.
  - 5. Provide consultation with the Owner's representative to determine initial system requirements. Provide initial programming and program testing to ensure system operation as Owner has directed. Modify program documentation as required to show final system setup. Include this documentation in O&M Manual.
  - 6. Provide programming of the digital communicator as required to report system alarm, trouble, arm, disarm, and restore signals to the Central Receiving Station.
  - 7. Provide tamper alarm on each junction box and terminal cabinet which shall be activated upon opening or removal of enclosure cover.
  - 8. Provide label on ceiling tile below equipment installed above suspended acoustic ceilings.
- B. Wiring:
  - 1. Comply with requirements of Section 260500, except minimum conduit size for home runs shall be 3/4 inch. Exposed wiring is permitted only in existing construction where wiring cannot be fished.
  - 2. Install conductors in conduit except wiring may be open cabling where installed as follows:
    - a. In attic, ceiling, and crawl spaces that are accessible.
    - b. In cable trays.
    - c. Where exposed above 16 feet in high ceiling spaces.
  - 3. Install cable without splices.
- C. Requirements for Open Cable:
  - 1. Install cable parallel and perpendicular to building lines.
  - 2. Cable installation shall comply with NEC 300-4 where installed through studs, joists, rafters, and similar structural members.
  - 3. Secure cable by straps or similar fittings so designed and installed as not to damage the cable, at intervals not exceeding 4.5 feet.
  - 4. Protect cables with plastic bushing through device plates and outlet boxes.
  - 5. Provide conduit sleeves for installing cables thru fire rated construction, draft stops, and partition walls in attics, crawl spaces, and accessible ceiling spaces.

### 3.3 DESIGN REQUIREMENTS

Following is minimum intrusion protection and access control criteria for the system design.

- A. Perimeter Protection - Magnetic Contacts: Provide contact devices in each door leaf of all exterior operable doors.
- B. Perimeter Protection: Provide break glass detection in spaces with exterior windows.
- C. Alarm Zoning: Provide separate alarm zones to allow Community Spaces to be occupied while School Use Only spaces are armed, see Drawings for spaces.
- D. Area Zoning: System design shall allow arming/disarming by Alarm Area to allow bypass of selected zones by authorized users while maintaining security in any other Alarm Areas. Provide alarm area zoning as directed by the Owner.
- E. Access Control Locations: Provide input/output interface with access control system.
- F. Provide for input/output interface with CCTV system. Initiate supervisory alarm upon loss of CCTV video signal. Initiate CCTV recording upon intrusion alarm. Coordinate requirements with Section 282300.

### 3.4 TESTING

- A. Test conductors for continuity prior to cover.
- B. Test complete system including each detector, contact, and key pad station and demonstrate satisfactory operation in presence of Owner and his representatives. Furnish all equipment, two-way radios, etc., required for testing.

### 3.5 INSTRUCTION

- A. Demonstrate operation, maintenance and programming of system to Owner's personnel prior to Contract Closeout. Allow one four hour session scheduled at convenience of Owner.
- B. Use operation and maintenance manuals as basis of instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
- C. Demonstrate operation, control, trouble shooting, maintenance, and testing of system.

END OF SECTION



## PART 1 GENERAL

### 1.1 SCOPE AND RELATED DOCUMENTS

- A. The project CCTV system shall be an expansion of the District-Wide S2 NetBox VRx CCTV system. Provide new equipment at the project site and include the necessary programming for viewing, recording, and playback control functions of the new CCTV System to and from the following locations:
  - 1. Locally at the School.
  - 2. Remotely at the Owners Administrative Offices.
  - 3. Remotely at the Owners Technology Department Offices.
- B. Provide a complete and fully operational IP Camera CCTV system meeting the functional and operation requirements of this section and all related sections. The System includes but is not limited to cameras, lenses, camera housings, environmental enclosures and accessories, Video Server(s), remote viewing software, video monitors, IP converters, power supplies, mounting hardware, brackets, fasteners, equipment racks, cable and all other connectors, hardware and components for a complete and coordinated system.
- C. All cameras shall be Day/Night cameras.
- D. The CCTV System shall utilize the new data infrastructure cabling, as described in Section 271001 - Telecommunications Premises Wiring. Provide power extenders where required for cameras that exceed distance limitations for Ethernet cabling.
- E. Head-End type equipment includes, Video Server, Video Manager, Video Extender, and uninterruptible power supplies.
- F. Configure the system as described and shown. Closed Circuit Television equipment shall conform to IEEE 802.3af specifications.
- G. The system shall meet ALL of the requirements listed in Section 271001, prior to "Substantial Completion".
- H. The work of this section and sections 281300 and 281600 are to be performed by the same contractor.

### 1.2 RELATED SECTIONS

- A. Section 260500 - Basic Materials and Methods.
- B. Section 271001 - Telecommunications Premises Wiring.
- C. Section 281300 - Electronic Access Control.
- D. Section 281600 - Intrusion Alarm System.

### 1.3 SYSTEM OPERATION

- A. The CCTV System shall record EACH camera, when motion is present in EACH Cameras Field-of-View.
- B. The Owners existing PC's that are connected to the LAN and/or WAN shall accommodate the following features:
- C. View Live Video from any site.
- D. View Recorded Video from any site.
- E. Provide the ability to export video clips from the Video Server(s) to email and CD.

#### 1.4 QUALITY ASSURANCE

- A. Provide a Staff Commitment Letter in the Submittal and Shop Drawings submittal package, that states the following:
  - 1. Identify and designate two (2) Manufacturer Trained and Certified Technicians for the duration of this project.
  - 2. One of the Technicians shall be the designated LEAD TECHNICIAN.
  - 3. The other Technician shall be the designated BACK-UP TECHNICIAN.
  - 4. Submit copies of the above designated technicians Manufacturer Certification(s).
    - a. To be deemed a qualified Sub-Contractor for this project, a minimum of two (2) technicians shall hold the following Manufacturers Certifications PRIOR to issuing submittals for this project:
      - 1) ExacqVision software Certified.
  - 5. Additional field technicians may also work on the site, but only while one of the two designated technicians are on-site.
  - 6. Identify and designate a Project Manager whose responsibilities will include, but are not limited to:
    - a. The Primary Point of Contact between the Architect and the sub-contractor.
    - b. This person can be the Lead Technician.
    - c. Scheduling of technicians to perform the work on the Owners premises.
    - d. Scheduling of any meetings.
    - e. All meetings shall be on the Owners premises.
    - f. Scheduling and coordination of any deliveries to the Owners premises.
- B. The system, devices, and equipment, shall be manufactured under the appropriate category by Underwriters' Laboratories, Inc. (UL), and shall bear the UL label. Partial or pending listings are not acceptable. The installation of EACH device and/or component shall be in compliance with the UL listing. The system, devices, and equipment shall fully comply with the latest issue of these standards, where applicable, which includes, but is not limited to:
  - 1. National Fire Protection Association (NFPA) - USA:
    - NFPA 70 National Electrical Code
    - NFPA 72 National Fire Alarm Code
  - 2. Underwriters Laboratories Inc. (UL) - USA:
    - UL 50 NEMA 4X Enclosures for Electrical Equipment
    - 1950 Electrical Safety
  - 3. Meet or exceed Building Codes and Standards:
    - Local Authority Having Jurisdiction (AHJ) Requirements
    - State: WAC 51-20 Washington Barrier Free Regulations
  - 4. International:

International Building Code  
International Electrical Code (see NFPA 70)

- C. Approvals:
  - 1. The system shall have proper listing and/or approval from the following nationally recognized agencies:
    - a. UL Underwriters Laboratories Inc.
    - b. ULC Underwriters Laboratories Canada.
    - c. IP66 Water/Dust Protection.
    - d. IEC 60068-2-75 Impact Protection.
- D. Provide and/or perform on-site installation assistance to the Installing Vendor throughout the duration of the project, up to and including acceptance of the CCTV System as defined in Section 271001.
- E. Service and Software Modifications:
  - 1. Provide the services of a Manufacturer Certified/Authorized Technician to perform all system software modifications, upgrades or changes.
  - 2. For non-emergency service, response time of the technician to the site shall not exceed 4 hours. If the call is received by the sub-contractor before 1:00pm, service shall be provided that day, and if the call is received after that time, then the response shall be the following business day.
  - 3. Provide all hardware, software, programming tools and documentation necessary to modify the system on-site. Modification includes addition and/or deletion of system devices, changes to system operation, and custom label changes for devices. The system structure and software shall place no limit on the type or extent of software modifications on-site.

## 1.5 SUBMITTALS AND SHOP DRAWINGS

- A. See Section 271001 - Telecommunications Premises Wiring for additional requirements.
- B. Provide ALL requested submittal documents in "Training Materials and Programming Survey" listed elsewhere in this specification. This includes, but is not limited items listed under "Interview the Owner":
  - 1. The "Section 282300 CCTV System – PRE-INTERVIEW of Owner Requested Systems Programming Sheet".
  - 2. Provide a sample copy of the Training Syllabus.
  - 3. Provide a sample copy of the Step-by-Step Instructions.
- C. Provide a Staff Commitment Letter as described in "Quality Assurance" listed elsewhere in this specification.
- D. Provide a copy of no less than two (2) separate technicians (from the sub-contractor local office) Factor Certifications for the following items:
  - 1. S2 software Certified.
- E. Provide documentation of the On-Site System Information Binder enclosure.
  - 1. Include the list of documents that will be provided in the On-Site System Information Binder.

- F. Provide all test forms for review.
- G. Submit the “System Device Naming Matrix” listed elsewhere in this specification, with the Data Sheet submittal.
- H. Provide the “Video Server(s) Recording and Storage Requirements” calculations on the Shop Drawings.
  - 1. Include the “Spare Capacity” requirements listed elsewhere within this specification, when executing the calculations.
  - 2. Evenly distribute the Mega-Pixel Cameras on EACH Video Server(s) when multiple Video Server(s) are being used (where ever possible), to maximize the Recording Storage time.
- I. EACH camera shall be identified by a Camera ID # located inside of a Hexagon, which will be located in the arch of each camera’s intended field-of-view.
  - 1. The number sequence shall:
    - a. Begin at the buildings main entrance (at the interior of the building).
    - b. Go clockwise through the entire building.
    - c. Where exterior cameras are shown, the number sequence shall continue (starting at the main entrance and going clockwise), only after all of the interior cameras have been identified.
  - 2. EACH Fixed camera shall show the cameras Field-of-View (two lines in a “V” shaped pattern, projecting outwards from the camera). Show an “Arch” that has arrows at each end, connecting the two lines, indicating that this is the entire cameras Field-of-View. Place a Hexagon in the middle of arch.
  - 3. The Shop Drawings shall show the intended Field-of-View for all Fixed Cameras. Use light “hatching” to show this area. This shall be shown on the Site Plan(s) and Floor Plan(s).
    - a. Site Plans: Show all exterior devices on the poles and on the structure.
- J. Submit the System Device Naming Matrix with the Data Sheet submittal.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. See Section 271001 - Telecommunications Premises Wiring for additional information.
- B. The CCTV System design, devices and/or wiring arrangement shown on the drawings represent the intended field of view. The Installing Contractor is responsible to determine the correct camera and mounting requirements to achieve the views indicated. Any changes resulting from differences between the specified product and other manufacturers or substitute manufacturers, shall be the responsibility of the Installing Vendor.
- C. Substitutions of the specified equipment and/or supplier will be considered provided that sufficient documentation is provided to the Engineer which certifies that the equipment and or supplier qualification meets the requirement of these specifications. Any request for substitution shall be submitted by the Installing Vendor in writing so as to be received by the Engineer not later than (10) days prior to the bid due date. Approval by the Engineer will be issued by addendum prior to the bid date.



- D. Provide all equipment as defined in the specification(s) and shown on the drawings.
- E. Refer to Part 1 for any equipment that is not specifically defined.

## 2.2 COORDINATION

- A. Include each of the following items in the bid for this project.
- B. Refer to "Submittals" for additional coordination requirements.
- C. Contact the Owner's Representative for this System for the purpose of setting up and attending a Pre-Installation project kick-off meeting at the location selected by the Owner (somewhere within the District).
  - 1. Be responsible for providing a sign in sheet (with the date, time, location, project name, the printed name of each person in attendance, their title, phone number, and email address).
  - 2. Be responsible for taking Meeting Minutes, typing them into a formal document, and distributing them via email to each attendee, the Architect, and the Engineer.
  - 3. The items discussed at the Pre-Installation project kick-off meeting shall include, but not be limited to:
    - a. Camera Field of Views.
    - b. Camera Titling. See "System Device Naming Matrix" elsewhere in this specification.
    - c. Cameras to be identified on the Multi-Screen Display Monitor.
    - d. Configuration settings.
    - e. General coordination with staff.

## 2.3 SYSTEM WORKSTATION(S)

- A. Owner Provided Workstation(s):
  - 1. Owner Provided Workstation(s) shall be used for this project. These workstations are intended to be used for tasks other than for this system.
    - a. Provide the required cabling, terminations, and configuration to meet all of the system requirements.
    - b. Remote Monitoring via software: The system software shall be loaded on the Owner provided PC's. Provide, load, configure, and test the new software on EACH PC, as required.
      - 1) Coordinate with the Owner to confirm which PC's will receive the new software.
      - 2) Coordinate with the Owners IT Department, as required.
    - c. Provide and Install the most current version of CCTV System software on the CCTV System Workstation(s). Coordinate with the IT Department, as required.
    - d. Provide and install the appropriate quantity of manufacturer approved Seat Licenses for (4) software licenses, installation and configuration of the software as required at the locations listed in Section 1.1 of this specification.

## 2.4 VIDEO SERVER(S), VIDEO MANAGER(S) AND SYSTEM SOFTWARE

- A. The following functional software capabilities are to be considered standard, without the need for add-on software or hardware. Not all of the system features are listed in this specification. This information shall be used as a summary of the requirements. This summary does not

lessen the specified system Make, Model Number, and performance requirements in any way.

B. General:

1. The digital video management system shall accept IP camera input streams, digitally record these video streams, and make them available for live monitoring and investigative review purposes. The system shall operate on a client/server platform, whereby any number of client workstations may connect to one or multiple recorders. The system shall simultaneously and seamlessly record IP video streams.
2. Video Recording: See "CCTV System Recording and Storage Requirements" listed elsewhere within this specification.
3. Video Export and Printing: The system client interface shall allow the printing of video images to the default Windows printer and the export of video and audio to any device shown as a drive letter.
4. Export:
  - a. The system shall have the ability to export individual images and video clips in standard Windows image file formats as well as secure, proprietary formats.
  - b. Still image formats: .BMP .JPEG.
  - c. Video/Audio Clip Formats: XPA (Integral XPress format), .EXE (self-extracting executable, playable on any Windows computer), .MPG, or .AVI.
  - d. The system shall have the capability to export video clips or still images from multiple cameras to a single file. Each camera's name, date and time stamp, and an authentication utility shall be viewable in the exported clip or image.
  - e. The system shall be able to immediately export a pre-configured amount of video to a removable medium such as DVD+RW by pushing a single button on the front panel of the system chassis.
5. Printing: The system shall support direct printing of individual images or all images displayed in the client software application to the default system printer. The system name, image time and date stamp, camera name, and optional operator-entered comments shall be printed along with each image.

C. CCTV System Recording and Storage Requirements:

1. Not all of the Video Server(s) features are listed in this specification. The information under this header shall be used as a summary of requirements. This summary does not lessen the specified Video Server(s) Make and Model Number requirements in any way.
2. ANY and ALL Recording shall ALWAYS: Record Network IP Cameras at the following resolution settings: Mega-Pixel Cameras:
  - a. The "Recording Quality" setting shall be set to the Highest Recording Resolution possible for each camera on the Video Server(s). Use the manufacturers recommended file size calculations, if available. At a minimum, use the following information for estimating hard drive storage:
  - b. Have the oldest video data written over first (i.e.: First In, First Out), while the most current video shall always remain on the hard drive.
  - c. In addition, the CCTV System provided shall:
    - 1) Record all cameras as defined within this specification, regardless of the System Operator choosing basic CCTV System functions. The recording of cameras shall not be halted or stopped in any way, in order to view Live or Recorded image(s).
    - 2) Record EACH Mega-Pixel IP Camera at 7.5 Images Per Second (IPS) using H.264.

- D. Video Server(s): Provide Video Server(s).
- E. Video Manager: Provide Video Manager.
- F. System Software: System software for the Remote Viewing of Live and/or Recorded Images on the Video Server(s) shall be achieved by the use of system compatible software.
- G. Operating Software: The Owner shall provide any and all legally required additional software license(s) by Microsoft™ and other related software.
- H. CCTV System Software:
  - 1. Provide any and all legally required additional software license(s) by the CCTV System manufacturer and other related software.
  - 2. Load the CCTV System software. Provide, load, configure, and test the new software on EACH Video Server, as required.
  - 3. Provide and Install the S2 software on the Video Server(s), Video Manager(s), and Client Workstations. Provide all necessary software licenses as required by the software manufacturer.
    - a. Load, configure, program, and test each Server and PC's as required for a fully functional system.
    - b. Program the District Server(s) and PC's as required to enable remote viewing over the District Wide Area Network from existing District computers.
- I. Coordinate with the Owners IT Department, as required.
- J. To be deemed a qualified Sub-contractor for this project, a minimum of two (2) technicians shall hold the following Manufacturers Certifications PRIOR to issuing submittals for this project.
- K. Camera Licensing: Provide individual IP Camera Licenses for EACH camera provided for this project, as required by the software manufacturer.

## 2.5 CCTV CAMERA POWER SUPPLY (CCPS)

- A. Prior to Bidding, confirm with the manufacturer regarding specific camera and/or power supply requirements for the cameras that are to be powered, to insure compatibility and proper power load requirements.
- B. Include the "Spare Capacity" requirements listed elsewhere within this specification, for the calculations and sizing requirements of the CCPS.
- C. The CCPS shall have the following features:
  - 1. Sixteen (16) Class 2 Rated circuit breaker power limited outputs.
  - 2. Sixteen (16) Illuminated power indication LED's and sixteen (16) on/off power switches.
  - 3. The Power Supply shall be available in 20 amp (480 VA).
  - 4. Provide quantities as required.

## 2.6 SURGE SUPPRESSION

- A. Provide (1) dedicated TVSS at EACH 120vac connection point.

- B. Provide manufacturer and model number to match panelboards.

## 2.7 MONITOR (RACK MOUNT)

- A. For system equipment located in a Rack, provide one (1) combined Rack Mount, Keyboard, Monitor and Mouse in a pull out drawer for the purpose of programming and/or maintaining devices/equipment located in the CCTV Rack. Provide the appropriate cable lengths and quantities as required.

## 2.8 NETWORK RELATED EQUIPMENT

- A. Router(s)/Switch(s):
  - 1. Utilize the Owners Ethernet Switch(es).
  - 2. Program all other system equipment.
- B. Data Infrastructure:
  - 1. See Section 271001, provide EACH of the following items at EACH location required:
    - a. Cat6 Cable Infrastructure within Building.
    - b. Multi-Mode Station Fiber outside Building.
  - 2. Patch Panels.

## 2.9 UNINTERRUPTED POWER SUPPLY (UPS)

- A. For the purpose of maintaining a functional system during power outages, provide Uninterruptible Power Supply at the video server(s) head-end equipment location.
- B. The UPS shall be capable of providing backup power for the entire CCTV System for a minimum of five (5) minutes of continuous operation. This includes, but is not limited to the Video Servers, Video Manager, Power Supplies and POE injectors. All equipment shall bear the UL label. Provide the following in EACH Rack as required.
- C. The UPS shall have the following features:
  - 1. A Single UPS shall serve each designated location. Multiple UPS's at a designated CCTV equipment location will NOT be acceptable.
  - 2. The equipment shall be manufactured for 19" Rack Mounting.
  - 3. Output Voltage Distortion shall be Less than 5% at full load.
  - 4. Output Connections shall be NEMA 5-15R and/or NEMA 5-20R.
  - 5. Surge energy rating shall be 1,020 Joules.
  - 6. Filtering Full time multi-pole noise filtering: 0.3% IEEE surge let through of zero clamping response time and meets UL 1449.
  - 7. Uninterrupted Power Supply:
    - a. The MDF UPS shall be manufactured by American Power Conversion (APC): Model # SUA5000R5TXFMR.
    - b. EACH Designated IDF location UPS shall be manufactured by American Power Conversion (APC): Model # SMT1000RM2U. Provide quantities as required.
  - 8. Network Monitoring Card with Environmental Monitoring.
    - a. Manufactured by American Power Conversion (APC): Model # AP9631. Provide (1) for EACH UPS provided for this project.

## 2.10 RACK(S)

- A. Use rack locations noted on drawings.

- B. ALL Racks shall be provided by Section 271001. Coordinate as required for the CCTV System Installing Vendor to install the CCTV System equipment within these racks.
- C. The CCTV System Installing Vendor shall provide all system equipment within the Racks, as required, for a complete and fully functional system.

## 2.11 FIELD DEVICES

- A. Cameras:
  - 1. Multi-Directional, Indoor:
    - a. Networkable, PoE+, vandal-resistant, 4x2MP multi-sensor, multi-directional camera with lens modules, defocus detections, built-in analytics, defog detection with day/night 2MP lens modules suitable for view indicated. Hanwha PNM-9000VQ or equal. Provide mounting brackets and accessories as required for surface (acoustic ceiling tile, hard ceiling, or wall mounted).
  - 2. Multi-Directional, Outdoor Building Mount:
    - a. Networkable, PoE+, vandal-resistant, 4x5MP multi-sensor, multi-directional camera with lens modules, defocus detections, built-in analytics, defog detection with day/night 5MP lens modules suitable for view indicated. Hanwha PNM-9000VQ or equal. Provide mounting brackets and accessories as required for surface (parapet or wall mounted).
  - 3. 180 Degree, Outdoor Pole Mount:
    - a. Networkable, PoE+, vandal-resistant, 180 degree multi-sensor camera with lens modules, defocus detections, built-in analytics, defog detection with day/night 7.3MP lens modules suitable for view indicated. With pole mounted media converter for fiber to Ethernet. Hanwha PNM-9020V or equal. Provide pole mount adapter, media converter and accessories.
  - 4. Lens Modules:
    - a. Provide the lens type as required to meet the Owners field-of-View requirements. Where a field-of-View is shown on the plans that shall be used as a guide line to assist the Installing Vendor for the focusing requirements. As requested by the Owner, change the lens and/or lenses, where required, to meet the Owners final field-of-View requirements. Review with Owner prior to submitting documents.
- B. Monitor(s) (located in the Admin/Receptionist Area):
  - 1. High Resolution LED Display Monitor:
    - a. PRIOR to rough-in, Coordinate with all trades, this includes, but is not limited to; the structural Framing, Electrical Contractor, and the Architect.
    - b. High Resolution 42" LED Display Monitor. Manufactured by LG: Model # 42LE530C. Provide quantities as shown on the drawings.
      - 1) Recessed Monitor Mount. Manufactured by Peerless: Model # IM760P. Provide quantities as shown on the drawings.

## 2.12 VIDEO EXTENDER FOR MONITORS

- A. Software to program switches: Just Add Power: Model #Media Switcher Control Software.
- B. Transmitter-HDMI to IP Converter: Just Add Power: Model # VBS-HDMI-408A. Provide quantities as required.
- C. Receiver-HDMI to IP Converter: Just Add Power: Model # VBS-HDMI-208A Provide

quantities as required.

## 2.13 VIDEO TAPE THE TRAINING

- A. The Installing Vendor shall include in their Base Bid the time, staff, and resources to provide Step-by-Step Training that is being Videotaped.
- B. A videographer that is regularly engaged in that type of business shall provide no less than (4) hours of actual videotaping time. Provide additional time if requested by the Owner.
  - 1. A lavalier microphone shall be used by the presenter.
  - 2. Provide a minimum of (12) DVD's of the training session.
    - a. Provide one in each Training Manual.
    - b. Provide one in each O&M Manual.
    - c. Provide the remaining copies to the engineer.

## 2.14 EXTENDED WARRANTY

- A. The following items shall be included in the Base Bid and the work performed within the warranty period shall be provided at no additional cost to the Owner.
- B. The warranty shall begin when the Testing of the System has successfully passed all of the operational and performance testing requirements, as defined in Section 271001.
- C. The warranty period shall be no less than (3) years from the date that the warranty begins.
- D. The warranty shall include, but not be limited to, the following items:
  - 1. Provide no less than (1) software upgrade per year.
  - 2. Include labor, material, mark up, OH&P for any equipment failure within the above stated timeframe.

## 2.15 COMMISSIONING

- A. See Part 3 for Commissioning information.

## 2.16 SYSTEM DEVICE NAMING MATRIX

- A. The installing Vendor shall include in the pricing of their bid, the time and materials to generate and create a single System Device Naming Matrix. From left to right, list the information for EACH device, which shall include, but not be limited to the following:
  - 1. Each row shall have an "Item #".
  - 2. The device name (i.e.: Camera).
  - 3. The device abbreviation.
    - 2.16.1.3.1 This is a sample abbreviation that could be used: (i.e. Camera = Cam).
  - 4. The device ID number.
  - 5. Device Manufacturer.
  - 6. Device model number.
  - 7. List the Serial Number for EACH device.
  - 8. Device Location (for example; South Wing Side Door, MDF Room XXX, etc.).
  - 9. For other system equipment (such as "Head end Equipment"), add rows to the bottom of the matrix, and list the appropriate information. Group this information by location. Such as MDF Room XXX, IDF Room XXX, etc.

- B. Use the maximum characters allowable from the system, to be incorporated into a fully functional system. At the Top of the Matrix, state the Maximum number of characters that are available.
- C. Submit this information with the Submittals and Shop Drawings in 11' x 17' format, or smaller.
- D. Prior to ANY system programming, obtain written approval from the Engineer of the System Device Naming Matrix. Make corrections as noted.

## 2.17 SYSTEM CABLES, CONNECTORS, AND PATCH CORDS

- A. Include the "Spare Capacity" requirements listed elsewhere within this specification, for the calculations and sizing requirements of the cables and/or conductors.
- B. Cables/Conductors: The minimum allowable size conductors are specified below. Use larger conductors and/or additional conductors, as required. Prior to Bidding, consult with the system Manufacturer that the following cable types are acceptable. It shall be the Installing Vendors responsibility to provide and install Manufacturer approved cables. Use the Manufacturers equivalent cable requirements, to meet all code requirements [such as "Wet Rated" or "Aerial Rated" cable] for the appropriate devices.
  - 1. CAT6A cable(s): Refer to Section 271001. The color of the outer jacket of the cable is identified in Section 271001.
  - 2. For Interior Power Cable(s):
    - a. Non-Plenum: West Penn 227 (12/2 NS), or approved equal.
    - b. Plenum: West Penn 25227B (12/2 NS), or approved equal.
  - 3. For Exterior Power Cable(s): Wet Rated Aquaseal: West Penn AQ227, or approved equal.
- C. Connectors/Terminations: Use the manufacturer approved wire strippers and crimping tool as required. Refer to Section 271001.
- D. Patch Cords: Size EACH cable length to provide ease of maintenance, while not leaving excessive slack. Refer to Section 271001. The color of all system Patch Cords shall match the CCTV system infrastructure cables.
- E. See PART 3 of this specification and Section 271001 for additional information.

## 2.18 TEST FORMS

- A. See Section 271001 for testing requirements.
- B. Include in the pricing of their bid, the time and materials to completely fill out EACH TEST FORM. Electronic copies of the required Test Forms will be provided to the Installing Vendor upon award of the project. Sample Test Forms are provided at the end of this specification.

## 2.19 TRAINING MATERIALS AND PROGRAMMING SURVEY

- A. The Installing Vendor shall include in the Pricing of their Bid, the time and materials necessary to generate and create the following Documentation, provide the staff and necessary equipment as required to provide the following services, as described below.

- B. EACH of the documents shall have the following:
1. List the Name or Title of the document, the Section Number, and Section Title. This shall be bold and centered at the top.
  2. Header of document: The Project Name and the current date.
  3. Footer of document: Use multiple pages as required, but identify each page by having the footer state "Page 1 of X", "Page 2 of X", etc.
- C. Interview the Owner for no less than a minimum of one (1) 4-Hour session. Allow for additional time if required, at no additional cost to the Owner. The Installing Vendor LEAD TECHNICIAN AND BACKUP TECHNICIAN shall be present for this meeting. The purpose of this Interview is to verbally discuss all of the feature sets of the system. The dialog shall describe the benefits for implementing each of the systems features, thus allowing the Owner to make an informed decision on the how they can maximize the functional operation of their system.
1. Prior to starting the Interview process with the Owner, have EACH attendee fill out a "Sign In Sheet" listing EACH attendee's name, department they work in, and their phone number.
  2. Provide a detailed list of features with a document titled "Section 282300 CCTV System – PRE-INTERVIEW of Owner Requested Systems Programming Sheet". This shall be provided in the "Submittal and Shop Drawings" with the Section 271001 submittal. This shall be used as the basis of discussion for the Interview process.
    - a. For EACH separate software feature, provide a row with an ascending number indicating the "Item #" (on the far left side of the page).
    - b. Next to the Item #, provide a Yes, No, and N/A column. This shall be checked off by the Installing Vendor during the course of the Interview, to determine which options the Owner would like to have programmed.
    - c. On each row, provide a brief description of the feature set.
    - d. On the far right of each row, provide adequate space to write comments.
  3. All parties shall review the drawings and discuss the intended functions of EACH device. This will allow all parties to have a complete understanding of EACH system devices purpose and the performance requirements of the system that was identified during the Interview process.
  4. At the conclusion of the Interview with the Owner, prior to leaving the premises, the Installing Vendor shall do the following:
    - a. Review with the Owner, by verbally recapping EACH of the feature sets listed on the "Section 282300 CCTV System – PRE-INTERVIEW of Owner Requested Systems Programming Sheet" and reiterating this with a Yes (the Owner wants this feature) or No (the Owner does not want this feature). Make any corrections as required.
    - b. Provide no less than three (3) copies of the completely filled out, "Section 282300 CCTV System – PRE-INTERVIEW of Owner Requested Systems Programming Sheet" to the Engineer.
  5. For Bidding Purposes, the Installing Vendor shall be expected to program the system to Industry Standards, based on a project of this size, scope, typical functionality for this market segment, and as described throughout this specification.
    - a. Review the testing requirements specified elsewhere within this specification for additional information.
- D. Within five (5) business days of the conclusion of the Interview, provide the following documents to the Engineer for review:
1. The updated Interview Document with a new title of "Section 282300 CCTV System –



Owner Requested Systems Programming Sheet”. This shall have the Yes, No, and N/A columns electronically filled out to demonstrate what will and will not be programmed. Include at the conclusion of this document, the following;

- a. The date(s) of the Interview with the Owner.
  - b. The address, building name, room name, and room number of the location that the Interview took place at.
  - c. Provide copies of the sign in sheet(s).
2. A Training Syllabus titled “Section 282300 CCTV System – Training Syllabus”, based on the features that the Owner has selected to be programmed into their system.
- E. Training Manuals for the Site Staff:
1. At the 1st training session, prior to starting, provide a quantity of up to ten (10) training manuals to the site staff.
  2. The training manual shall be specific to the site (i.e. Binder spine, binder cover insert, and the binders internal documents).
  3. Each of the training manuals shall be in a 3-ring “D” style binder. The binder shall be sized to allow for 20% additional documentation. The spine of the binder shall have a clear cover with an insert clearly typed with the following label “Section 282300 CCTV System – (site name here) training manual”. The binder shall have a clear front cover with an insert clearly typed with the title of the spine on the front sheet, located at the top of the page, and centered. Under the title of the spine, the following information shall also be included on the front sheet of the binder; the site name and site address, the project name and project address, the current date, the installing vendors name, address, contact name and phone. Each binder shall include the following;
    - a. Use color coded numbered tabs to separate each item defined below and for each device that was installed. Provide these items in the following order.
    - b. Provide an 8½” x 11” clear heavy plastic sheet in front of a table of contents page as the first page of the binder indicating each of the equipment or device documents contained in each tab section.
    - c. “Section 282300 CCTV System – (Site Name Here) Training Syllabus”.
    - d. Provide the power point presentation using actual screen shots of typical functions that are specifically intended to demonstrate the aspects of the Owners new system. These shall be step-by-step instructions of the most common features that are used on the software. This includes, but is not limited to:
      - 1) How to view individual cameras, and change the camera that is being displayed.
      - 2) How to view recorded video.
      - 3) How to view multiple recorded images simultaneously.
      - 4) How to use the search functions to find a specific date, specific time, or specific object.
      - 5) How to “Burn” a CD/DVD of an event.
    - e. Include Color copies of EACH slide that was presented in the power point presentation. Provide a maximum of three (3) legible slides per page, with lines beside each slide to write notes.
    - f. Include the Manufacturers Software User’s Manual(s).

## 2.20 ADDITIONAL SYSTEM EQUIPMENT

- A. See Part 3 of this specification for additional provision of system Equipment and/or Labor.

## 2.21 CC-GMP (CCTV SYSTEM GRAPHIC MAP PLAQUE)

- A. Prior to manufacturing or installation, submit the plan(s) for approval.
- B. The Graphic shall have the following physical characteristics and features:
  - 1. The Graphic shall be secured in a black anodized aluminum frame, have Tempered Glass to protect the graphic image, and be mounted with a concealed security hanging system.
  - 2. Locate at the top of the graphic, the name of the Owner, the Building name or Project name, each approximately one-inch in text height. The size and font type of text shall be consistent on EACH Graphic that is submitted.
  - 3. For multi-story buildings and also areas with a Mezzanine space, the bottom of the graphic shall be the lowest level of the building, continuing to the top of the graphic with the highest level of the building.
  - 4. Show the "North" arrow on the drawing.
  - 5. Show a "You Are Here" (in Red) with an arrow pointing at the wall or area location of where Graphic Map is to be installed.
- C. CC-GMP#1: The Graphic shall have the following features:
  - 1. Provide a graphical representation of the Site Plan, which shall include the entire building floor plan.
  - 2. Site Plan: The actual graphic shall include the information on the Site Plan, which includes, but is not limited to: Bus Parking, EACH Parking Lot, Side Walks, and other Site features.
  - 3. Floor Plan.
    - a. Scale down the entire building floor plan to accurately fit onto the Site Plan graphic. 2.21.3.3.2 Building Room names and numbers. For large rooms, enlarge the text height to be 1/8"=1'-0". For smaller rooms, where the text won't fit within the room, the room name and number is not required and may be omitted from this graphic.
    - b. The Camera Symbol(s) used on the Bid Set of Drawings shall be used on the graphic to show EACH Exterior Camera and EACH Interior Camera.
    - c. Show a thick bold outline around the walls of the MDF and EACH designated IDF location. Only show the thick bold outline around the walls or location that has a CCPS (CCTV System Power Supply) or other CCTV System equipment.
    - d. MDF Room name and number/IDF Room Names and Numbers. For Telecommunication rooms, enlarge the text height to be approximately 1/4"=1'-0" and make the text bold. Provide the room text with an arrow pointing to the room location. The purpose of this is to identify any location that has CCTV System equipment. For example, an IDF Room may have a CCPS (CCTV System Power Supply).
    - e. The Graphic shall be scaled to the size of the frame indicated in the model number and shall be printed on paper.
  - 4. The CC-GMP#1 shall be manufactured by HR Kirkland: Model# 24" x 36" Frame Kit – Glass. Provide (1) in the MDF Room (mounted on the wall near the CCTV Rack).
- D. CC-GMP#2: The Graphic shall have the following features:
  - 1. This graphic map is a reduced scale (11" x 17") of the CC-GMP #1.
  - 2. The graphic map shall be professionally laminated with a minimum 3.0 mil and be wrinkle free.
  - 3. Provide (5) copies.

## PART 3 EXECUTION

### 3.1 GENERAL

- A. Prior to development of shop drawings, review system with Architect and Engineer.
- B. Prior to rough-in, review shop drawings with all other associated trades in presence of Architect or Engineer.
- C. Install all cabling, devices, and/or equipment per the manufacturer's recommendation.

### 3.2 INSTALLATION

- A. EACH CABLE RUN SHALL CONTINUOUS, WITHOUT ANY SPLICES, from the device to the terminal strip on the system patch panel(s). Any cable run that does not meet this requirement shall be replaced at no additional cost to the Owner.
- B. Setup, connect, and configure the Servers/Workstations/Monitors per the manufacturer's recommendations to operate as intended. Load, configure, and test the software for a fully functional system.

### 3.3 MOUNTING HEIGHTS, LOCATIONS, AND SETTINGS

- A. CCTV System Head end and other hardware: All Head end equipment shall be rack mounted.
- B. Rack(s): All cabling for the rack(s) shall have Service Loops and Cable management.
- C. General Camera Information:
  - 1. Prior to rough-in, examine the surrounding area and the cameras intended Field-of-View (FoV) (from the perspective of where the camera is to be installed). Cameras shall be installed with an unobstructed FoV. This includes but is not limited to; existing objects, such as lights, exit signs, or other physical impediments. Any camera that has the final and approved FoV that is obstructed will require the Installing Vendor to relocate the camera, at no additional cost to the Owner. Coordinate with the Engineer and all trades to insure that the cameras FoV will not be obstructed. Prior to relocating any camera, obtain written direction from the Engineer.
    - a. Coordinate with the Owner to relocate banners, art, or anything else that may block the cameras FoV and/or mounting requirements.
    - b. Wall Mount Cameras shall be installed at all areas as shown on the drawings.
- D. Camera Mounting:
  - 1. All cameras shall be flush to the ceiling or wall surface, unless otherwise noted.
  - 2. Prior to rough-in, coordinate with the CCTV Installing Vendor as required.
  - 3. Exterior Camera Mounting Requirements:
    - a. Reinforce the Structure and Mounting Surface to properly secure the mounting of Exterior Cameras, as required.
    - b. Install per camera manufacturer recommendations.
  - 4. Interior Camera Mounting Requirements:
    - a. Install per camera manufacturer recommendations.
    - b. Provide support rails as described in "Field Devices" for camera back box for locations on Access Ceiling Tiles and where required.

5. Camera Focusing:
  - a. After the CCTV System has been powered up, cameras have been back focused (where applicable) and configured, then the camera shall then be positioned as discussed during the Interview with the Owner, which is described in "Training Materials and Programming Survey" listed elsewhere within this specification.
  - b. Fixed Cameras shall be adjusted and focused for the intended Field of View (FoV). Readjust the cameras to the Owner's needs, as required.
6. Viewing Monitor:
  - a. Mounting (for wall or ceiling mounts): Reinforce the wall and/or ceiling as required to accommodate no less than four (4) times the weight capacity rating of the Monitor Mount. Secure the monitor mount as required.
  - b. Coordinate with the Owner to identify the cameras that are to be displayed on the Admin monitor(s) as discussed during the Interview with the Owner, which is described in "Training Materials and Programming Survey" listed elsewhere within this specification.
7. Remote Viewing of VIDEO SERVER(S)(s):
  - a. Load and configure the software on the Owners existing PC's, as required.
  - b. Train the Owners IT department how to load and configure the software on additional PC's, as required.
  - c. Allow for three (3) workstations at Wallace Elementary and five (5) remote at District offices.

### 3.4 DATA CABLES AND OUTLET LOCATIONS

- A. General.
  1. Data Outlet and the camera shall have a Service Loop at each device.
  2. Exterior Cameras shall have the Data Outlet located on the interior of the building, on the wall or ceiling surface within 5'-0" of the wall penetration of the exterior camera.
  3. Interior Cameras shall have the Data Outlet located on the wall or ceiling surface within 5'-0" of the camera (in plan view).
- B. Configure the Video Server(s) in such a manner that the Fixed Mega-Pixel Cameras are equally distributed across multiple Video Server(s) (where applicable) to maximize the days of on-site recorded video storage.
- C. Time and Date Synchronization.
  1. EACH of the Video Server(s) shall be synchronized for the Time and Date to be exactly the same (where applicable).
  2. The "CCTV System" shall be synchronized to other designated systems, such as the Access Control System, for the Time and Date to be exactly the same (where applicable).
- D. The Installing Vendor shall program the system as defined in the documents that were completed during the "Interview the Owner", as described throughout this specification, and as required for a fully functional system.
- E. The Installing Vendor shall program the Configuration Files of the system to be automatically backed up onto the Owners Designated Server. These backups shall occur once per week. Coordinate with the Owners IT Department, as required. This includes, but is not limited to:
  1. EACH of the Configuration Files of EACH Video Server(s).

2. EACH Workstation.

- F. For Bidding Purposes, the Installing Vendor shall be expected to program the system to Industry Standards, based on a project of this size, scope, typical functionality for this market segment, and as described throughout this specification.
1. Review the testing requirements specified elsewhere within this specification for additional information.

3.5 TESTING

- A. See Section 271001 for additional Testing requirements.
- B. The Installing Vendor shall provide the staff and necessary equipment to meet or exceed the testing requirements and fill out each Test Form, as required.

3.6 TRAINING

- A. Training for Site Staff:
1. The training sessions shall be held at the project Site.
    - a. Provide Training for up to ten (10) Site Staff.
    - b. Provide a total of two (2) separate training sessions for the Owners personnel. Schedule both training sessions with the Owner, providing a minimum of 14 days advance notice, and offer a minimum of three dates to choose from.
  2. The Site Training Session(s) shall only take place AFTER the Owners Administrative Staff have had their first training session.
  3. The 1st Training Session shall consist of:
    - a. Providing the printed Training Manuals to EACH attendee, as described elsewhere in this specification in "Training Materials and Programming Survey".
    - b. Being conducted by one of the designated Installing Vendor technicians. The training shall be a minimum of one (1) 4-Hour session and provide a thorough and in depth full feature training session. Provide additional training time as required, to answer EACH of the staff's questions, at no additional cost to the Owner. This training shall address EACH of the software features that meet the Owners requirements identified on the documents that were filled out during the "Interview with the Owner". This includes, but is not limited to:
      - 1) The "Section 282300 CCTV System – Owner Requested Systems Programming Sheet".
        - a) Using an Installing Vendors laptop and projector, connect to the Owners WAN and demonstrate each of these features and functions.
        - b) At the Owners option, the Installing Vendor may be allowed to provide the Training Session on the Owners Workstation.
  4. The 2nd Training Session shall consist of:
    - a. A refresher training session shall be held approximately 30 days after the first training session. The training session shall be a minimum of two (2) hours that may be conducted by one of the Installing Vendors designated technicians that attended the first training session. Provide additional training time as required, to answer EACH of the staff's questions, at no additional cost to the Owner.
    - b. Using an Installing Vendors laptop and projector, connect to the Owners WAN and demonstrate each of the features and functions that the Owner's staff would like clarification on.

- 1) No less than five (5) business days in advance of this meeting, the Installing Vendor shall request from the Owner, EACH of the items that the Owner would like clarification on.
  - a) The documents that were filled out during the “Interview with the Owner” shall be used as the reference document.
  - b) At the Owners option, the Installing Vendor may be allowed to provide the Training Session on the Owners Workstation.
- 2) Following the 2nd training session, the Installing Vendor shall include additional programming to accommodate system functionality changes, based on the requirements of the Owner. Provide up to two (2) hours of system programming changes.

### 3.7 AS-BUILTS

- A. Provide all As-Built documentation as defined in Section 271001 - Low Voltage Systems General Requirements and listed elsewhere in this specification.
- B. Update all documents provided in the Submittal and Shop Drawings to accurately reflect the actual equipment that was provided for this project, and the actual locations of the installed equipment.
- C. The Installing Vendor shall include in the pricing of their bid, the time and materials to generate and create the documentation, as described below.
  1. Provide an “Equipment Information Sheet”, in the O&M manuals. At a minimum, from left to right, provide the following information:
    - a. Each row shall have an “Item #”.
    - b. Manufacturers Name.
    - c. Equipment Device Type (such as Workstation, Control Panel, etc).
    - d. Location (such as MDF room 103, or area of building).
    - e. IP Address.
    - f. Software Name.
    - g. Software Version that is installed on the device.
    - h. List the “Highest Level” configurable password for EACH device.
    - i. List “EACH System Operator” password.
    - j. List all other password settings for EACH device.
- D. Provide ALL CD(s)/DVD(s) of installation software, legally required software licenses, and the associated documentation to reinstall all portions of the software that is running on the new and/or existing Server/Workstations.
  1. Separate ALL information by Server, and EACH individual Workstation, into large plastic Ziploc bags that are clearly identified with a PC generated label. The information on the label shall include, but is not limited to:
    - a. Project Name.
    - b. Date.
    - c. PC location (building name, room name, and room number).
    - d. List the contents of EACH bag.
  2. Include a “Proof of Delivery Form” that includes, but is not limited to:
    - a. Documentation: The quantities of EACH Binder. The Binder Spine Name.
    - b. Software: List EACH bag for EACH PC and lists the contents of EACH bag.

### 3.8 COMMISSIONING

- A. The equipment and systems referenced in this section are to be commissioned per Division 01. The contractor has specific responsibilities for scheduling, coordination, startup, test development, testing and documentation. Coordinate all commissioning activities with the Commissioning Authority.

**CAMERA TEST FORM**

CAMERA NAME

CAMERA LOCATION

CAMERA #

CAMERA TYPE

MODEL #

LENS TYPE

SERIAL #

IP ADDRESS

MAC ADDRESS

TEST DATE

				Camera Feature	Comments
<b>Visual Inspection - at Video Server</b>					
Item 1	Yes	No	N/A	Is camera focused during the day?	
Item 2	Yes	No	N/A	Is camera focused during the night?	
Item 3	Yes	No	N/A	Camera back-focus set for low light operation?	
Item 4	Yes	No	N/A	Is camera properly aimed? (field of view)	
Item 5	Yes	No	N/A	Is field of view clear of all obstructions?	
Item 6	Yes	No	N/A	Is Camera view what owner expect?	
Item 7	Yes	No	N/A	Is Camera motion detection setup per spec?	
Item 8	Yes	No	N/A	If equipped, is heater blower functional?	
Item 9	Yes	No	N/A	Are the frames per second set to owner spec?	
<b>Visual Inspection - at MDF/IDF location</b>					
Item 11	Yes	No	N/A	Is the Cabling installed in a neat manner?	
Item 12	Yes	No	N/A	Are all of the cables labeled properly?	
Item 13	Yes	No	N/A	Are all cables installed without any splices?	
Item 14	Yes	No	N/A	Are all cables of the approved type?	
Item 15	Yes	No	N/A	Do all the cables have proper service loop?	
Item 16	Yes	No	N/A	Are all cables the proper color?	
<b>Visual Inspection - at Camera location</b>					
Item 17	Yes	No	N/A	Do all cameras have the proper patch cord?	
Item 18	Yes	No	N/A	Is the camera clean and ready for use?	
Item 19	Yes	No	N/A	Is Camera viewable from handheld?	
Item 20	Yes	No	N/A	Is the Data Jack accessible? Note location -	
Item 21	Yes	No	N/A	Does the camera have a service loop?	
Item 21	Yes	No	N/A	Is the Camera installed properly?	

Signature

Print

Technician: \_\_\_\_\_

Representing: \_\_\_\_\_ Date: \_\_\_\_\_

Owner Rep: \_\_\_\_\_

Representing: \_\_\_\_\_ Date: \_\_\_\_\_

Architect: \_\_\_\_\_

Representing: \_\_\_\_\_ Date: \_\_\_\_\_



VIDEO SERVER TEST FORM

SERVER NAME

SERVER LOCATION

SERVER #

MODEL #

STORAGE CAPACITY

SERIAL #

IP ADDRESS

MAC ADDRESS

ADMIN PASSWORD

USER PASSWORD

**Function or Feature Comments**

Item 1	Yes	No	N/A	Is Auto backup enabled?
Item 2	Yes	No	N/A	Do operators have correct access rights?
Item 3	Yes	No	N/A	Are operator functions being logged in history?
Item 4	Yes	No	N/A	Is the Time/Date correct?
Item 5	Yes	No	N/A	Is the time and Date in sync with all servers
Item 6	Yes	No	N/A	Is the video server installed correctly?
Item 7	Yes	No	N/A	Are all the cables dressed properly?
Item 8	Yes	No	N/A	Are the video Server passwords programmed?
Item 9	Yes	No	N/A	Is the Video quality set to the highest level possible
Item 10	Yes	No	N/A	Images per second set correctly for each camera?
Item 11	Yes	No	N/A	Motion detection zones programmed correctly?
Item 12	Yes	No	N/A	Sensitivity adjustment displayed to Owner?
Item 13	Yes	No	N/A	Areas to be ignored programmed correctly?
Item 14	Yes	No	N/A	Camera Titled to Match the Naming Matrix?
Item 15	Yes	No	N/A	Time and Date stamp shown on recorded Video?
Item 16	Yes	No	N/A	Is the current Time and Date set?
Item 17	Yes	No	N/A	Is the Loss of Video programmed and tested
Item 18	Yes	No	N/A	Does the loss of Video meet the Owners request?

Signature

Print

Technician: \_\_\_\_\_

Representing: \_\_\_\_\_ Date: \_\_\_\_\_

Owner Rep: \_\_\_\_\_

Representing: \_\_\_\_\_ Date: \_\_\_\_\_

Architect: \_\_\_\_\_

Representing: \_\_\_\_\_ Date: \_\_\_\_\_

END OF SECTION



## PART 1 GENERAL

### 1.1 SECTION INCLUDES

- A. Building Fire Detection and Alarm System, Bidder Design.

### 1.2 RELATED SECTIONS

- A. Section 142400 - Elevators.
- B. Section 211000 - Water-Based Fire Suppression System.
- C. Section 212400 - FM200 Fire Protection System.
- D. Section 255000 - Integrated Automation Facility Controls.
- E. Section 260100 - Electrical General Requirements.
- F. Section 260500 - Basic Materials and Methods.
- G. Section 260526 - Grounding and Bonding.

### 1.3 REGULATORY REQUIREMENTS

- A. Conform to requirements of Washington State Fire Marshal's office and local Fire Marshal.
- B. Conform to requirements of following publications in addition to requirements of 260100:
  - IFC International Fire Code
  - NFPA 72 National Fire Alarm Code
  - Local fire alarm code adopted by the jurisdiction

### 1.4 SYSTEM DESCRIPTION

- A. Fire Alarm System: Supervised, non-coded, addressable, using Style 4 (Class B) signaling line circuit (SLC) intelligent loop wiring for initiating and monitoring, and Class B (two wire with end-of-line device) for signaling.
- B. Alarm Sequence of Operation: Actuation of any manual or automatic initiating device results in system ALARM which includes the following operations:
  - 1. Display alarm status information at control panel and remote annunciator.
  - 2. Audible and visual alarm signals operate continuously until initiating devices are restored to normal and control panel is reset. If alarm silence switch is activated, alarm LED annunciation continues. New alarm resounds signals.
  - 3. Alarm signal is transmitted to remote Central Station.
  - 4. Relays activate to initiate HVAC shut down, release door hold open devices, close smoke dampers, and operate elevator and stairwell pressurization fans.
- C. Trouble Sequence of Operation: Grounded circuit, open circuit, power failure, or system failure results in system TROUBLE which includes the following operations:

1. Display trouble status information by zone at the control panel. Audible trouble signal operates continuously until activation of silence switch.
  2. Trouble signal is transmitted to remote Central Station.
- D. Sprinkler Supervision: Closing OSY, PIV, or zone valves, or abnormal air pressure for dry systems results in a system supervisory which includes the following operations:
1. Display supervisory status information at the control panel. Audible trouble signal operates continuously until activation of silence switch.
  2. Sprinkler supervisory signal is transmitted to remote Central Station.
- E. Duct Detector Supervision: Actuation of any smoke duct detector results in supervisory which includes the following operations:
1. Display supervisory status information at the control panel. Audible trouble signal operates continuously until activation of silence switch.
  2. Duct detector supervisory signal is transmitted to remote Central Station.
- F. Zoning: As approved by authority having jurisdiction. Use final room names, room number, and area designations as verified with the Owner.

#### 1.5 SYSTEM PARAMETERS

- A. Design: Comply with requirements of the International Fire Code, International Building Code, and local fire alarm code as adopted and supplemented by authority having jurisdiction and applicable for the Building Occupancy, by Group and Division, indicated in the Construction Documents. Location of control panel, remote annunciator, and door hold open devices are indicated on the Electrical Plans. Desired location of equipment and minimum requirements for signaling and initiating devices are indicated on the Electrical Plans. Provide additional devices as required.
- B. Pre-bid Coordination: Obtain and review all construction documents prior to bidding as required to verify site conditions, floor plans, building sections, ceiling types, building construction, mechanical systems, building equipment and other conditions that will affect the fire alarm system design. Verify fire alarm design and system requirements with local authority having jurisdiction.
- C. Fire Suppression System(s): Building 1 (Main School Building and Auxiliary Gym Addition) to have a water based fire suppression system. Building 2 (Shop Building, Building 3 (Field House) and Portable Classroom Building to remain unsprinklered. Coordinate scope of sprinkler coverage with Section 211000; provide complete coverage for buildings without fire suppression.
- D. Device Compatibility: All alarm, initiating, and accessory devices provided shall be listed in the device compatibility document available from the manufacturer for the fire alarm control panel installed.
- E. Detectors: Unless otherwise indicated, provide detectors as follows:
1. Smoke Detectors: Photo-electric or ionization type.
  2. Heat Detectors:
    - a. Indoor high ambient temperature areas (e.g. boiler rooms, kitchens, attics, ceiling spaces, etc.): rate anticipation heat detectors.
    - b. Other locations: combination rate of rise and fixed temperature heat detectors.

- F. Outdoor Installation: Equipment and devices installed outdoors shall be weatherproof and otherwise suitable for the application.
- G. Wire Guards: Provide for detectors and signaling devices located in gymnasiums, multipurpose rooms, locker rooms, play sheds and similar areas of high abuse. Guards shall be listed for use with the device protected.
- H. Audible Signaling Devices: Spacing, locations, and system design shall provide alarm audibility of not less than 15 db above ambient noise levels.
- I. Visual Signaling Devices: The following building areas and spaces are to be considered public areas subject to requirements for ADA visual signal devices: Halls, corridors, toilets, rest rooms, conference rooms, open offices, reception areas, break rooms, work rooms, waiting areas, and entries. Spacing, location, and candela rating shall comply with alarm notification visibility requirements of NFPA and ADA.
- J. Elevators: Smoke detectors for Machine Room, Shaft, and Lobbies shall have auxiliary contacts to initiate elevator recall.
- K. Access: Provide service access to detectors not readily accessible and to sampling tubes of duct smoke detectors.
- L. Duct Smoke Detectors:
  - 1. Provide for HVAC units rated above 2000 CFM.
  - 2. Provide for smoke dampers unless total coverage smoke detection is provide in all areas served by the HVAC system per IMC requirements.
  - 3. Provide each duct smoke detector with a remote LED/Test station located in an accessible location approved by the Fire Marshal.
  - 4. Coordinate quantity, location, and access for duct smoke detectors with Division 23 Contractor.
- M. Provide identification sticker on end of line (EOL) devices.
- N. Provide conductors installed in conduit except fire rated MC cable or fire rated open cabling is approved where concealed above accessible panel ceiling spaces and/or building construction if acceptable to the Authority Having Jurisdiction.
- O. Device Locations: Subject to review and approval by Architect/Engineer during shop drawing review. Changes in device locations may be directed and shall be accommodated subject to Code compliance.
- P. Additional Devices: In addition to initiating and signaling devices indicated and specified, include in the Contract an allowance to provide 10% additional initiating and/or signaling devices as directed at no additional cost. Include conduit, wire, outlet box, programming, and testing.
- Q. Transient Voltage Surge Suppression (TVSS): Provide TVSS protection on all outside plant fire alarm circuits.

#### 1.6 SYSTEM MONITORING

- A. Provide wireless (RF or cellular) transmission of addressable, supervisory, alarm and trouble

signals to an approved local UL Central Station. Include Central Station setup and connection charges.

- B. Charges for 24 hour Central Station monitoring shall be paid by Owner.

#### 1.7 SUBMITTALS

- A. Submit qualifications specified under Part 1 of this section.
- B. Submit product data for all items specified under Part 2 of this section.
- C. Provide shop drawings of complete system as required by Fire Marshal. Include graphic annunciator plaque, wiring diagrams, system layout and battery calculations. Indicate wire color coding and termination points for control panel, remote annunciator, and each type of device. Show equipment and device locations, size, type, quantity, and routing of interconnecting wiring, end of line locations, and zoning.
- D. Submit product data and shop drawings to Fire Marshal for review and approval in addition to Architect/Engineer submittal requirements.
- E. Submit record drawings along with reports specified under Testing.
- F. Submit System Record of Completion [NFPA 72, Figure 7.8.2 (a)], Emergency Communications Systems Supplementary Record of Completion [NFPA 72, Figure 7.8.2 (b)], Power Systems Record of Completion [NFPA 72, Figure 7.8.2 (c)], Notification Appliance Power Panel Supplementary Record of Completion [NFPA 72, Figure 7.8.2 (d)].

#### 1.8 OPERATION AND MAINTENANCE DATA

- A. Include data for complete system in Operation and Maintenance Manuals.

#### 1.9 QUALIFICATIONS

- A. Company: Have minimum five (5) years experience in the installation of fire alarm systems and capable of providing 24 hour repair service with 2 hour response time.
- B. Shop Drawing Preparation: Technician possessing a current Certification in Engineering Technologies (NICET) Level III certification shall design and prepare the fire alarm system shop drawings unless otherwise approved by the AHJ.
- C. Installers: Trained technicians possessing a current specialty electrician certificate of competency issued by the State of Washington and National Institute for Certification in Engineering Technologies (NICET) Level II certification shall perform the work.
- D. Authorized factory representative of the system being installed shall supervise installation, testing, and adjustment of the system.
- E. Approved Sub-Contractors:  
Convergent Technologies, Portland, OR;  
GB Manchester, Vancouver, WA.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Edwards EST.

### 2.2 CONTROL PANEL

- A. Fire Alarm Control Panel (FACP): Microprocessor based addressable control panel with flush wall mounted cabinet.
- B. Power Supply: 120 volt AC power input, 24 volt DC system operation. Include transient surge protection, automatic battery charger and 24 volt rechargeable, maintenance free, sealed lead-acid batteries capable of operating system under alarm condition for five minutes after a 60 hour interruption of 120 volt AC power.
- C. Initiating Circuits: Supervised programmable input/output circuits (500 point minimum capacity) with 80 character minimum LCD status display and keypad.
- D. Smoke Alarm Verification Circuit: Delays alarm and resets smoke detectors allowing second (verified) alarm initiation. Adjustable alarm delay 1-60 seconds; adjustable verification period 1-120 seconds.
- E. Signal Circuits: Supervised signal modules with march time feature and trouble LED indication. Provide signal controller(s) for synchronizing strobes to flash together. Provide sufficient size and quantity so that no signal circuit is loaded more than 75% of listed capacity.
- F. Audio Communications: UL 864 and UL 1711; Supervised modules as required to provide oscillator tone and voice communications through system alarm speakers. Include audio master control, oscillator control switches, speaker circuit manual control switches, pre-amp monitors, power amplifiers, hand held paging microphone, and approved recorded message announcement system. Provide amplifier(s) as required for speaker system operating capacity plus 125% minimum spare capacity. Provide flush mounted remote microphone/audio control station where indicated.
- G. Panel Status Indicators: LED annunciation of normal power, battery power, battery trouble, ground detection, system trouble, alarm silence, and trouble silence. Audible signal annunciation of any alarm or trouble condition or system.
- H. Operating Controls: Lamp test, panel reset, alarm silence, trouble silence, and Drill. Operating controls shall be enabled by key switch or shall be located behind locking cabinet door.
- I. History File: Minimum 400 event capacity in non-volatile memory. Include provisions to allow RS232 interfaces with remote personal computer and printer (2 ports minimum).
- J. Signal Transmission: Provide output connections for addressable alarm, trouble, and supervisory signal transmission via the alarm transmitter.
- K. Auxiliary Relays: As required, with 120 VAC rated contacts; include for HVAC fan shutdown, electro-magnetic door holders, elevator pressurization fan operation, smoke

dampers, and elevator recall sequencing.

### 2.3 REMOTE ANNUNCIATOR

- A. Annunciator: Recessed weatherproof enclosure containing supervised back-illuminated LCD display with key enabled acknowledge, system reset, and signal silence.
- B. Option: Where approved by the AHJ, remote annunciation may be deleted if system alarm is transmitted, received, and reported to the fire department by zone.

### 2.4 GRAPHIC PLAQUE

- A. White plexiglass with dark contrast graphics and painted or anodized metal frame (finish selected by Architect/Engineer). Show one-line building layout by floor with zone configuration approved by Fire Marshal. Provide adjacent to each control panel and remote annunciator.

### 2.5 INITIATING DEVICES

- A. Manual Stations: UL 38; addressable, single or dual action, downward pull lever, key reset without break-glass feature.
- B. Heat Detectors: UL 521; addressable combination rate-of-rise and fixed temperature 135 deg F rated, self restoring rate-of-rise element, low profile addressable twist lock base, LED status indicator, listed for 2500 square feet. In high ambient areas provide 190 deg F fixed temperature rated detectors listed for 625 square feet.
- C. Smoke Detectors, Photo-Electric Type: UL 268; addressable light scattering photodiode principle of operation, LED status indicator, test feature, integral 135 deg F fixed temperature sensor, addressable twist-lock base, supervised 2-wire operation.
- D. Smoke Detectors, Ionization Type: UL 268; addressable dual chamber, LED status indicator, test feature, adjustable sensitivity, addressable twist- lock base, supervised 2-wire operation.
- E. Duct Detector, Smoke: UL 268; addressable photoelectric or ionization type smoke detector, duct mounted detector housing with sampling tubes extending width of duct, visual indication of detector actuation. Provide auxiliary DPDT contacts for HVAC shutdown and/or smoke damper actuation, rated 1/8 HP at 120 VAC and 1/4HP at 240 VAC minimum.
- F. Remote Status/Test Station: 24 volt DC detector status LED indicator and key operated alarm initiating test switch mounted on a flush stainless steel cover plate. Provide engraved nameplate indicating function and location (e.g. "SMOKE DETECTOR, ELEVATOR SHAFT").

### 2.6 SIGNALING DEVICES

- A. Alarm Speakers, Indoor: UL 1480; high fidelity voice/tone re-entrant loudspeaker, low profile housing, 400 to 4000Hz frequency range or better, 25V or 70V field selectable input, multi- tap power selection up to 2 watts minimum, rated 77 dB (UL) or better at 10 feet and 1/4 watt. Provide integral alarm strobe where indicated. Housing color shall be white or red as selected by Owner.



- B. Alarm Speakers, Outdoor: UL 1480; basic voice/tone re-entrant loudspeaker, low profile weatherproof housing, 25V or 70V field selectable input, multi- tap power selection up to 8 watts rated 77 dB (UL) or better at 10 feet and 1/4 watt. Provide integral alarm strobe where indicated. Provide exterior mounted devices with weather resistant backbox. Housing color shall be white or red as selected by Owner.
- C. Alarm Horns: UL 464; basic electronic horn rated 96 dB at 10 feet. Provide integral alarm light where indicated. Provide exterior mounted horns with weather resistant backbox.
- D. Alarm Strobes: UL 1971; lamp and flasher, field selectable intensity settings, with clear lens and visible FIRE markings on device housing. Provide standard or high candela intensity strobes as required for location and spacing of devices. Housing color shall be white or red as selected by Architect. Strobes shall be synchronized to flash together.
- E. Ceiling mounting signaling devices may be installed in lieu of wall mounted subject to location, spacing, and intensity rating complying with alarm notification audibility and visibility requirements of NFPA and ADA.

## 2.7 AUXILIARY DEVICES AND ACCESSORIES

- A. SLC Interface devices: Remote addressable module for monitoring status of alarm initiating circuit devices or to provide remote control (pilot duty) from the SLC loop.
- B. Door Holders: Semi-flush magnetic door holder, 24 volt DC coil, for wall-to-door installation. Provide floor installation where indicated.
- C. Door Closer, with Electric Hold Open: Specified under Division 08, 24 volt DC.
- D. Fire Door Releasing Device, Overhead Coiling Shutters: Specified under Division 08, 24 volt DC.
- E. Wire Guards: Provide on automatic detectors and signaling devices located in Gymnasium, Multipurpose Rooms, Play Sheds, and similar areas of high abuse.
- F. Access Doors: Milcor Style M locking access panel, keyed to match electrical panelboards. Provide where required to maintain service access to detectors.
- G. Signal Expander: Independent 4-circuit power supply with battery back-up, 120 VAC input, 24 VDC output. 1.5 amp minimum output each circuit.
- H. Audio Power Booster: Independent 2 or 4-circuit audio power supply with synchronized strobe power and battery back-up, 120 VAC, as required.
- I. Audio Communications Remote Station: Remote microphone and control console for audio communications system, flush mount.
- J. Batteries for Equipment Power Supplies: Provide maintenance free, rechargeable type, as recommended by equipment manufacturer. Batteries provided shall not be older than 60 days from date of manufacture.
- K. Transient Voltage Surge Suppression (TVSS): UL 497B; modular, solid state, multistage, automatic reset circuit protectors with screw terminals. Provide matching base for plug-in

devices. Device selection shall be as recommended by product manufacturer based on type of signal circuit. Provide Edco #SLCP, PHC, and SAC series protectors installed in a Hoffman CH series hinged door enclosure with mounting board and phenolic label on enclosure front to read "FIRE ALARM TVSS".

- L. System Record Documents Storage Cabinet: Documentation cabinet, minimum 18 gauge cold rolled steel with red finish, prominently labeled "SYSTEM RECORD DOCUMENTS"; compliant with NFPA 72, 7.7.2. Manufacturer: Space Age Electronics SRD ACE-11 or equal.

## 2.8 CODED TRANSMISSION

- A. Digital Communicator: Fire Marshal approved, UL listed, digital communicator for alarm system reporting complete with power supply, dual phone line monitoring, line seizure, supervisory feature, battery back-up, low battery reporting, and required phone cable for connection to two (2) phone jacks. Communicator shall be integral with the fire alarm control panel.
- B. Alarm Transmitter: Fire Marshal approved, UL listed, wireless radio frequency (RF) or GSM transmission system complete with power supply, transceiver module, antenna, battery back-up, battery charger, low power reporting, failure reporting, mounting hardware, coaxial cable. Transmission format shall provide full addressable alarm, trouble and supervisory data and be compatible with the approved Central Station. Provide a NEMA 1 surface mounted cabinet with locking hinged door to house all transmitter components. Wireless transmitters shall be furnished with remote antenna where required for proper system operation.

## 2.9 MATERIALS

- A. Conductors for 120 Volt Circuits: Building wire as specified in Section 260500.
- B. Conductors for 24 Volt DC Circuits: Comply with NFPA 70, Article 760 for insulation requirements. Solid copper conductor, minimum #14 AWG for signal circuits and #16 AWG for initiating circuits. Jacketed twisted pair, copper conductor, with shielding as recommended by alarm system manufacturer for SLC intelligent loop wiring. Outside plant cable shall UL listed for the purpose.
- C. Conduit: As specified in Section 260500, metallic only.
- D. MC Cable: As specified in Section 260500; UL listed and approved for fire alarm and control, multi-conductor and/or twisted shielded pair as required.
- E. Device and Junction-Boxes: As specified in Section 260500, except surface boxes shall be furnished by alarm system manufacturer to match devices. Boxes shall be red in color. Device and junction boxes located outside of buildings shall be tamper proof. Outdoor boxes shall be weatherproof.

## PART 3 EXECUTION

### 3.1 PREPARATION

- A. Coordinate with the approved Central Station to verify type of wireless transmission system

to be provided. Wireless transmission system type shall be as selected by Owner where more than one option is available. Where approved wireless transmission service is not available, arrange with Owner's telephone system installer to provide two phone lines terminated at the FACP digital communicator with required telephone jacks.

- B. Coordinate and arrange with the approved Central Station to verify wireless signal strength at the project site as required to verify wireless service availability.
- C. After building structure is in place and prior to completion of rough-in, meet with the inspecting authority on site to review system requirements and location of devices and equipment using the approved shop drawings. The purpose of this meeting is to avoid additional devices and other required changes that are often identified during final inspection.

### 3.2 INSTALLATION

- A. Install system in accordance with manufacturer's instructions. Provide all necessary programming and adjustment of system equipment to make operational. Provide setup and programming of the audio communications system to include an approved pre-recorded message as required by the Fire Marshal.
- B. Wiring methods shall comply with requirements of Section 260500. Wiring shall be dedicated to the fire alarm system consistently color coded per shop drawings. Wiring shall not share conduits with other systems.
- C. Coordinate quantity, location, and access for duct smoke detectors and sampling tubes with Division 23 Contractor. Furnish sampling tube/detector housing assemblies for installation by ductwork installer. Do not locate sampling tubes less than 6 duct widths from return air inlet, bend in duct, or other obstruction in duct. Locate sampling tube/detector housing assemblies for smoke dampers on the damper housing where recommended by smoke damper manufacturer.
- D. Do not locate detectors within 4 feet of HVAC supply and return registers and not in a direct airflow. Do not locate detectors within 1 foot of light fixtures.
- E. Provide recessed backboxes for semi-flush installation of devices where construction permits, otherwise provide surface boxes.
- F. Mounting Heights: Install wall mounted equipment and devices, measured to center of device above finished floor, unless otherwise indicated on shop drawings approved by the Authority Having Jurisdiction (AHJ).

Manual Stations	48 inches to top
Alarm Signaling Devices and Remote Alarm Lights	80 inches to bottom
Remote Annunciator and Graphic Plaques	60 inches to bottom

- G. Detectors shall not be installed until finish work and construction clean up of all trades is complete, and area is ready for occupancy.
- H. Provide 24 volt DC power to electro-magnetic door holders and door closers with electric hold open. Mount outlet box for electro-magnetic door holder to withstand 80 pounds pulling force.

- I. Fire Protection Monitoring and Signal Power: Provide addressable interface modules, conduit, wire and connections to fire sprinkler flow switches, sprinkler valve tamper switches, pressure switches, electric sprinkler alarm bell, kitchen hood fire dampers, and to kitchen hood extinguishing system alarm contacts. Include 24 VDC power for sprinkler alarm bell furnished under Section 211000. Coordinate number and location of alarm and supervisory connections with fire protection shop drawings.
- J. Elevator Recall and Power Shut Down Warning: Provide SLC control modules at each elevator controller for fire alarm output interface. One control contact each is required for designated recall level, alternate recall level, and power shut down warning. Program SLC relay operation for recall and warning functions as directed by elevator contractor based on alarm inputs from associated smoke detectors located in machine room, top of elevator shaft (if provided), and each elevator lobby.
- K. Smoke Control: Provide conduit, wire, interface relay, and connection to smoke dampers and to motor controllers of pressurization and/or exhaust fans. Include addressable interface modules where required.
- L. Fan Shut-Down: Provide conduit, wire, relays and connection for shutdown of air moving equipment rated over 2000 cfm per IMC Section 606. Final connection to HVAC equipment with integral motor controls shall be provided under Division 25.
- M. High Volume Low Speed (HVLS) Fan Shutdown: Provide conduit, wire, relays and connection for shutdown of paddle fans 6 feet in diameter and larger upon sprinkler water flow alarm per NFPA 13 Section.
- N. Adjust sensitivity for each smoke detector based on the application and type of space being protected as recommended by the product installation instructions.
- O. SLC Interface: Provide addressable interface modules for all non-addressable initiating devices and equipment furnished under other sections.
- P. Provide 24 volt DC power to fire door releasing devices unless otherwise indicated. Provide wiring to initiate release upon activation of the smoke detection located adjacent to the door opening.
- Q. Primary Power Supply: Provide dedicated branch circuit(s) for fire alarm control, transmitter, and NAC auxiliary power supplies. The location of the circuit disconnecting means shall be permanently identified at each cabinet. Where the circuit disconnecting means is located at the panelboard branch circuit breaker, provide a red pad locking attachment.
- R. Wireless Transmitter: Locate and install wireless transmitter in vicinity of the Fire Alarm Control Panel (FACP) as approved by the Fire Marshal. Provide required wiring and connections between the FACP communicator and the transmitter for addressable alarm, trouble, and supervisory transmission. Where wireless signal strength is not sufficient for use of an integral antenna at the transmitter, install a remote antenna at an Architect/Engineer approved location as required.
- S. Alarm speakers: Adjust speaker taps meet decibel and intelligibility requirements of NFPA. Connect speakers for 70 volt operation. Add additional speakers where required by Fire Marshal.

- T. TVSS: Provide transient voltage surge protection on each outside plant fire alarm system signaling, notification, initiating, and control/interface circuit. Locate TVSS with 15 feet of the fire alarm control panel for dedicated inter-building circuit home runs. Locate TVSS within 15 feet of building entrance for indoor circuits extending outdoors (e.g. PIV tamper). Bond TVSS to the building grounding electrode system using #10 AWG minimum copper ground conductor.
- U. Pathway Identification: J-boxes, outlets and conduit covers shall be identified red in color. Conduit in accessible attic and ceiling spaces, and where surface mount in electrical, telecomm and mechanical spaces, shall be identified red in color every 8 feet or fraction thereof, along its length.

### 3.3 TESTING

- A. Test system in accordance with NFPA 72 and Fire Marshal requirements.
- B. During testing verify device address descriptions match device type, location description, and zoning assignments shown on record drawings. Submit address log and correction report and confidence test report with record drawings.
- C. Complete all Record of Completion documentation outlined in Part 1 and turn over to Engineer and AHJ.

### 3.4 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate operation, maintenance and programming of system to Owner's personnel prior to Contract Closeout. Allow one four hour session scheduled at convenience of Owner.
- B. Use operation and maintenance manuals as basis of instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
- C. Demonstrate operation, control, trouble shooting, maintenance, and testing of system.

END OF SECTION



**DIVISION 31**  
**EARTHWORK**





## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

- A. Section Includes:
  - 1. Protecting existing vegetation to remain.
  - 2. Removing existing vegetation.
  - 3. Clearing and grubbing.
  - 4. Stripping and stockpiling topsoil.
  - 5. Stripping and stockpiling rock.
  - 6. Removing above- and below-grade site improvements.

### 1.3 DEFINITIONS

- A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
- B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.
- C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow.
- D. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.
- E. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

### 1.4 MATERIAL OWNERSHIP

- A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

### 1.5 INFORMATIONAL SUBMITTALS

- A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

1. Use sufficiently detailed photographs or video recordings.
  2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plant designated to remain.
- B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

## 1.6 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
  2. Provide alternate routes around closed or obstructed trafficways if required by Owner or authorities having jurisdiction.
- B. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- C. Do not commence site clearing operations until temporary erosion- and sedimentation-control measures are in place.
- D. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."
1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Protect existing site improvements to remain from damage during construction.
1. Restore damaged improvements to their original condition, as acceptable to Owner.

### 3.2 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
  - 1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
  - 2. Grind down stumps and remove roots larger than 2 inches (50 mm) in diameter, obstructions, and debris to a depth of 18 inches (450 mm) below exposed subgrade.
  - 3. Chip removed tree branches and dispose of off-site.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
  - 1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches (200 mm), and compact each layer to a density equal to adjacent original ground.

### 3.3 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to depth of 10 inches (250 mm) in a manner to prevent intermingling with underlying subsoil or other waste materials.
  - 1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects larger than 2 inches (50 mm) in diameter; trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.
  - 1. Limit height of topsoil stockpiles to 72 inches (1800 mm).
  - 2. Do not stockpile topsoil within protection zones.
  - 3. Stockpile surplus topsoil to allow for respreading deeper topsoil.

### 3.4 STOCKPILING ROCK

- A. Remove from construction area naturally formed rocks that measure more than 1 foot (300 mm) across in least dimension. Do not include excavated or crushed rock.
  - 1. Separate or wash off non-rock materials from rocks, including soil, clay lumps, gravel, and other objects larger than 2 inches (50 mm) in diameter; trash, debris, weeds, roots, and other waste materials.
- B. Stockpile rock away from edge of excavations without intermixing with other materials. Cover to prevent windblown debris from accumulating among rocks.
  - 1. Limit height of rock stockpiles to 36 inches (900 mm).
  - 2. Dispose of surplus rock. Surplus rock is that which exceeds quantity indicated to be stockpiled or reused.

### 3.5 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, steps, and aggregate base as indicated.
  - 1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
  - 2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

### 3.6 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
- B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials, and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION

## PART 1 - GENERAL

### 1.1 SUMMARY

#### A. Section Includes:

1. Excavating and filling for rough grading the Site.
2. Excavating and backfilling for foundation preparation activities.
3. Gravel working pad for foundation preparation activities.
4. Subbase course for concrete walks and pavements.
5. Subbase course and base course for asphalt paving.
6. Excavating and backfilling trenches for utilities and pits for buried utility structures.

### 1.2 DEFINITIONS

#### A. Backfill: Soil material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

#### B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

#### C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

#### D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

#### E. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

#### F. Fill: Soil materials used to raise existing grades.

#### G. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

#### H. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

- I. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.
- J. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct pre-excavation conference.

### 1.4 INFORMATIONAL SUBMITTALS

- A. Material test reports.

### 1.5 FIELD CONDITIONS

- A. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth-moving operations.

## PART 2 - PRODUCTS

### 2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.
  - 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; compacted to at least 95 percent of the maximum dry density, as determined by ASTM D1557; gradation to conform to WSDOT SS 9-03.14(2) – Select Borrow, the imported granular material should be fairly well graded between coarse and fine, and of the fraction passing the US Standard No. 4 Sieve, less than 5 percent by dry weight should pass the US Standard No. 200 Sieve.
- E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; compacted to at least 95 percent of the maximum dry density, as determined by ASTM D1557; gradation to conform to WSDOT SS 9-03.9(3) –

Crushed Surfacing Base Course and have less than 8 percent passing the US Standard No. 200 Sieve.

- F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
- G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.
- H. Trench Backfill: Naturally or artificially graded mixture of natural or crushed gravel; The pipe zone backfill should be compacted to at least 90 percent of the maximum dry density as determined by ASTM D1557; gradation shall conform to WSDTO SS 9-03.12(3)-Gravel Backfill for Pipe Zone Bedding and consist of a well-graded granular material with a maximum particle size of 1 inch and less than 10 percent by dry weight passing the US Standard No. 200 Sieve.

## 2.2 ACCESSORIES

- A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored to comply with local practice or requirements of authorities having jurisdiction.
- B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored to comply with local practice or requirements of authorities having jurisdiction.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.
- B. Protect and maintain erosion and sedimentation controls during earth-moving operations.
- C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

### 3.2 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
  - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

### 3.3 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
- B. Trench excavation to be completed in accordance with the City of Kelso Engineering Design Manual; current edition and the WSDOT Standard Specification.
- C. Trenching operations shall not proceed more than one-hundred (100) feet in advance of pipe laying except with written approval of the city
- D. When trenching operations involve cutting through concrete pavement, the removal and reconstruction of the entire concrete panel is required.
- E. Where a sewer main crosses under A.C. water main the Contractor shall replace the existing A.C. main over the excavation with Ductile Iron Pipe Class 52 to a point of bearing soil a minimum of three (3) feet each side of the excavation.
- F. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.
  - 1. Clearance: 12 inches each side of pipe or conduit.
- G. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
  - 1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

### 3.4 SUBGRADE INSPECTION

- A. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired dump truck to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
- B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.



### 3.5 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.
  - 1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

### 3.6 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
  - 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

### 3.7 UTILITY TRENCH BACKFILL

- A. Pipe installation shall be backfilled in accordance with the City of Kelso Engineering Design Manual; current edition, WSDOT Standard Specifications, and the manufacturer's specifications.
- B. No backfill shall be placed over the pipe until the work has been inspected and approved by the City of Kelso. Any portion of the sewer covered before inspection shall be uncovered at the owner's expense within two days after notice to do so has been issued by the City of Kelso.
- C. Trenches shall be carefully backfilled by tamping to a depth of six inches above the pipe. All backfill shall be Class B in accordance with WSDOT Standard Specifications.
- D. Place backfill on subgrades free of mud, frost, snow, or ice.
- E. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- F. Initial Backfill: Place and compact initial backfill per the city of Kelso standard specification for crushed surfacing top course.
  - 1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
- G. Final Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.
- H. Warning Tape: Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

### 3.8 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:
  - 1. Under grass and planted areas, use satisfactory soil material.
  - 2. Under walks and pavements, use satisfactory soil material.
  - 3. Under steps and ramps, use engineered fill.
  - 4. Under building slabs, use engineered fill.
  - 5. Under footings and foundations, use engineered fill.

### 3.9 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
  - 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
  - 2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

### 3.10 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:
  - 1. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.
  - 2. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.
  - 3. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

### 3.11 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

- B. Site Rough Grading: The subgrade will be excavated to two (2) feet below finished floor elevation to allow for the placement of a Gravel Working Pad, which will allow for the installation of the Vibro-Replacement Aggregate Piers, as specified in section 316623.

### 3.12 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

- A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:
  - 1. Shape subbase course and base course to required crown elevations and cross-slope grades.
  - 2. Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
  - 3. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

### 3.13 GRAVEL WORKING PAD FOR VIBRO-REPLACEMENT AGGREGATE PIERS

- A. Place Gravel Working Pad on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place and compact Gravel Working Pad as follows:
  - 1. Place Gravel Working Pad in one 12 inches layer.
  - 2. Compact Gravel Working Pad to at least 95% of the maximum dry density, as determined by ASTM D 1557.

### 3.14 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform inspections:
- B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.
- C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
- D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.
- E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.15 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
  - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.16 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION

## SECTION 31 66 23

### Vibro-Replacement Aggregate Piers

#### PART 1 GENERAL

##### 1.1 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

1. ASTM INTERNATIONAL (ASTM)

a. ASTM C33 Standard Specification for Concrete Aggregates

b. ASTM D5778 Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils

ASTM D1143 Standard Test Methods for Deep Foundations Under Static Axial Compressive Load

##### 1.2 RELATED DOCUMENTS

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

B. Geotechnical Information, provided for bidders' information only:

1. Geotechnical Engineering Report for the project prepared by PBS Engineering and Environmental Inc. dated July 7, 2020 including addendum No. 1 dated April 2, 2021 and Soil Improvement – Geotechnical Basis of Design Letter dated May 5, 2021.

C. Provided Contract Drawings:

1. General Structural Notes and Foundation Plans.

2. Foundation Loads.

D. IBC. (2018). International Building Code. Country Club Hills, IL: International Code Council, Inc. Washington State Amendments to the International Building Code 2018 Edition.

E. ASCE. (2016). Minimum Design Loads for Buildings and Other Structures (ASCE 7-16).

##### 1.3 WORK INCLUDED

Design and construct ground improvement using Vibro-Replacement Aggregate Piers (VRAPs). The work covered by this specification consists of providing all engineering, supervision, labor, materials, and equipment required to design and construct VRAPs at the locations, to the elevations and to the requirements shown on the design and developed from pre-production test results.

A. The work for this Section shall include, but not be limited to:

1. Design of a ground improvement system that satisfies the performance criteria presented in this specification.
2. Develop and submit a detailed VRAP installation program that will meet the performance specification presented in these specifications.
3. Construction of the VRAPs to the line and grade shown on the Drawings provided by the Design-Build contractor.
4. Pre-drilling of holes as necessary.
5. Disposal of spoils and/or water generated by the VRAP installation process.
6. Perform verification testing as detailed in these specifications, including the execution of a test program is a part of this specification.
7. Preparation of daily QA reports.
8. Install VRAPs in a manner that meets the requirements of these specifications and the approved design
9. Perform the work in a manner that will not damage any existing utilities or nearby structures.
10. Sequence the work with related activities such as subsurface utility installations in the vicinity of the VRAP ground improvement area.
11. It shall be the Design-Build Contractor's responsibility to determine and implement the system and criteria to ensure that the specified performance is achieved.

B. The General Contractor is responsible for performing work in support of and related to the installation of the VRAP ground improvement system; the work is expected to include, but not necessarily limited to, the following:

1. Acquisition of all permits required by the local jurisdiction to perform the ground improvement work shown in the final, stamped design.
2. Installing fences, temporary water service connection (including obtaining a meter), temporary electrical power, and other site controls as considered necessary by Design-Build Contractor and as required by permits.

3. Removal of existing pavements, foundations, abandoned utilities, or other structures as necessary to complete the VRAP ground improvement.
4. Grubbing, clearing, and grading of the site and all work required to provide a working surface sufficiently level and of an adequate strength to perform the ground improvement installations.
5. If needed, construction of temporary aggregate access roads to provide adequate support for the construction equipment.
6. Field layout and survey of VRAP locations in advance of installation.
7. Field surveying and development of the “as-built” locations, as-built VRAP depths, and top elevations of all piers installed.

#### 1.4 VRAP Design

- A. Ground improvement design shall be based on the foundation plans presented in the referenced Structural Plans, Notes, and Specifications.
- B. Ground improvement elements shall be designed in accordance with generally-accepted engineering practice and the methods described in Section 1 of these Specifications. The design shall meet the following criteria.
  1. The project schedule anticipates submitting the ground improvement design for building permit approval before the Washington State Building Code updates to the IBC 2018 model code and attendant change to the provisions of ASCE 7-16.
  2. The design shall not assume perfect shear strain compatibility between ground improvement elements and the surrounding soil.
  3. Site-specific seismic response is not required.
  4. Seismic parameters for liquefaction analysis:
    - a. Subduction event:  $M_w = 9.0$ , PGA at ground surface =  $0.49g$
    - b. Groundwater depth: 7 feet, assumed to be level across the site
  5. For the spread footings:
    - a. 2,500 psf (static),
    - b. 3,300 psf (seismic or other transient conditions).
  6. Allowable long-term static settlement beneath building:
    - a. Total = 1.0 inch

b. Differential = 0.75 inch over any 30-foot span

7. Allowable seismic settlement beneath building

a. Total= 4.0 inch

b. Differential = 2 inches over any 30-foot span

8. The maximum allowable lateral spreading displacement is:

a. 18 inches at the edge of the building nearest to the free face

9. Due to site constraints, the lateral extent of the ground improvement outside the building footprint should be determined by the Design-Build Contractor. The Geotechnical Engineer has identified a minimum distance beyond the building footprint of ½ of the ground improvement embedment depth per the Soil Improvement – Geotechnical Basis of Design Letter dated May 5, 2021.

10. Ground improvement minimum embedment depth should correspond to the minimum required crust thickness to reduce risk of surface manifestation of liquefaction and limit long-term and seismic settlement to the magnitudes in 1.4 B6 and B7. The Geotechnical Engineer has identified this embedment depth to be a minimum of 40 feet per the Soil Improvement – Geotechnical Basis of Design Letter dated May 5, 2021.

C. The design submitted by the Design-Build Contractor shall consider the bearing capacity and settlement across the entire area supported by the ground improvement elements under both long-term static loading and subsequent to the design level seismic events. Both total and differential settlement shall be considered.

D. The ground improvement system shall be designed to preclude excessive ground deformations at the tops of the VRAPs in response to foundation bearing stresses. The design shall clearly identify the minimum diameter of the installed ground improvement elements and the allowable as-built tolerance of the element diameter.

E. The VRAP design should also include an estimate of the resultant peak particle velocity (RPPV), induced by construction vibrations, at adjacent structures. Estimate RPPV should not exceed the maximum threshold set forth in these Specifications.

#### 1.5 VRAP Construction

VRAP construction includes, but is not limited to:

A. Furnish all equipment, materials, power, water, cement, and other necessary items required for VRAP installation.

B. Construct runoff containment ponds if necessary.

C. Construct VRAPs as shown on the Drawings.

D. Coordinate and conduct modulus testing, CPT soundings, and any other QA/QC



activities incorporated in the approved design.

E. Cooperate with Owner-supplied QA inspection activities.

F. Remove equipment, unused materials and all waste products/spoils off site.

G. Restore the building pad to its original grade after ground improvement.

H. Comply with all local, state, and federal requirements.

## 1.6 SUBMITTALS

Owner approval is required for submittals with an "O" designation; submittals not having an "O" designation are for Design-Build Contractor Quality Control approval.

The following shall be submitted:

### Preconstruction Submittals

VRAP Improvement Plan; O

Mitigation Plan; O

### Test Reports

Aggregate Grain Size Analysis; O

VRAP Modulus Test Report and Survey; O

Soil Improvement Test Report (if required by design;) O

### Closeout Submittals

Documentation; O

## 1.7 VRAP IMPROVEMENT PLAN

A. Prior to beginning work, the Design-Build Contractor shall submit three (3) sets of detailed design calculations, construction drawings, and shop drawings, (the Design Submittal) for approval by the Architect and Owner. A detailed explanation of the design parameters for settlement calculations shall be included in the Design Submittal. The Design Submittal shall contain the following information:

1. Final, stamped drawings that include a VRAP numbering scheme and the test program location and arrangement.

2. Other drawings and designs needed to secure permits for the work. Examples of such drawings include a grading plan, erosion control plan, traffic plan, etc.

3. A redline of these specifications noting any exceptions to the design, construction, or QC requirements.

4. A written procedure for accomplishing the work described in this section and shown on the Drawings. The written procedure shall:

5. Specifically describe how the equipment and procedures will be used to build the VRAP columns to meet the intent of the Specification and Drawings and achieve the intended pier diameter shown on the Drawings. Procedures shall include

methods for locating the VRAPs in the field and confirming that the piers are plumb.

6. Describe the Design-Build Contractor's quality control and documentation methods, and include:

7. A detailed description of the Quality Control Plan to be undertaken each day during VRAP installation to confirm that the installed piers conform to design elevations, minimum replacement ratio, relative density, diameter, and required horizontal and vertical alignments.

8. Details and setup of modulus testing and, for soil densification applications, details of post-improvement penetration resistance testing.

9. Example formats of Daily Production Reports conforming to the requirements stated herein.

10. Names, certifications and licenses of the laboratory and companies responsible for performing quality control tests.

11. Describe the Design-Build Contractor's plan for use of water containment areas, and prevention of water inflows into the river, and provide drawings showing layout of water containment ponds.

12. Provide details of spoils: Submit sketches and narrative that describe the procedures to collect, contain, and temporarily store spoils. Identify the spoils disposal locations.

13. Provide details of repairing VRAP areas that do not meet the acceptance criteria.

14. A written schedule for accomplishing the work described in this specification and shown on the Drawings. The schedule shall show the Design-Build Contractor's planned number of machines, number of shifts, and working hours.

## 1.8 DOCUMENTATION

A. The Design-Build Contractor shall institute and maintain a monitoring and documentation program during the installation of all VRAPS (including test areas). The Design-Build Contractor shall provide competent and qualified personnel to continuously observe and record the required data. The program shall include, but is not limited to, the inspection, testing, and documentation of the following:

1. Daily Production/Quality Control Report shall be submitted to the Engineer at the end of the next working day. The Daily Production/Quality Control Report, shall be filled out, checked for correctness, and signed by the Design-Build Contractor's field superintendent.

2. The Daily Report shall contain, but not be limited to, the following information:

- a. Day, month, year, time of beginning and end of work shift; name of each superintendent in charge of the work for the Design-Build Contractor; a list of all workers names associated with each rig; and a summary of equipment used during the shift.
- b. Details of predrilling activities, including but not limited to, elevation, diameter, drilling equipment, portion of boring backfill, and type of backfill materials used.
- c. The locations, installation sequence, and as-installed top and bottom elevations of the VRAPS installed during the work shift, and any deviations from the planned locations and vertical alignment.
- d. Time of start and completion of each VRAP installed during the work shift and a summary of any downtime during the shift including time of work stoppage, duration, reason, and if work stoppage occurred while constructing an aggregate pier.
- e. The report shall include as a minimum the results of the following QC parameter monitoring for each VRAP:
  - i. Rig number and type;
  - ii. Date and time (start and finish) of VRAP construction;
  - iii. VRAP number and reference drawing number;
  - iv. Aggregate consumption per 5 foot depth;
  - v. Average compaction energy per 5 foot depth;
  - vi. Average lift thickness;
  - vii. Completed diameter of each element;
  - viii. Description of obstructions, interruptions, or other difficulties during installation and how they were resolved.

B. The Engineer reserves the right to have a full-time or part-time representative observe and document the VRAP, related construction, and verification exploration.

### 1.9 Mitigation Plan

If the VRAP acceptance criteria in paragraph Acceptance Criteria are not achieved the Design-Build Contractor shall submit a proposed mitigation plan for remixing, or adding columns, or repair of failed sections for review and approval.

### 1.10 VRAP Verification Test Results

Submit to Engineer within 24 hours following completion of each set of verification tests

including test areas. Verification tests include:

- One modulus test
- Densification test results (CPT or SPT) as required by the approved design

#### 1.11 Final Report

Upon the completion of ground improvement activities, the Design-Build Contractor shall submit a final report summarizing the methods used, column installation data, and test results of all wet-grab samples or cores and their identifying locations. The Design-Build Contractor shall submit, with the final report, an as-built drawing prepared at a common engineering scale identifying the final locations of all installed VRAPs with their respective column numbers

#### 1.12 QUALITY ASSURANCE

A. The Design-Build Contractor shall have a full-time representative to verify and report all QA installation procedures. The Design-Build Contractor shall immediately report any unusual conditions encountered during installation to their in-house Design Engineer, the General Contractor, and to the Engineer.

B. The Design-Build Contractor shall monitor ground improvement element installation and log the element number, time of installation, depth, compacting process, and volume of aggregate installed as a function of depth.

C. The Design-Build Contractor shall continuously monitor ground vibrations as specified in these Specifications

D. The QC procedures shall include the preparation of ground improvement Progress Reports completed during each day of installation and containing the information outlined in Section 1.9b of these Specifications.

##### E. Responsibilities of the Engineer

1. The Engineer shall review the Design-Build Contractor's Design Submittal.
2. The Engineer shall monitor the installation of ground improvement elements to verify that all work is performed in accordance with the approved Design Submittal.
3. The Engineer shall report any discrepancies to the Design-Build Contractor and General Contractor immediately.

#### 1.13 QUALITY CONTROL

A. Modulus Test: Testing to determine specification compliance will be provided by the Design-Build contractor and will consist of one modulus test of a VRAP. The results of the modulus test shall meet the following criteria to pass:

1. The Ground Improvement Design Engineer shall approve of the location of the

modulus test.

2. Deflections of the top of the test pier shall be measured by a suitable method.
3. Load increments, decrements, and duration shall be determined using ASTM D1443 as general guidelines.
4. Surficial disturbance shall be compensated for by applying a seating load equal to 5% of the total load to the loaded steel plate before applying load increments.
5. The modulus testing shall be performed as described in the design submittal.

B. Soil Improvement Testing: Post improvement CPT testing shall be required for all designs that achieve the performance requirements by densification of soils between VRAPs.

1. CPT testing to determine specification compliance shall be provided by the Design-Build contractor and shall be completed prior to removing ground improvement equipment from the site. Testing should conform to ASTM D5778.
2. A minimum of one CPT sounding shall be made per 4,000 square feet of treated area, but not less than four post-improvement CPT soundings shall be made.
3. CPT Testing shall be conducted at midpoint locations between the column pattern, or as otherwise shown on the Drawings and approved by the Engineer.
4. The results of the CPT testing shall be evaluated using methods that are consistent with current state of the practice.
5. Minimum tip resistance post improvement shall be provided in the Design-Build Contractor design package and approved by the Owner and Engineer.

C. VRAP Diameter

1. The diameter of installed ground improvement elements shall be verified at the start of the project and as the project progresses.
2. A minimum of 5 of the first 200 installed ground improvement elements shall be excavated down to bearing grade to verify the installed element diameter. The 5 elements shall be under new building foundations.
3. The diameter of the elements shall be measured at the base of foundation excavation planed at the selected element location.
4. Additional element diameter checks shall be completed on one element for every 200 installed elements to the completion of the project. The Engineer shall determine which elements will be checked for installed diameter.

## 2.1 MATERIALS

A. The VRAP aggregate shall consist of hard, angular to sub-angular durable rock fragments, with the majority of particles in the range of 1/8th -inch to 1-1/2 inches such as ASTM C33 size No. 57.

1. Aggregate may also be other graded aggregate selected by the Design-Build Contractor, approved by the Engineer, and successfully used in the modulus test.

B. Potable water or other suitable source shall be used to increase aggregate moisture content where required. Access to water on site shall be coordinated with the Owner.

C. Aggregate used as structural backfill or to restore the building pad to its original grade should conform to WSDOT 9-03.(3), or as otherwise approved by the Engineer.

## 2.2 EQUIPMENT

The vibrator/probe/mandrel shall be capable of providing sufficient energy to achieve the column dimensions and density anticipated in the design.

## PART 3 EXECUTION

### 3.1 INSTALLATION OF VRAPs

#### A. Horizontal and Vertical Alignment Tolerances

1. The center of each ground improvement element shall be within six inches of the plan locations indicated.
2. The final measurement of the top of elements shall be the lowest point on the aggregate in the last compacted lift.
3. Elements installed outside of the above tolerances and deemed not acceptable shall be rebuilt at no additional expense to the Owner.

#### B. VRAP Construction

1. Wet, Top Feed Method of Construction: Due to the silty nature of the on-site site soils, the wet top feed method of construction is not permitted on this site.
2. Dry, Bottom Feed Method of Construction.
  - a. Lower the vibrator/probe/mandrel to the design depth and deliver aggregate to the vibrator/probe/mandrel tip through the tremie system as necessary.
  - b. Raise and lower the vibrator/probe/mandrel repeatedly such that each repenetration advances within 2 feet of the previous penetration depth, or refusal (whichever occurs first) and the required aggregate pier diameter is

achieved.

c. Do not raise the vibrator/probe/mandrel more than 4 feet at any time unless the aggregate stops flowing to the bottom of the vibrator/probe/mandrel.

d. Remove obstructions that prevent installation of the VRAP to design depth or cause the VRAP to stray from its specified location during installation. Obstructions include, but are not limited to, boulders, timber, concrete, brick, utility lines, etc., that prevent installing the aggregate piers to the required depth or cause the pier to drift from the required location.

e. Due to varying consistency of the layered soil deposits, refusal may be encountered above the design installation depth at some locations. All refusal locations and depths are subject to the Engineer's approval.

f. The foundation bearing surface shall be compacted and firm prior to the construction of the foundation

#### C. Repair of Damage

The Design-Build Contractor shall be responsible for the repair to waterfront structures, roads, utilities, structures, buildings, etc., if the damage, as determined by the Engineer, is due to this ground improvement work. Obtain approval from the Engineer for repair action prior to repair and following completion of repair. All corrective actions and any additional testing required by the Engineer shall be at the Design-Build Contractor's expense.

### 3.2 REJECTED VRAPs

If an aggregate pier is installed in an incorrect location or exceeds the specified tolerances, the Design-Build Contractor shall replace the pier. Pier replacement may be avoided if alternate remedial procedures are approved by the Engineer.

### 3.3 VIBRATION MONITORING

A. The Design-Build Contractor shall demonstrate by use of portable seismographs that the vibrations generated from the work, measured at any other nearby structures and buildings, are less than 1.0 inch per second resultant peak particle velocity (RPPV) or as recommended by the project Engineer.

1. If the measured vibrations at nearby structures or buildings exceed this velocity, the Design-Build Contractor shall change construction methods to the specified and approved low vibration design build ground improvement systems.

B. The Design-Build Contractor shall report daily measured RPPVs during monitoring for review by the project team.

C. The Design-Build Contractor shall perform vibration monitoring for the duration of the ground improvement work or until the Engineer recommends that vibration monitoring is not required.

D. Cost of vibration monitoring shall be provided as a separate bid item.

### 3.4 EXCAVATION AND UTILITIES NEAR VRAPs

A. Excavations conducted after VRAP installation shall be performed such that the horizontal distance between the edge of any VRAP element and the nearest edge of the excavation is such that the element is not affected and in accordance with the Design Submittal.

B. If installed VRAP elements are located within the zone of influence of excavation, the Design-Build Contractor and Engineer shall collaborate to develop solutions to excavation or construction methods that will avoid detrimental impact to installed VRAPs.

C. Placing and compacting select aggregate in excavation zones that have disrupted the structural continuity of the VRAP element operations, materials equipment, and testing shall adhere to the following requirements:

1. Gradation of the aggregate shall conform to Part 2.1 of these specifications.
2. The impact compaction equipment shall be motorized and the procedure shall ensure controlled placement of the aggregate. Compaction of the aggregate shall reach 95% of the maximum dry density. The maximum dry density shall be determined by the modified proctor method (ASTM D1557).
3. Placement and compaction of fill within the ground improvement area shall be observed and tested by the Engineer. The Engineer shall also execute density testing on-site and submit results of the density testing to the Design-Build Contractor and Owner's representative.
4. Scheduling of excavation placement, and compaction shall be determined by the Design-Build Contractor. The Design-Build Contractor will provide the aforementioned schedule to the Engineer and make arrangements for observation of placement and compaction, and execution of density testing

### 3.5 EXCAVATION AND PREPARATION OF VRAP TOPS

A. Prior to placement of the concrete foundations, VRAP tops shall be excavated in a manner that will prevent the soil matrix surrounding the VRAPs from softening and ensure that a direct connection between the VRAP and the foundation will be achieved. The following excavation procedure shall be followed:

B. VRAP tops and footing bearing soils shall be compacted with a motorized impact compactor. Tampers of the "sled" variety shall not be employed.

C. The entire surface area below the structural fill working pad shall be compacted to ensure that any loose surface soil and/or loose surface aggregate is densified.

D. The following criteria shall apply, and shall be verified by the Engineer in a written report:



1. The structural fill working pad excavation has been kept free of water following completion of excavation work. This will ensure that the unconfined matrix soil surrounding the VRAPs has not been softened. Softening of the matrix soil may negatively impact the load bearing capability of the reinforced subgrade.
2. That at each footing location, all VRAPs have been fully exposed within the limits of the structural fill working pad.
3. Inspection of each VRAP top after exposure by the structural fill immediately prior to construction of the structural fill working pad.

E. Assurance that no excavation has been made within a distance that will affect any completed pier, without being approved in writing by the Design-Build contractor and Engineer.

### 3.6 FOOTING SUBGRADE PREPARATION

- A. All footings and mat foundations shall bear directly on the VRAPS unless the Design Submittal requires a crushed rock working layer or load transfer platform.
- B. The footing bearing surface shall be free of all water and compacted prior to placement of any reinforcing steel.
- C. Reinforcement and foundation concrete placement shall be accomplished in a timely manner so that no degradation of the bearing surface occurs.

END OF SECTION



**DIVISION 32**  
**EXTERIOR IMPROVEMENTS**



## PART 1 GENERAL

### 1.1 SECTION INCLUDES

- A. Aggregate base course.
- B. Paving aggregates.

### 1.2 REFERENCE STANDARDS

- A. AASHTO M 147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses; American Association of State Highway and Transportation Officials; 1965 (2004).
- B. AASHTO T 180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18 in.) Drop; American Association of State Highway and Transportation Officials; 2010
- C. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates; 2006.
- D. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>)); 2012.
- E. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method; 2007.
- F. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2011.
- G. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils; 2010.
- H. WSDOT Standard Specifications for Road, Bridge, and Municipal Construction; 2021.

### 13 SUBMITTALS

- A. See Section 01 33 00 for submittal procedures.
- B. Materials Sources: Submit name of imported materials source.
- C. Aggregate Composition Test Reports: Results of laboratory tests on proposed and actual materials used.
- D. Compaction Density Test Reports.

## 14 DELIVERY, STORAGE, AND HANDLING

- A. When necessary, store materials on site in advance of need.
- B. When aggregate materials need to be stored on site, locate where indicated on drawings.
- C. Aggregate Storage, General:
  - 1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
  - 2. Prevent contamination.
  - 3. Protect stockpiles from erosion and deterioration of materials.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. See 31 20 00 Earth Moving

### 2.2 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for general requirements for testing and analysis of aggregate materials.
- B. Where aggregate materials are specified using ASTM D2487 classification, test and analyze samples for compliance before delivery to site.
- C. If tests indicate materials do not meet specified requirements, change material and retest.
- D. Provide materials of each type from same source throughout the Work.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify that survey bench marks and intended elevations for the work are as indicated.
- B. Verify substrate has been inspected, gradients and elevations are correct, and is dry.

### 3.2 PREPARATION

- A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.

- B. Do not place aggregate on soft, muddy, or frozen surfaces.

### 3.3 INSTALLATION

- A. Spread aggregate over prepared substrate to a total compacted thickness of as indicated on Plans.
- B. Place aggregate in maximum lifts thickness of 0.35 feet.
- C. Level and contour surfaces to elevations and gradients indicated.
- D. Add small quantities of fine aggregate to coarse aggregate as appropriate to assist compaction.
- E. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.
- F. Use mechanical tamping equipment in areas inaccessible to compaction equipment.
- G. Apply herbicide to finished surface.

### 3.4 TOLERANCES

- A. Flatness: Maximum variation of 1/4 inch measured with 10 foot straight edge.
- B. Scheduled Compacted Thickness: Within 1/4 inch.
- C. Variation From Design Elevation: Within 1/2 inch.

### 3.5 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection and testing.
- B. Compaction density testing will be performed on compacted aggregate base course in accordance with ASTM D1556.
- C. Results will be evaluated in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D 698 ("standard Proctor").
- D. If tests indicate work does not meet specified requirements, remove work, replace and retest.
- E. Frequency of Tests: Per City of Kelso Construction Specifications and Details.
- F. Proof roll compacted aggregate at surfaces that will be under slabs-on-grade.

3.6 CLEANING

- A. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.
- B. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION



## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

### 1.2 SUMMARY

- A. Section Includes:
  - 1. Hot-mix asphalt paving.
- B. Related Requirements:
  - 1. Section 321123 "Aggregate Base Course" for subgrade preparation, fill material, separation geotextiles, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.
  - 2. Section 321313 "Concrete Paving" for concrete pavement and for separate concrete curbs, gutters, and driveway aprons.

### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include technical data and tested physical and performance properties.

### 1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of state in which Project is located.
- B. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of Washington State Department of Transportation (WSDOT) for asphalt paving work.
  - 1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

## PART 2 - PRODUCTS

### 2.1 AGGREGATES

- A. Coarse Aggregate: ASTM D 692/D 692M, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.

- B. Fine Aggregate: ASTM D 1073 or AASHTO M 29, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.
- C. Mineral Filler: ASTM D 242/D 242M or AASHTO M 17, rock or slag dust, hydraulic cement, or other inert material.
- D. Base Aggregate shall comply with WSDOT SS 9-03.9(3).

## 2.2 ASPHALT MATERIALS

- A. Asphalt Binder: ASTM D 6373 or AASHTO M 320 binder designation PG 64-22.
- B. Tack Coat: ASTM D 977 or AASHTO M 140 emulsified asphalt, or ASTM D 2397/D 2397M or AASHTO M 208 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

## 2.3 AUXILIARY MATERIALS

- A. Herbicide: Commercial chemical for weed control, registered by the EPA, and not classified as "restricted use" for locations and conditions of application. Provide in granular, liquid, or wettable powder form.

## 2.4 MIXES

- A. Hot-Mix Asphalt: Class ½ inch, PG 64-22 hot-laid, hot-mix asphalt plant mixes per WSDOT Standard Specifications as amended by the American Public Works Association
- B. Contractor shall provide an approved design mix. Mix design verification is valid for one year from the date of verification. At the discretion of the Engineer, Owner may accept mix designs verified beyond the verification year with certification from the Contractor that the materials and sources are the same as those shown on the original mix design.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that subgrade is dry and in suitable condition to begin paving.
- B. Proceed with paving only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Protection: Provide protective materials, procedures, and worker training to prevent asphalt materials from spilling, coating, or building up on curbs, driveway aprons, manholes, and other surfaces adjacent to the Work.

- B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

### 3.3 PATCHING

- A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches (300 mm) into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.
- B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.
  - 1. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.
- C. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).
  - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
  - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
- D. Placing Patch Material: Fill excavated pavement areas with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.
- E. Placing Patch Material: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

### 3.4 SURFACE PREPARATION

- A. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
- B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
- C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).
  - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
  - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

### 3.5 PLACING HOT-MIX ASPHALT

- A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
  - 1. Spread mix at a minimum temperature of 250 deg F (121 deg C).
  - 2. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- B. Place paving in consecutive strips not less than 10 feet (3 m) wide unless infill edge strips of a lesser width are required.
- C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

### 3.6 JOINTS

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
  - 1. Clean contact surfaces and apply tack coat to joints.
  - 2. Offset longitudinal joints, in successive courses, a minimum of 6 inches (150 mm).
  - 3. Offset transverse joints, in successive courses, a minimum of 24 inches (600 mm).
  - 4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."

### 3.7 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
  - 1. Complete compaction before mix temperature cools to 185 deg F (85 deg C).
- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
  - 1. Average Density: 91 percent of reference maximum RICE theoretical density (AASHTO T-209) but not less than 90 percent or greater than 96 percent. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

- D. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
- E. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
- F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- G. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

### 3.8 INSTALLATION TOLERANCES

- A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
  - 1. Base Course: Plus or minus 1/2 inch (13 mm).
  - 2. Surface Course: Plus 1/4 inch (6 mm), no minus.
- B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot (3-m) straightedge applied transversely or longitudinally to paved areas:
  - 1. Base Course: 1/4 inch (6 mm).
  - 2. Surface Course: 1/8 inch (3 mm).
  - 3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch (6 mm).
- C. Fog Seals: Apply fog seal at a rate of 0.10 to 0.15 gal./sq. yd. (0.45 to 0.7 L/sq. m) to existing asphalt pavement and allow to cure. With fine sand, lightly dust areas receiving excess fog seal.
- D. Slurry Seals: Apply slurry coat in a uniform thickness according to ASTM D 3910 and allow to cure.
  - 1. Roll slurry seal to remove ridges and provide a uniform, smooth surface.

### 3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.
- C. Replace and compact hot-mix asphalt where core tests were taken.

END OF SECTION



## PART 1 - GENERAL

### 1.1 SUMMARY

- A. Section Includes Concrete Paving. Including the Following:
  - 1. Pedestrian Paths/Plaza Areas
  - 2. Curb Ramps
  - 3. Curbs and gutters
- B. Related Requirements:
  - 1. Section 321123 "Aggregate Base Course" for subgrade preparation, fill material, separation geotextiles, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.
  - 2. WSDOT Section F Standard Plans; current edition.
  - 3. WSDOT Standard Specifications Division 8; current edition.

### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

### 1.3 QUALITY ASSURANCE

- A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
  - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

### 1.4 PRECONSTRUCTION TESTING

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

## PART 2 - PRODUCTS

### 2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with ACI 301 unless otherwise indicated.

- B. Provide manufacturer's certification that products meet or exceed specifications.
- C. Layout Plan
  - 1. Provide hand-marked sketch or exhibit indicating proposed location of expansion, construction, and contraction joints. All joints not marked otherwise shall be assumed as surface joints.
  - 2. Layout plan shall be reviewed and approved by the engineer a minimum of 48 hours prior to pour. For complex pours, allow additional time for review, approval, and related revisions to pour plan and formwork. No additional time or cost shall be added to the contract for formwork revisions.

## 2.2 CONCRETE MATERIALS

- A. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:
  - 1. Cement: ASTM C595, Type 1L (15)
  - 2. Fly Ash: ASTM C 618, Class F.
  - 3. Slag Cement: ASTM C 989.
- B. Normal-Weight Aggregates: ASTM C 33/C 33M, Class 4S, uniformly graded. Provide aggregates from a single source.
- C. Air-Entraining Admixture: ASTM C 260/C 260M.
- D. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
- E. Color Pigment: ASTM C 979/C 979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, nonfading, and resistant to lime and other alkalis.
  - 1. Color: As indicated by manufacturer's designation.
- F. Water: Potable and complying with ASTM C 94/C 94M.
- G. Concrete curb ramps: conform to WSDOT Standard Specification Section 8.

## 2.3 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry or cotton mats.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.
- D. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.



1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Anti-Hydro International, Inc.
  - b. ChemMasters, Inc.
  - c. Dayton Superior.
  - d. Euclid Chemical Company (The); an RPM company.
  - e. Kaufman Products, Inc.
  - f. Lambert Corporation.
  - g. Laticrete International, Inc.
  - h. Nox-Crete Products Group.
  - i. Right Pointe.
  - j. SpecChem, LLC.
  - k. TK Products.
  - l. Unitex by Dayton Superior.
  - m. Vexcon Chemicals Inc.
  - n. W.R. Meadows, Inc.

## 2.4 RELATED MATERIALS

- A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork in preformed strips.

## 2.5 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301 (ACI 301M), for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
- B. Cementitious Materials: Use fly ash and slag cement as indicated below:
  1. Fly Ash: 15 percent.
  2. Slag Cement: 30 percent.
  3. Combined Fly Ash and Slag Cement: 35 percent.
- C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
  1. Air Content: 5.5 percent.
- D. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
- E. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd.
- F. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

G. Concrete Mixtures: Normal-weight concrete.

1. Compressive Strength (28 Days): 4000 psi
2. Maximum W/C Ratio at Point of Placement: 0.45.
3. Slump Limit: 5.5 inches plus or minus 1 inch.

2.6 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M. Furnish batch certificates for each batch discharged and used in the Work.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Compact prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
- B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

3.2 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.
- B. Moisten base to minimize absorption of water from fresh concrete.
- C. Coat surfaces of manhole and catch basin frames with oil to prevent bond with concrete pavement.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

- B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, to match jointing of existing adjacent concrete paving:
- E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch (6-mm) radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

### 3.5 CONCRETE PLACEMENT

- A. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- B. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- C. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- D. Screed paving surface with a straightedge and strike off.
- E. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

### 3.6 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
  - 1. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch (1.6 to 3 mm) deep with a stiff-bristled broom, perpendicular to line of traffic.

### 3.7 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

- B. Comply with ACI 306.1 for cold-weather protection.
- C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- D. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, or a curing compound.

### 3.8 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117 (ACI 117M) and as follows:
  - 1. Elevation: 3/4 inch (19 mm).
  - 2. Thickness: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
  - 3. Surface: Gap below 10-feet- (3-m-) long; unleveled straightedge not to exceed 1/2 inch (13 mm).
  - 4. Joint Spacing: 3 inches (75 mm).
  - 5. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.
  - 6. Joint Width: Plus 1/8 inch (3 mm), no minus.

### 3.9 REPAIR AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.
- B. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- C. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

## PART 1 - GENERAL

### 1.1 SUMMARY

- A. Section includes painted markings applied to asphalt and concrete pavement.

### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work on-site include, but are not limited to, the following:
  - 1. Aexcel Inc.
  - 2. Colorado Paint Company.
  - 3. Columbia Paint & Coatings, Inc.
  - 4. Conco Paints.
  - 5. Diamond Vogel Paints.
  - 6. Dow Chemical Company (The).
  - 7. Dunn-Edwards Corporation.
  - 8. Ennis-Flint.
  - 9. General Paint.
  - 10. Insl-X Products; Benjamin Moore & Co.
  - 11. McCormick Paints.
  - 12. PPG Paints.
  - 13. Rodda Paint Co.
  - 14. Rust-Oleum Corporation; a subsidiary of RPM International, Inc.
  - 15. Scott Paint.
  - 16. Sherwin-Williams Company (The).
  - 17. Transpo Industries, Inc.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" the ABA standards of the Federal agency having jurisdiction and ICC A117.1

## 2.3 PAVEMENT-MARKING PAINT

- A. Pavement-Marking Paint: MPI #32, solvent-borne traffic-marking paint.
  - 1. Color: White.
- B. Pavement-Marking Paint: MPI #97, latex traffic-marking paint.
  - 1. Color: White.
- C. Glass Beads: AASHTO M 247, Type 1.
- D. Glass Beads for paint within public Right-of-Way shall meet WSDOT Standard Specification Section 9-34.4. Glass beads for plastic shall be as recommended by material manufacture.
- E. Pavement-Marking Paint within the public Right-of-Way shall meet WSDOT Standard Specification Sections 9-34.

## PART 3 - EXECUTION

### 3.1 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.
- B. Allow paving to age for a minimum of 30 days before starting pavement marking.
- C. Sweep and clean surface to eliminate loose material and dust.
- D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.
  - 1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils. Apply paint so that it cannot run beneath stencil.
  - 2. Broadcast glass beads uniformly into wet markings at a rate of 6 lb/gal.
- E. Pavement markings within the public Right-of-Way shall conform to WSDOT section 8-22, 9-21 and 9-34. Measurement and Payment sections do not apply.

END OF SECTION

## PART 1 GENERAL

### 1.1 SECTION INCLUDES

- A. Posts, rails, and frames.
- B. Wire fabric.
- C. Manual gates with related hardware.
- D. Accessories.

### 1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast in Place Concrete

### 1.3 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.
- C. ASTM A392 - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric 2011a (Reapproved 2017).
- D. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- E. ASTM F567 - Standard Practice for Installation of Chain-Link Fence 2014a.
- F. CLFMI CLF-FIG0111 - Field Inspection Guide 2014.
- G. CLFMI CLF-PM0610 - Product Manual 2017.
- H. FS RR-F-191/1D - Fencing, Wire and Post Metal (Chain-Link Fence Fabric) 1990.

### 1.4 SUBMITTALS

- A. Refer to Section 013300 - Submittals, for
- B. Product Data: Provide data on fabric, posts, accessories, fittings and hardware.
- C. Project Record Documents: Accurately record actual locations of property perimeter posts relative to property lines [\_\_\_\_\_].

### 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

- B. Fence Installer: Company with demonstrated successful experience installing similar projects and products, with not less than three years of documented experience.

## 1.6 WARRANTY

- A. Correct defective Work within a five year period after Date of Substantial Completion.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Chain Link Fences and Gates:
  - 1. Master-Halco, Inc; [www.masterhalco.com/#sle](http://www.masterhalco.com/#sle).
  - 2. Merchants Metals; [www.merchantsmetals.com/#sle](http://www.merchantsmetals.com/#sle).
  - 3. Substitutions: Refer to Section 012500.

### 2.2 COMPONENTS

- A. Line Posts: 4.0 inch diameter for welded fabrication.
- B. Corner and Terminal Posts: 4.0 inch diameter for welded fabrication.
- C. Gate Posts: 4.0 inch diameter for welded fabrication.
- D. Top and Brace Rail: 2-1/2 inch diameter, plain end, sleeve coupled.
- E. Bottom Rail: 2-1/2 inch diameter, plain end, sleeve coupled.
- F. Gate Frame: 2-1/2 inch diameter for welded fabrication.
- G. Fabric: 2 inch diamond mesh interwoven wire, 6 gauge, 0.1920 inch thick, top selvage knuckle end closed, bottom selvage twisted tight.
- H. Fabric with Pre-Inserted Slats: 2 inch diamond mesh interwoven wire, 6 gauge, 0.1920 inch thick, top selvage knuckle end closed, bottom selvage twisted tight.
  - 1. Privacy Slats: High-density polyethylene (HDPE), woven into fabric.
    - a. Visual Barrier: 95 percent.
    - b. Slat Color: Black.

### 2.3 MATERIALS

- A. Posts, Rails, and Frames:
  - 1. Formed from hot-dipped galvanized steel sheet, ASTM A653/A653M, HSLAS, Grade 50, with G90 (Z275) zinc coating.
  - 2. Line Posts: Type I round in accordance with FS RR-F-191/1D.



3. Terminal, Corner, Rail, Brace, and Gate Posts: Type I round in accordance with FS RR-F-191/1D.
- B. Wire Fabric:
  1. ASTM A392 zinc coated steel chain link fabric.
  2. Comply with CLFMI CLF-PM0610.

#### 2.4 MANUAL GATES AND RELATED HARDWARE

- A. Hardware for Single Swinging Gates: 180 degree hinges, 2 for gates up to 60 inches high, 3 for taller gates; fork latch with gravity drop and padlock hasp; keeper to hold gate in fully open position.
- B. Hardware for Double Swinging Gates: 180 degree hinges, 2 for gates up to 60 inches high, 3 for taller gates; drop bolt on inactive leaf engaging socket stop set in concrete, active leaf latched to inactive leaf preventing raising of drop bolt, padlock hasp; keepers to hold gate in fully open position.
- C. Hinges: Finished to match fence components.
  1. Brackets: Round.
  2. Mounting: Center.
  3. Closing: Manual.
- D. Latches: Finished to match fence components.
  1. Brackets: Round.
  2. Locking: Mechanical.

#### 2.5 LIGHT-DUTY ARCHITECTURAL HARDWARE

- A. Mechanical Latches: Steel latch, with mounting bracket for a nominal 1-5/8 inches (41 mm) diameter pipe post frame.
  1. Finish: Galvanized.
- B. Hinge Set: Self-closing, for top and bottom support of swinging gate.
  1. Swing Direction: One way.
  2. Mounting to Round Fence Post and Gate Frame: Integral clamp.
  3. Finish: Galvanized.

#### 2.6 ACCESSORIES

- A. Caps: Cast steel galvanized; sized to post diameter, set screw retainer.

- B. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; steel.

## 2.7 FINISHES

- A. Components (Other than Fabric): Galvanized in accordance with ASTM A123/A123M, at 1.7 ounces per square foot.
- B. Components and Fabric: Vinyl coated over coating of 1.8 ounces per square foot galvanizing.
- C. Hardware: Hot-dip galvanized to weight required by ASTM A153/A153M.
- D. Accessories: Same finish as framing.
- E. Color(s): Black.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verification of Conditions: Verify that areas are clear of obstructions or debris.

### 3.2 PREPARATION

- A. Removal: Obstructions or debris.

### 3.3 INSTALLATION

- A. Install framework, fabric, accessories and gates in accordance with ASTM F567.
- B. Place fabric on outside of posts and rails.
- C. Set intermediate posts plumb , in concrete footings with top of footing 2 inches above finish grade. Slope top of concrete for water runoff.
- D. Line Post Footing Depth Below Finish Grade: ASTM F567.
- E. Corner, Gate and Terminal Post Footing Depth Below Finish Grade: ASTM F567.
- F. Brace each gate and corner post to adjacent line post with horizontal center brace rail. Install brace rail one bay from end and gate posts.
- G. Provide top rail through line post tops and splice with 6 inch long rail sleeves.
- H. Do not stretch fabric until concrete foundation has cured 28 days.
- I. Stretch fabric between terminal posts or at intervals of 100 feet maximum, whichever is less.
- J. Position bottom of fabric 2 inches above finished grade.
- K. Fasten fabric to top rail, line posts, braces, and bottom tension wire with tie wire at maximum 15 inches on centers.

- L. Attach fabric to end, corner, and gate posts with tension bars and tension bar clips.
- M. Do not attach the hinged side of gate to building wall; provide gate posts.
- N. Install hardware and gate with fabric to match fence.

### 3.4 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch.
- B. Maximum Offset From True Position: 1 inch.
- C. Do not infringe on adjacent property lines.

### 3.5 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Layout: Verify that fence installation markings are accurate to design, paying attention to gate locations, underground utilities, and property lines.
- C. Post Settings: Randomly inspect three locations against design for:
  - 1. Hole diameter.
  - 2. Hole depth.
  - 3. Hole spacing.
- D. Fence Height: Randomly measure fence height at three locations or at areas that appear out of compliance with design.
- E. Gates: Inspect for level, plumb, and alignment.
- F. Workmanship: Verify neat installation free of defects. See CLFMI CLF-FIG0111 for field inspection guidance.

### 3.6 CLEANING

- A. Clean jobsite of excess materials; scatter excess material from post hole excavations uniformly away from posts. Remove excess material if required.
- B. Clean fence with mild household detergent and clean water rinse well.

END OF SECTION



## PART 1 GENERAL

### 1.1 SUMMARY

#### A. Section Includes

1. Skate deterrents.

### 1.2 REFERENCE STANDARDS

- #### A. ASTM B211/B211M - Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire 2019.

### 1.3 SUBMITTALS

- #### A. Refer to Section 013300.
- #### B. Product Data: Provide manufacturer's specifications and descriptive literature, installation instructions, and maintenance information.
- #### C. Samples: Submit one sets of skate deterrents.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- #### A. Skate Deterrents:
1. The Park Catalog: [www.theparkcatalog.com/#sle](http://www.theparkcatalog.com/#sle).
  2. Basis of Design: Skate Stoppers; FR 0.5: [www.skatestoppers.com/#sle](http://www.skatestoppers.com/#sle).
  3. StopAGrind: [www.stopagrind.com/#sle](http://www.stopagrind.com/#sle).
  4. Substitutions: Section 012500.

### 2.2 SKATE FURNISHINGS

- #### A. Skate Deterrents:
1. Material: Aluminum; ASTM B211/B211M; 6061 alloy, T6 temper; clear anodized finish.
  2. Anchoring: Tamper-resistant screws, pins or bolts as recommended by manufacturer.
  3. Epoxy: As recommended by Manufacturer.
  4. Corner Radius: 12 inch radius.
  5. Outside Dimensions: 2 inches (width) by 3-3/4 inches (deep) by 1 inch (tall)
  6. Spacing: As recommended by Manufacturer.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Verify proper installation of mounting surfaces, and other mounting devices; and ready to receive skate deterrent.
- B. Do not begin installation until unacceptable conditions are corrected.

#### 3.2 INSTALLATION

- A. Install skate deterrents in accordance with manufacturer's installation instructions.
- B. Provide level mounting surfaces for skate deterrents.

END OF SECTION

# **DIVISION 33**

## **UTILITIES**





## PART 1 GENERAL

### 1.1 SUMMARY

- A. The purpose of this section is to describe the commissioning process specific for those sections found in Division 33.

### 1.2 ADMINISTRATIVE REQUIREMENTS

- A. General Responsibilities: The Contractor's commissioning responsibilities applicable to each of the Utilities contractors are as follows:
  - 1. In each purchase order or subcontract written, include requirements for submittal data, commissioning documentation, O&M data and training.
  - 2. Attend a commissioning kick-off meeting and other meetings necessary to facilitate the Commissioning process.
  - 3. Contractors shall assist in clarifying the installation, operation, maintenance, and control of commissioned equipment if requested by the Commissioning Authority.

### 1.3 COORDINATION

- A. Refer to Section 01 91 00 for a listing of all sections where commissioning requirements are found, for systems to be commissioned and for functional testing requirements.

### 1.4 SUBMITTALS

- A. General Submittals: Contractor shall provide to the Commissioning Authority, through established channels, normal cut sheets and shop drawing submittals, and manufacturer's installation and start-up checklists, for all commissioned equipment.

## PART 2 PRODUCTS

Not Used

## PART 3 EXECUTION

### 3.1 SYSTEM STARTUP

- A. Installation Checklists: The Contractor shall complete the checklist(s) provided using the Facility Grid app.
  - 1. The completion of these checklists does not limit the Contractor's responsibilities for quality control and scheduling as indicated elsewhere in the documents, nor does this checklist include all submittal, inspection, or quality assurance requirements for the work of this Section.
- B. Pre-Verification Testing (PVT): The Contractor will perform the Pre-verification tests as provided with the Facility Grid app. When all pre-verification testing has been completed, the CA will schedule Functional Performance testing and substantial completion may be issued.

### 3.2 CLOSEOUT ACTIVITIES

- A. Training: The Owner personnel shall be trained on procedures related to the following:
  - 1. Review with Owner's staff the "As Built" Drawings showing where main lines run, shut off valves are located and other site related maintenance items can be found.
  - 2. Review the Operations and Maintenance Manuals and discuss with the Owner's staff maintenance for the items listed in 1.1A above.

### 3.3 DOCUMENTS REQUIRED

- A. The General Contractor will provide the following documentation before Final Acceptance:
  - 1. Copy of Completed Installation Checklists
  - 2. Completed Inspection Forms with approval signatures of all Authority Having Jurisdiction.

END OF SECTION

## PART 1 GENERAL

### 1.1 General

- A. The installation of the project's Site Water Utility Distribution Piping shall follow the latest edition of the Washington State Department of Transportation APWA (WSDOT/APWA) Specifications for Road Bridge, and Municipal Construction. The WSDOT/APWA specification sections are replaced, or supplemented, by the City of Kelso as detailed on sheet C607 and C608, and C609 of the Civil Plan Set.

END OF SECTION



## 1.1 RELATED REQUIREMENTS

- ## 1.2 SECTION INCLUDES

- ### 1.3 SUBMITTALS

- ## 1.4 REFERENCE STANDARDS

- ## 1.5 ADMINISTRATIVE REQUIREMENTS

- ## 1.6 DEFINITIONS

- BID SET – 5/28/2021



- C. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.
- D. When trenching operations involve cutting through concrete pavement, the removal and reconstruction of the entire concrete panel shall be required.
- E. Where a sewer main crosses under an A.C. water main the Contractor shall replace the existing A.C. main over the excavation with Ductile Iron Pipe Class 52 to a point of bearing soil a minimum of three (3) feet each side of the excavation.

### 3.3 INSTALLATION - PIPE

- A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.
- B. Pipe laying shall be in accordance with the WSDOT Standard Specifications and the City of Kelso Engineering Design Manual.
- C. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.
  - Replace existing sewer pipe per plan. Proposed pipe replacement to be ductile iron per WSDOT Standard Specification 9-05.13. Ductile iron pipe shall conform to ANSI A 21.51 or AWWA C151 and shall be cement mortar lined and have a 1-mil seal coat per AWWA C104. The ductile iron pipe shall be Special Thickness Class 51, minimum Pressure Class 350. Cast iron fittings may be used with ductile iron pipe.
  - All joints and connections shall be airtight and watertight, as determined by testing and inspection procedures outlined in Chapter 6 of the City of Kelso Engineering Design Manual. Joints for ductile iron pipe shall be push-on type or mechanical joint conforming to the WSDOT standards specification. Pipe and jointing shall be installed in accordance with the instructions furnished by the pipe manufacturer and approved by the engineer.
  - Contractor to determine pipe size and if pipe has minimum 0.5% slope. If minimum slope is not discovered, contact engineer.
  - PVC Pipe: Also comply with ASTM D2321.
- D. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch (3 mm) in 10 feet (3 m).
- E. Connect to building sanitary sewer outlet, through installed sleeves.
- F. Install trace wire 6 inches (150 mm) above top of pipe; coordinate with City of Kelso Engineering Design Manual, Chapter 6.

### 3.4 INSTALLATION – CLEANOUT

- A. Install in accordance with the City of Kelso Engineering Design Manual.
- B. Form bottom of excavation clean and smooth to correct elevation.

- E. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

### 3.5 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 01 40 00.
- B. No backfill shall be placed over the pipe until the work has been inspected and approved by the City. Any portion of the sewer covered before inspection shall be uncovered at the owner's expense within two days after notice to do so has been issued by the City.
- C. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.
- D. Provide as-builts of all public sanitary laterals prior to paving. The information is to be submitted to Construction Services at the City.

### 3.6 PROTECTION

- A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.

END OF SECTION 33 31 11



## 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. Washington State Department of Ecology, 2019 Stormwater Management Manual for Western Washington.
- C. City of Kelso Engineering Design Manual, Chapter 2 Storm Drainage, Grading, and Erosion Control.

### 1.2 SUMMARY

- A. Section Includes:
  - 1. Pipe and fittings.
  - 2. Cleanouts.
  - 3. Area Drains.
  - 4. Roof Drains.

### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings:
  - 1. Area Drains. Include plans, elevations, sections, details, frames, covers, and grates.

### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic drains, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle area drains according to manufacturer's written instructions.

## PART 2 - PRODUCTS

### 2.1 PIPE AND FITTINGS

- A. Provide products that comply with applicable code(s) and City of Kelso Engineering design Manual.

## 2.2 CLEANOUTS

- A. PVC Cleanouts:
  - 1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

## 2.3 AREA DRAINS

- A. The drain basins required for this contract shall be manufactured from PVC pipe stock, utilizing a thermoforming process to reform the pipe stock to the specified configuration. The drainage pipe connection stubs shall be manufactured from PVC pipe stock and formed to provide a watertight connection with the specified pipe system. This joint tightness shall conform to ASTM D3212 for joints for drain and sewer plastic pipe using flexible elastomeric seals. The flexible elastomeric seals shall conform to ASTM F477. The pipe bell spigot shall be joined to the main body of the drain basin or catch basin. The raw material used to manufacture the pipe stock that is used to manufacture the main body and pipe stubs of the surface drainage inlets shall conform to ASTM D1784 cell class 12454.
- B. The grates and frames furnished for all surface drainage inlets shall be ductile iron for structure sizes 8", 10", 12", 15", 18", 24", 30" and 36" and shall be made specifically for each basin so as to provide a round bottom flange that closely matches the diameter of the surface drainage inlet. Grates for drain basins shall be capable of supporting various wheel loads as specified by Nyloplast. 12" and 15" square grates will be hinged to the frame using pins. Ductile iron used in the manufacture of the castings shall conform to ASTM A536 grade 70-50-05. Grates and covers shall be provided painted black.

## 2.4 ROOF DRAINS

- A. The roof drain connection shall be in compliance with the Roof Drain Connection detail on sheet C602 in plan set.

## PART 3 - EXECUTION

### 3.1 EARTHWORK

- A. Excavation, trenching, and backfilling are specified in Section 312000 "Earth Moving."

### 3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

- C. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- D. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
- E. Install gravity-flow, nonpressure drainage piping according to the following:
  - 1. Install piping pitched down in direction of flow.
  - 2. Install PE corrugated sewer piping according to ASTM D 2321.

### 3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure drainage piping according to the following:
  - 1. Join corrugated PE piping according to ASTM D 3212 for push-on joints.
  - 2. Join dissimilar pipe materials with nonpressure-type flexible couplings.

### 3.4 CLEANOUT INSTALLATION

- A. Set cleanout for softscapes frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches (450 by 450 by 300 mm) deep. Set with tops 1 inch (25 mm) above surrounding earth grade.
- B. Set cleanout for hardscapes frames and covers in concrete pavement and roads with tops flush with pavement surface.
- C. Set cleanout for softscapes water tight plug 1" above surrounding finished grade surface.
- D. Per Roof Drain Connection Detail on sheet C602 of the conformed planset, cleanouts shall be connected at each roof drain connection location. Cleanouts to be included with Roof Drain Connection quantity.

### 3.5 AREA DRAIN INSTALLATION

- A. The specified PVC surface drainage inlet shall be installed using conventional flexible pipe backfill materials and procedures. The backfill material shall be crushed stone or other granular material meeting the requirements of class 1, class 2, or class 3 material as defined in ASTM D2321. Bedding and backfill for surface drainage inlets shall be well placed and compacted uniformly in accordance with ASTM D2321.
- B. The drain basin body will be cut at the time of the final grade. No brick, stone or concrete block will be required to set the grate to the final grade height.
- C. For load rated installations, a concrete slab shall be poured under and around the grate and frame. The concrete slab must be designed taking into consideration local soil conditions, traffic loading, and other applicable design factors.

- D. For other installation considerations such as migration of fines, ground water, and soft foundations refer to ASTM D2321 guidelines.

### 3.6 CONNECTIONS

- A. Make connections to existing piping and underground manholes.
  - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch (150-mm) overlap, with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
  - 2. Make branch connections from side into existing piping, NPS 4 to NPS 20 (DN 100 to DN 500). Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
  - 3. Make branch connections from side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches (76 mm) of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches (150 mm) of concrete for minimum length of 12 inches (300 mm) to provide additional support of collar from connection to undisturbed ground.
    - a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi (20.7 MPa) unless otherwise indicated.
    - b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
  - 4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

### 3.7 IDENTIFICATION

- A. Materials and their installation are specified in Section 312000 "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.
  - 1. Use detectable warning tape over nonferrous piping and over edges of underground structures.

### 3.8 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (610 mm) of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
  2. Defects requiring correction include the following:
    - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    - d. Infiltration: Water leakage into piping.
    - e. Exfiltration: Water leakage from or around piping.
  3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
  4. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
1. Do not enclose, cover, or put into service before inspection and approval.
  2. Test completed piping systems according to requirements of authorities having jurisdiction.
  3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
  4. Submit separate report for each test.
  5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
    - a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
    - b. Option: Test plastic piping according to ASTM F 1417.
    - c. Option: Test concrete piping according to ASTM C 924 (ASTM C 924M).
- C. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

### 3.9 CLEANING

- A. Clean interior of piping of dirt and superfluous materials. Flush with water.

END OF SECTION

