

## **MECHANICAL SPECIFICATIONS**

### **DIVISION 20 MECHANICAL**

20 02 00	Operation and Maintenance Manual for Mechanical .....
20 05 00	Common Work Results for Mechanical .....
20 05 19	Piping Specialties for Mechanical .....
20 05 29	Hangers and Supports for Mechanical .....
20 05 30	Sleeves and Seals for Mechanical .....
20 05 48	Vibration and Seismic Controls for Mechanical .....
20 05 90	Underground Utilities Excavation and Fill for Mechanical .....
20 05 93	Testing, Adjusting, Balancing for Mechanical .....
20 07 00	Mechanical Insulation .....
20 08 00	Commissioning of Mechanical Systems .....

### **DIVISION 21 FIRE SUPPRESSION**

21 10 01	Water-Based Fire Suppression Systems .....
----------	--

### **DIVISION 22 PLUMBING**

22 11 00	Facility Water Distribution.....
22 11 23	Domestic Water Pumps .....
22 13 00	Facility Sanitary Sewerage .....
22 16 00	Facility Natural Gas Piping System .....
22 33 00	Domestic Water Heaters .....
22 40 00	Plumbing Fixtures .....

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

23 09 33	Electric and Electronic Control System for HVAC .....
23 09 93	Sequence of Operation for HVAC Controls .....
23 31 00	HVAC Ducts and Casings .....
23 33 00	Duct Accessories .....
23 34 00	Fans .....
23 35 00	Special Exhaust Systems .....
23 37 00	Air Outlets and Inlets .....
23 74 23	Make-Up Air Units .....
23 81 53	Packaged Gas Heat/Electric Cool .....
23 82 46	Electric Heaters .....

## **SECTION 20 02 00 – OPERATION AND MAINTENANCE MANUAL FOR MECHANICAL**

### **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 20 05 00 apply to this Section.

#### **1.2 WORK INCLUDED**

- A. Operation and Maintenance Manual

#### **1.3 SUBMITTALS**

- A. General: Comply with Section 20 05 00 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 (includes fire sprinkler heads, plumbing fixtures, valves, plumbing specialties, equipment, air outlets/inlets, dampers, etc.).
- 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. System wiring diagrams and schematics.
  10. Control sequence descriptions with setpoints and range of adjustments.
  11. Programming logic.
  12. Description of unique devices/controls/programs specific to this system.
  13. Programmers manuals.
- C. Sources: Provide names, addresses, and phone numbers for local manufacturer's representative, service companies, and parts sources for mechanical system components.
- 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 SYSTEM DESCRIPTIONS

- A. General: Provide brief description of the project's mechanical systems to give an overview to Owner's maintenance and facilities staff.
- B. Fire Suppression: Include type of fire suppression systems, system major characteristics, areas served, how system is sub-divided into zones, location of valves, how system is intended to operate, and significant safety or operational aspects.
- C. Plumbing: Include plumbing materials used, locations of main utility connections, how piping systems are routed, valve locations, equipment descriptions, system major characteristics, any special systems, and significant safety or operational aspects.
- D. HVAC Systems: Include type of HVAC system, system major characteristics, equipment used, areas served, how system is sub-divided into zones, how system is intended to operate and system setpoints, and any significant safety or operational aspects

## 2.4 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. This is to be a Contractor prepared listing derived from the manufacturer's operation and maintenance data and practical considerations.

- 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.

## 2.5 REDUCED RECORD DRAWINGS

- A. Reduced As-Built Drawings: Provide reduced as-built construction drawings for fire suppression, plumbing, HVAC, Controls. Drawings' size shall be 11" x 17", except where such size precludes the reading of portions of the drawing, a larger size may be used.

## **PART 3 EXECUTION**

### 3.1 NOT APPLICABLE

END OF SECTION

## **SECTION 20 05 00 – COMMON WORK RESULTS FOR MECHANICAL**

### **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 20, 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 20, 21, 22, 23, 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.
- 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. Comply with code accessibility requirements.
  - 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.

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 20 08 00. 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.

## 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. 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. HVAC ductwork.
  - 3. For any parts of any system which are to be installed differently than as shown on the drawings.
  - 4. Construction revisions to accommodate Substituted Equipment.
  - 5. Other areas/work as noted in the Contract Documents.
  - 6. 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:
    - a. Engineering and shop drawings.
    - b. Rough-in.
    - c. Trim.
  - 5. Plumbing:

- a. Underground.
- b. Aboveground.
- c. Fixtures and Trim.
- 6. HVAC System:
  - a. Equipment.
  - b. HVAC Ductwork and Accessories
- 7. Controls:
  - a. Engineering and shop drawings.
  - b. Rough-in
  - c. Trim.
  - d. Programming
- 8. Balancing.
- 9. Commissioning.
- 10. O&M Manual, Record Data.
- 11. 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. ACAD Record Drawings: Upon completion of the project, the Contractor shall transfer all the data from the field record drawings to electronic drawing files using ACAD \*.dwg format; latest release or next earlier version. Obtain from the Architect/Engineer's office the original electronic drawing files and revise these originals. Prior to incorporating the field record drawing data into ACAD, the

Contractor shall submit and obtain the Architect/Engineer's comments of the field record drawings and incorporate any corrections into the electronic files. Label files "AS-BUILT," along with date and name of Contractor.

- D. ACAD Record Drawings Submittal: Submit 2 CD's, each having ACAD and pdf files of the field record drawings and 3 full size paper plots.
- E. 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 project final acceptance 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.
  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.
- B. **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.

#### 1.12 ENGINEER REVIEWS AND WITNESSING

- A. General: See Division 00 and 01 for scheduling, notification, and additional requirements.
- B. 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.
- C. 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.
- D. Re-Review Fees: The project budget allows for one review by the Engineer for specified reviews. 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.
- B. NFPA 791: Unlabeled Electrical Equipment Evaluation.

### **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 vendor 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. Certification is not required where the AHJ does not require it.

Where field modifications are made to a NRTL certified product, and where required by the AHJ, provide a field evaluation (with a written report) by the NRTL that certified the product to confirm that the product continues to comply with its certification. Due to custom requirements of this project modifications may be required necessitating NRTL field evaluation (see equipment specifications and system requirements).

## 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 2 x 4 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: 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.
  6. Alarms: For EC motors 1 HP and larger provide with integral controls to detect the following failures and to automatically reset motor after failure remedy: phase failure, power failure, low voltage, locked rotor, motor high temperature. Provide with integral controls to detect the following failure with manual reset (by power disconnect): rotor position failure, electronics high temperature.

## 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>
Fire Suppression	Red	White

Potable Water  
Waste/Vent

Green  
Gray

White  
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 Section 23 09 33 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.). Labels

shall include the room names and numbers or area of building served; use final installed room designations.

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.

- G. Concealed Items: 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. The marking system shall consist of a round head screw (approximately 1/4" diameter head). Install screws to ceiling grid below the concealed item. Colors to be used shall be verified with Owner and, unless directed otherwise, shall be:

<u>Item</u>	<u>Color</u>
Fire Protection Component	Red
Domestic Plumbing Component	Green
HVAC System Component	Blue

- G. Concealed Items: 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. The marking system shall consist of printed labels made by a professional labeling machine, black lettering on clear self sticking tape, with minimum 1/2-inch high lettering using Arial font. Apply labels to ceiling grid below concealed item. Labels 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 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 20 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:
1. General: 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.
  2. 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 adjacent to the item. 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.
  3. 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.
  4. Installation Issues: 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.
  5. ADA Accessibility: Locate items which are required to be ADA accessible in accordance with code (including but not limited to IBC, ICC A117.1 and local amendments) for accessibility; verify accessibility requirements with the AHJ.
- 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. 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.
- G. 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.
- H. 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.
- I. 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.
- J. 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.
- K. 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.
- L. 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 Master Painters Institute Standards. 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 20:
  - 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.).
- C. Animal Protection: Mechanical system openings, overhangs, shrouds, coverings, gaps below units, and other elements where animals could enter or occupy shall be protected with screens to prevent animal entry or occupation. Screening shall be installed in a neat professional manner, square to the adjacent construction, and be securely attached with removable fasteners.

### 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.
- B. Personnel: 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. Instruction: 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. 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.

END OF SECTION

## **SECTION 20 05 19 – PIPING SPECIALTIES FOR MECHANICAL**

### **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 20 05 00 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 20 05 00.
- 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 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 20 05 00, Paragraph 2.1, Acceptable Manufacturers.
- B. Thermometers: Trerice, Weiss, Winters.
- C. Pressure Gauges: Trerice, Weiss, Winters.
- D. Strainers: Watts, Keckley, Mueller, Sarco, Taco, Paco, Bell & Gossett, Armstrong, Wilkins.
- E. Unions: Anvil, Nibco, Watts, Epco, 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 - INDUSTRIAL**

- A. Type: 7-inch scale, adjustable angle, red reading mercury, industrial thermometer.
- B. Construction: Aluminum or polyester case, acrylic plastic or heavy glass window, aluminum face, 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 tanks, minimum insertion length is 5". 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: White background with bold black numerals and Fahrenheit degree markings, red reading mercury.
- E. Accuracy: Plus or minus 1% of full scale.
- F. Ranges: Plus or minus 50% of systems normal operating temperature (at point of measurement), with figure intervals approximately 1/20th of range. For systems with multiple operating temperatures wider ranges may be used to allow the same thermometer type through-out the system.

### **2.3 PRESSURE GAUGES**

- A. General: 4-1/2" round dial, stem mounting, black impact resistant phenolic (or fiberglass reinforced polypropylene) flangeless case, white face with black numerals, phosphor bronze bourdon tube rated to minimum 250 psi, brass socket, acrylic window, and 1/4" npt (or 1/2" npt) bottom connection. Shut off cock not allowed (use ball valve). Rated for use with the system pressures and temperatures to be exposed to, but be rated for no less than 250° F. Accuracy

shall be 0.5% per ASME B40, 100 Grade 2A.

- B. Liquid Fill: Gauges used on pumps and where vibration or pulsation are present shall be liquid filled and be provided with a snubber. Liquid fill shall be suitable for ambient temperatures from 0 to 150° F, and for system temperatures to be encountered.
- C. Syphons: Gauges used on steam or steam condensate piping shall have syphons; rated for minimum 500 psi and 400° F.
- D. Pressure Gauge Ranges: 0 to 1.5 times systems normal operating pressure (at point of measurement), with numeral figures on 5 psig for gauges reading to 100 psi, and 10 psig on gauges reading to higher values. 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. 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.

## 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. 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. Hinged lockable steel access door, for mounting on face of wall, with minimum 16 gauge frame and 16 gauge door, concealed hinge, cam and cylinder lock, and anchor straps or anchor frame with mounting holes. Provide Type 304 stainless steel construction with No. 4 finish where used in restrooms, locker rooms, kitchens, and similar "wet" areas. Provide steel construction with prime coated finish in other areas. Door shall have rounded corners, and concealed pivoting rod hinge. 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).
- B. Fire Rating: Door shall maintain fire rating of element installed in; reference drawings for required rating.
- C. Access doors shall all be keyed alike. Provide two (2) keys for each door.

## 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 as indicated. Provide valve in blow-off connection on strainers, valve shall be same size as blow-off tapping.
- D. 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.

- E. 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.
- F. 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.
- G. Test Ports: Install at locations shown on drawings and where needed by Balancer to allow measurements for flow adjustments.
- H. 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.
- I. 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

## **SECTION 20 05 29 – HANGERS AND SUPPORTS FOR MECHANICAL**

### **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 20 05 00 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 20 05 00.
- 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.

#### **1.5 GENERAL REQUIREMENTS**

- A. Seismic: Provide adequate hangers, supports, anchors, and bracing to serve as seismic restraints. Seismic restraints shall comply with Section 20 05 48. Provide seismic restraint calculations and information per Section 20 05 48 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, 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 20 05 00, 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.

- 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).
- B. Identification: Steel pipe hangers and supports shall be stamped with the manufacturer's name, part number, and size.
- C. 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

- D. 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

- E. 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).
- F. 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.
- G. 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 (when required by the Engineer or AHJ).
3. Finish: In finished areas, the portion of fastener exposed to view shall match the exposed finish of item being fastened.

H. 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).

I. Steel: Structural steel per ASTM A 36.

J. 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.

K. 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".

L. 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 pipe 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".

M. 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 <u>In Inches</u>	Insulation Length <u>In Inches</u>	Shield Length <u>In Inches</u>	Minimum** Shield <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).

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. 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 20 05 48.

### 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.
- 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
- 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.

- 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.

### 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 hangar 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 20 05 48; provide anchors and bracing to resist seismic forces.

END OF SECTION

## **SECTION 20 05 30 – SLEEVES AND SEALS FOR MECHANICAL**

### **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 20 05 00 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 20 05 00.
- B. Product Data: Provide product data on all material to be use. Provide MSDS for all sealants, caulks and similar materials.
- C. 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, 3rd Edition.
- H. SMACNA-ARCH: SMACNA Architectural Sheet Metal Manual, 7th Edition.

## 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 20 05 00, Paragraph 2.1, Acceptable Manufacturers.
- B. Firestop Seal Materials: 3M, Dow Corning.
- 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.
- 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. Belowground Type:

- a. Non-Waterstop Type: Fabricated from any of the following: 18 gauge galvanized sheet metal, 22 gauge spiral seam galvanized steel duct, schedule 40 PVC, HDPE thermoplastic or Schedule 40 galvanized steel pipe.
- b. Waterstop Type: Constructed of HDPE thermoplastic or Schedule 40 steel pipe, with waterstop. Waterstop shall consist of 2-inch larger diameter collar, minimum 1/4 inch thick, located on sleeve so as to be centered within the element being penetrated, fully welded (for steel) or bonded/formed (for HDPE) to sleeve. Sleeve shall be suitable for use with "Link-Seal" type seal. Prime paint all surfaces with rust-inhibiting paint.

2. Aboveground Type:

- a. 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.
- b. 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:
  - 1. Aboveground Type: 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.
- E. Flexible Type: Flexible cellular elastomeric insulation, complying with ASTM C 534, Type 1. 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.

## 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. General: Commercially manufactured through-penetration and membrane-penetration firestop systems to prevent the passage of fire, smoke and gases, and to restore the original fire-resistance rating of the barrier penetrated.
- B. Listing: Firestopping shall be listed by UL in "Fire Resistance Directory" (category to match the application), or be qualified by another independent agency acceptable to the AHJ.
- C. Rating: Firestop system and devices shall be tested in accordance with ASTM E 814 or UL 1479, with "F" and "T" ratings as required to maintain the fire-resistance rating of the barrier penetrated, and as required by code.
- D. Fire Hazard: Materials shall have a flame spread of 25 or less, and a smoke development rating of 50 or less; when tested in accordance with ASTM E 84 or UL 723.
- E. Cabling Applications: Firestop systems used with loose electrical cabling shall be the type that allows for removal of the cable or installation of new cables without damage to the firestop system, or the need to replace or repair firestop materials.
- F. Insulation: Firestop system shall be applicable to insulated systems to allow the insulation to run continuous through the firestop system (unless noted otherwise).

## 2.6 NON-FIRESTOP SEALS

- A. Indoor Sealants:
  - 1. Smoke or Sound Sealant Applications: For use where a firestop seal is not required, but smoke or sound seal is required. Single component, elastomeric

or acrylic latex type sealant with STC ratings per ASTM E90. Sealants shall be of the following types, or approved equal:

- a. 3M "Smoke and Sound Sealant SS100".
  - b. Tremco "Tremstop".
2. Other Areas - Dry (Not Normally Exposed to Water/Moisture): Single component, latex sealant complying with requirements of ASTM C834. Sealants shall be of the following types, or approved equal:
- a. Tremco Corporation "Tremflex 834".
  - b. Pecora Corporation "AC-20 Arylic Latex".
  - c. Sonneborn Building Products "Sonolac".

B. Outdoor Sealants:

1. General: Single component, non-sag, low modulus, silicone elastomeric sealant conforming to requirements of ASTM C920, Type S, Grade NS, Class 100/50. Sealant shall be of the following types, or approved equal.
  - a. Dow Corning "790 Silicone Building Sealant".
  - b. Pecora Corporation "890 Silicone".
  - c. Tremco "Spectrem 1".
2. Adjacent to Aluminum: Single component, non-sag, medium modulus, silicone elastomeric sealant conforming to requirements of ASTM C920, Type S, Grade NS, Class 50. Sealant shall be primer-less type for use in joints adjacent to fluoropolymer coatings. Sealants shall be of the following types, or approved equal:
  - a. Dow Corning "795 Silicone Building Sealant".
  - b. GE Silicones, Momentive, SCS2000 and SCS7000.
  - c. Pecora "895 Silicone".
  - d. Tremco "Spectrem 2".

C. Expanding Foam Sealant:

1. General: Single component, polyurethane insulating sealant with flame spread index of 25 or less and smoke development rating of 50 or less. Shall expand and fully cure within 24 hours to a semi-rigid, closed cell, water and air resistant foam. Sealant shall be of the following types, or approved equal.
  - a. DAP "Kwik Foam".
  - b. Fomo Products "Handi-Foam".
  - c. Todol Products "EZ Flo Gun Foam".

- D. Link Seal: Seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening. The seal assembly shall expand when mechanically tightened to provide an absolute water-tight seal between the pipe and wall opening. Sizing shall be per manufacturer's recommendations. Seal shall be Pipeline Seal and Insulator, "Link-Seal" (or approved).

- D. Specialty: Packed fiberglass or wool insulation; with silicone sealant rated for use with temperatures and other conditions encountered.
- F. Grout: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout. Nonshrink; recommended for interior and exterior applications.
  - 1. Design mix shall provide 5000-psi, 28-day compressive strength. Premixed and factory packaged.

## **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, Belowground:
    - a. Belowground on Both Sides of Element Penetrated: Non-structural, belowground, non-waterstop type; except that penetrations of footings shall be structural type.
    - b. Belowground on One Side of Element Penetrated: Structural type.
  - 2. Horizontal, Aboveground:
    - a. Concrete and Masonry Walls: Structural type.
    - b. Other Walls: Non-structural type
  - 3. 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.
  - 4. Vertical, Not Slab on Grade:
    - a. Concrete Floors/Roofs: Structural type.
    - b. Other Floors/Roof: No sleeve required unless needed as part of the seal system or specifically noted to be provided (i.e. for acoustic, thermal, seal retention, or other purposes). Provide clearances around pipe same as a sleeve would provide (see specified sleeve size).
- 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 aboveground:
  - 1. Horizontal, Aboveground:
    - a. Concrete and Masonry Walls: Structural type.
    - b. Other Walls: Non-structural type.
  - 2. Vertical, Slab on Grade: Structural type.
  - 3. Vertical, Other than Slab on Grade:
    - a. Concrete Floors/Roofs: Structural type.
    - b. Other Floors/Roof: No sleeve required unless needed as part of the seal system or specifically noted to be provided (i.e. for acoustic, thermal, seal retention, or other purposes). Provide clearances around pipe same as a sleeve would provide (see specified sleeve size).
- 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 22 40 00.
- E. 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.

- F. 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

## **SECTION 20 05 48 – VIBRATION AND SEISMIC CONTROLS FOR MECHANICAL**

### **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 20 05 00 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 20 05 00.
- 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.
  - 7. This project's building is considered a "non-essential" facility.

#### 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 6th 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, 2nd Edition.
- F. UPC: Uniform Plumbing Code.

## **PART 2 PRODUCTS**

### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Products shall comply with Section 20 05 00, Paragraph 2.1, Acceptable Manufacturers.
- B. Products: Mason, Peabody, Kinetics Noise Control, Vibration Eliminators, VMC Group.
- C. Expansion Devices/Flexible Connectors: Unisource Manufacturing, Twin City Hose, and as specified in Section 20 05 19, 23 21 13, and 23 33 00.

### **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. 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).
- C. 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. Floor Type Spring Isolators: Open spring type with ratio between spring diameter divided by compressed spring height no less than 0.8. A ribbed neoprene acoustical friction pad shall be bonded to the underside of the isolator. Shall have bolted connections for rigid attachment to equipment, configured to allow for equipment leveling by bolt adjustment. Provide with height saving bracket. Mason Series SLF (or approved).
- C. Floor Housed Type:
  - 1. Ductile Iron: Housed spring isolator with ductile iron housing, base plate with mounting holes, spring inspection ports, neoprene cushion, adjustable upward rebound plate. OSHPD pre-approved. Provide with mounting brackets to suit equipment connected to. Mason Series SSLFH (or approved).
  - 2. Welded Steel: Housed spring isolator with welded steel housing, steel base plate with mounting holes, number of springs to suit application, neoprene vertical limit stops, spring bottom neoprene acoustical cups, bottom non-skid neoprene friction pad, and equipment attachment configuration to suit equipment served. OSHPD pre-approved. Provide with mounting brackets to suit equipment connected to. Mason Series SLR or SLRSO (or approved).
- D. 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).
- E. Vibration Isolating Roof Curbs-HVAC Equipment Applications:
  - 1. Curb Mount: 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 1" 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 20 05 29 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 20 05 19.
    - 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 23 33 00.

## 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. In-line pumps.

2. Rooftop curb mounted fans.

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 20 05 29. 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 20 05 29 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

## **SECTION 20 05 90 – UNDERGROUND UTILITIES EXCAVATION AND FILL FOR MECHANICAL**

### **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 20 05 00 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.

#### 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 20 work.
- C. Scheduling: Schedule work to avoid impacts to other trades due to open trenches, dewatering, and other activities.
- D. 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 20 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"

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

## 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 Thickness***</u>	<u>Minimum</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).

## 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 GENERAL BACKFILL MATERIALS

- A. Utility Foundation Backfill: Class A per WSDOT 2014, 9-03.12 (1) A.
- B. 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

- C. Drywell Backfills: Gravel backfill for drywells shall conform to the following gradings:

<u>Sieve Size</u>	<u>Percent Passing (By Weight)</u>
1-1/2" Square	100
1" Square	80-100
3/4" Square	0-20
3/8" Square	0-1.5

- D. 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).
- E. 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).

## 2.6 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>
Fire/Water	Blue
Sewer	Green
Storm	Green
Gas	Yellow
Water	Blue

## **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; 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. 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

## **SECTION 20 05 93 – TESTING, ADJUSTING, BALANCING FOR MECHANICAL**

### **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 20 05 00 apply to this Section.

#### **1.2 WORK INCLUDED**

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

#### **1.3 SUBMITTALS**

- A. General: Comply with Section 20 05 00.
- 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. Test Comm
  - d. Advanced Mechanical Services
  - e. Testing and Commissioning (TAC) Services
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).

#### 1.6 SCOPE OF AIR BALANCING

- A. Balance new AHU for total exhaust and supply airflows indicated. Adjust VFD's and adjust/replace fan sheaves as necessary. Sheaves will be furnished by AHU supplier, and be installed by balancer. Balancer shall return previously used sheaves to AHU supplier.
- B. Measure unit component pressure drops, fan pressure, and fan motor operating characteristics.
- C. Measure heating and cooling performance.
- D. Check overall unit operation in response to thermostat heating/cooling demands.

## **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.
- D. Potable Water: Instruments used in contact with potable water shall be cleaned and disinfected before use with a chlorine solution.

## 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 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.).

### 3.3 WATER BALANCING - PLUMBING

- 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 condition; balancing is to occur before system disinfection but with system in adequate clean condition.
  - 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. Remove air from the circulating system by opening all fixture valves to full flow position allowing system to flow.
  - 6. Check equipment for proper start-up and system operation.
  - 7. Review controls and sequences of operation.
- B. Tolerances: All water flow rates shall be adjusted to within plus 10 percent and minus 10 percent of the values shown in the contract documents (or as determined by the balancer where not indicated).
- C. Domestic Hot Water Systems: Balance domestic hot water system to provide even flow distribution to allow hot water to reach all fixtures. Use only clean instruments on system and perform balance prior to sterilizing of system. Where flow rates are not indicated, proportion pump water flow rate based on the linear footage of system served.
- D. Marking: Upon completion of flow readings and adjustments permanently mark all settings of balancing valves.
- E. 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. Final position of all valves (percent open or setting position on valve).
9. Final position of any speed controls (as percent of full).
10. 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 per Divisions 00 and 01.
- 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

## **SECTION 20 07 00 – MECHANICAL INSULATION**

### **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 20 05 00 apply to this Section.

#### **1.2 WORK INCLUDED**

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

#### **1.3 DEFINITIONS**

- A. R: Thermal resistance of insulation, in units of hr-sf-deg F/Btu.
- B. 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.
- C. 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 20 05 00.
- 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 20 05 29 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 20 05 29.

## 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. NCIS: 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 20 05 00, 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.
- E. Fire Protection Duct Wrap: 3M.

### 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. Rigid Glass Fiber:

1. Type: Rigid board type, constructed of inorganic glass fibers bonded by a thermosetting resin, complying with ASTM C 612, Type 1A and 1B. Johns Manville "800 series Spin-Glas".
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 0.23 Btu-in/hr-sq ft-deg F at 75 deg F.
4. Operating Temperature Limits: 40 deg F to 450 deg F.

C. Corner Angles: 0.016 inch thick aluminum, alloy 3003 or 5005, with factory applied Kraft backing, complying with ASTM B 209.

D. Weather Barrier Mastic: Water based vinyl-acrylic mastic for outdoor weather protection of thermal insulation; fire resistant, UV deterioration resistant. Childers "Vi-cryl" (or approved equal).

E. Glass Fiber Mesh: Open weave glass fiber reinforcing mesh for use with insulation coatings to bridge gaps and add strength to the coating. Minimum 5 strands x 5 strands per square inch. Non-combustible Childers "Chil-Glas" (or approved equal).

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.
3. Metal Jacket: Minimum 0.032-inch thick gauge galvanized steel complying with ASTM A 653; or fabricated of type 304 stainless steel; smooth surface. Provide with longitudinal slip joints and 2-inch laps. Jacketing at fittings shall be of same material, factory formed to suit fitting and insulation.

G. PVC Jacket: UV resistant polyvinyl chloride covering, minimum 20 mil thick, with joints secured and sealed with "Perma-Weld" Adhesive. Johns Manville "Zeston 300" (or approved).

H. Duct Insulation Types:

1. Aboveground-Inside Buildings:
  - a. Exposed-Subject to Damage:
    - 1) Rectangular Ducts: Rigid glass fiber with metal corner angles.

- 2) Round/Oval Ducts: Flexible glass fiber with PVC or metal jacket.
- b. Exposed - Not Subject to Damage: Flexible glass fiber.
- c. Concealed: Flexible glass fiber.
- 2. Aboveground-Outside Buildings:
  - a. Rectangular Duct: Rigid glass fiber with weather barrier mastic coating and steel or aluminum metal jacket.
  - b. Round/Oval Ducts: Flexible glass fiber with weather barrier mastic coating and steel or aluminum metal jacket.
- I. 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.
  - 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. Cellular Glass Insulation:

1. Type: Rigid closed-cell glass insulation, factory formed to match pipe size applied to. Pittsburgh Corning "Foamglas" (or approved).
2. Jacket: Field applied heat sealable water-proof jacketing, consisting of 3 layers of a polyer modified bituminous compound separated by glass fiber reinforcement and aluminum foil. Water vapor permeance shall not exceed 0.00 perms. Pittsburgh Corning "Pittwrap" (or approved).

3. Thermal Conductivity: Shall not exceed 0.29 Btu-in/ hr-sq ft-deg F at 75 deg F.
  4. Operating Temperatures: -450 deg F to 900 deg F.
  5. Compressive Strength: 90 psi.
- D. 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.
- E. 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.
- F. PVC Jacket: Pre-molded 30 mil thick PVC jacket; size and shape to match piping and fittings applied to. Johns Manville "Zeston Series 2000" (or approved). Provide in white color.
- G. 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. Metal and PVC Jacketing: See "Part 3 - Execution".

H. Pipe Insulation Thickness:

1. General: Provide minimum piping insulation thickness indicated, in inches.

INSULATION THICKNESS (INCHES)

Fluid Design Operating Range, deg F	Nominal Pipe Diameter (Inches)				
	<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. 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.
5. 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. Semi-Rigid Glass Fiber:
  - 1. Type: Semi-rigid board insulation, constructed of inorganic glass fibers bonded by a thermosetting resin.
  - 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 0.29 Btu-in/hr-sq ft-deg F at 75 deg F.
  - 4. Operating Temperature Limits: 0 deg F to 650 deg F.
- 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. Corner Angles: 0.016 inch thick aluminum, alloy 3003 or 5005, with factory applied Kraft backing, complying with ASTM B 209.
- 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 NCIS.
  - 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 NCIS 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.
6. Breeching: One layer of 2-inch thick high temperature flexible glass fiber insulation, with an exterior wrap of 1-inch thick flexible glass fiber insulation.

## 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.

## 2.7 FIRE PROTECTION DUCT WRAP

- A. Type: Encapsulated fireproof blanket for use as a zero-clearance to combustible construction and as an alternative to rated shaft enclosure for kitchen grease exhaust ducts and fire rated air ducts. 3M Fire Barrier Duct Wrap 615+ (or

approved equal).

- B. Materials: Inorganic fiber blanket encapsulated with aluminum foil scrim. Melting point shall be no less than 3200 deg F. Material shall be at least 1-1/2 inches thick, and be installed in layers and thickness necessary to provide the required fire resistance rating. Material shall be flexible, easily contoured, to allow wrapping around ductwork.
- C. Listing: Shall be listed and labeled for use as a field applied grease duct enclosure.

## **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 water heaters (except for base on electric water heaters).
6. Electric motors.
7. Fans.
8. Factory insulated or factory lined HVAC, AHU, and AC units.
9. Pumps handling hot water.
10. Relief Valves and associated drain piping.
11. Hose bibbs (except where used as drains hot water systems).
12. Fuel piping.
13. Heating system expansion tanks.
14. Water meter.
15. 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. See Section 23 33 00 for standing seam metal roofing to be applied over the tops of ducts. See drawings for additional requirements.

### 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 20 05 29.
- 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 20 05 30.
- F. Metal Jacketing:
  - 1. Applications: Provide metal jacket over piping insulation for the following:
    - a. Exposed rain leaders in occupied areas; from finished floor and up 8 feet.
    - b. Outdoor exposed piping.
  - 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 NCIS.
- 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.
- F. Jacketing: Provide all equipment insulation with vapor retardant jackets.

### 3.5 ACOUSTIC WRAP

- A. General: Install in accordance with manufacturers written instructions and NCIIIS. 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, fans, and at locations noted on plans.

### 3.6 FIRE PROTECTION DUCT WRAP

- A. General: Install in accordance with manufacturers written instructions and UL listing to provide duct protection equivalent to a 2 hour rated shift enclosure.
- B. Locations: Provide fire protection duct wrap at locations noted on plans and on all ducts serving Type I hoods.

END OF SECTION

## **SECTION 20 08 00 – COMMISSIONING OF MECHANICAL SYSTEMS**

### **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 20 05 00 apply to this Section.

#### **1.2 WORK INCLUDED**

- A. Commissioning of Mechanical Systems
- B. Documentation

#### **1.3 SUBMITTALS**

- A. General: Comply with Section 20 05 00.
- B. Qualifications: Submit qualifications of the firm proposed to perform the commissioning work and for the individuals that will be assigned.
- C. Commissioning Data:
  - 1. Commissioning plan.
  - 2. Commissioning preliminary report.
  - 3. Commissioning final report.

#### **1.4 GENERAL REQUIREMENTS**

- A. General: Commissioning shall be done by a Company which specializes in this work and independent and separate from the Companies installing the systems to be commissioned.
- B. Company Experience: The Company providing the commissioning work shall be experienced in commissioning HVAC control systems, and have commissioned at least five similar projects in the last three years.
- C. Individual Experience: The individuals performing the commissioning work shall have at least five years experience in commissioning, with the individual in the field in charge or the work having commissioned at least five similar projects in the last three years.
- D. Deferred Test: Tests may be deferred to allow for proper climatic or other conditions.

#### **1.5 REFERENCES**

- A. AABC: Associated Air Balance Council.
- B. AEE: Association of Energy Engineers.
- C. BCA: Building Commissioning Association.
- D. NEBB: National Environmental Balancing Bureau.

### **PART 2 PRODUCTS**

## 2.1 NOT APPLICABLE

### **PART 3 EXECUTION**

#### 3.1 GENERAL

- A. General: Provide commissioning as required by code and as specified herein.
- B. Building Occupancy: Building or portions thereof, required by code to be commissioned, shall not be considered ready for occupancy until such time that the Engineer and building official determine that the preliminary commissioning report required by this Section has been completed.

#### 3.2 HVAC SYSTEMS

- A. General: HVAC equipment and HVAC control systems shall be tested to ensure that control devices, components, equipment and systems are calibrated, adjusted and operate in accordance with approved plans and specifications.
- B. Sequences: Sequences of operation shall be functionally tested to ensure they operate in accordance with approved plans and specifications.
- C. Conditions: Testing shall affirm operation during actual or simulated winter and summer design conditions and during full outside air conditions.
- D. HVAC Equipment: Equipment functional performance testing shall demonstrate the installation and operation of components, systems, and system-to-system interfacing relationships in accordance with approved plans and specifications such that operation, function, and maintenance serviceability for each of the commissioned systems is confirmed. Testing shall include all modes and sequence of operation, including under full-load, part-load and the following emergency conditions:
  - 1. All modes as described in the sequence of operation.
  - 2. Redundant or automatic back-up mode.
  - 3. Performance of alarms.
  - 4. Mode of operation upon a loss of power and restoration of power.
- E. HVAC Controls: HVAC control systems shall be tested to document that control devices, components, equipment, and systems are calibrated, adjusted, and operate in accordance with approved plans and specifications. Sequence of operation shall be functionally tested to document they operate in accordance with approved plans and specifications.
- F. Economizers: Air economizers shall undergo a functional test to determine that they operate in accordance with manufacturer's specifications.

#### 3.3 DOCUMENTATION

- A. Format:
  - 1. Hard Copy: Provide reports in 8-1/2 x 11 format, in 3 ring notebooks, with labeled cover and spine, clean legible, and logically organized with table of contents, divider tabs, and names of companies involved in the project, commissioning company name, commissioning personnel, and contact information. Provide 3 copies per Divisions 00 and 01.

2. Electronic: Provide copy in \*.pdf format; submit with closeout documents per Divisions 00 and 01.
- B. Test Plan: Prepare a written commissioning test plan and submit for approval prior to beginning commissioning work. Test plan to include:
1. Equipment and systems to be tested.
  2. Roles and responsibilities of individuals performing the commissioning and of others involved in the project.
  3. Functional test procedures and forms.
  4. Conditions under which the test shall be performed (for example, winter design conditions, full outside air, etc.).
  5. Expected systems' response or acceptance criteria for each procedure.
  6. Time schedule for performance of the work; including any deferred tests.
  7. Forms as required by the WSEC or AHJ.
- C. Preliminary Commissioning Report:
1. General: A preliminary report shall be issued to identify issues preventing the commissioning work from being completed. If all commissioning work can be fully completed and the final report completed, a preliminary report is not required.
  2. Report: Compile all system and commissioning data; including all reviews, inspections, test procedures, and tests. Report shall include field notes of commissioning activities, equipment and system data, test procedures, tests performed, actual results as compared to expected (or specified) results, WSEC and any AHJ required commissioning forms (completed to the extent possible).
  3. Items to Complete: The preliminary report shall identify items needed in order to complete the commissioning, including:
    - a. Deficiencies found during testing required by this Section, which have not been corrected at the time of report preparation.
    - b. Deferred tests which cannot be performed at the time of report preparation due to climatic (or other) conditions.
    - c. Climate (or other) conditions required for performance of the deferred tests, and the anticipated date of each deferred test.
    - d. Proposed schedule for completion of report.
- D. Final Commissioning Report: Complete all commissioning work not previously completed and included in the preliminary report. Provide a complete final report with all systems and commissioning data; including test plan, all reviews, inspections, test procedures, tests, and results. Final report shall include all documentation required for the preliminary report and documentation regarding resolution of previous coded deficiencies.

END OF SECTION

## **SECTION 21 10 00 – WATER-BASED FIRE SUPPRESSION SYSTEMS**

### **PART 1 GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 20 05 00 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. Pre-Installation Conference
- H. Owner Instruction

#### **1.3 QUALITY ASSURANCE**

- A. General: Comply with 20 05 00 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 20 05 00.
- 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.

- 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. All portions of underground fire sprinkler piping shall be installed by a licensed fire sprinkler contractor, or by a level U certified plumbing contractor, as issued by the State's Fire Marshal's office.
- 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. System Description: Wet pipe or dry pipe fire sprinkler system provided for each building with a dry pipe system serving all areas subject to freezing (dry type heads off wet system are acceptable for limited coverage areas). All spaces within sprinklered areas shall be sprinklered as required by the AHJ.

#### 1.6 PRE-INSTALLATION CONFERENCE

- A. General: A pre-installation conference shall be held prior to the Contractor installing any of the materials of this section. The conference shall occur after all submittals have been satisfactorily reviewed by the Architect/Engineer and returned to the Contractor, and approximately 14 days prior to the proposed system installation date and prior to the fabrication of any system piping components. The purpose of this conference is to review the Contractors installation methods, materials, schedule, coordination with all other trades, and related construction/design issues to allow for efficient and proper construction. The Architect/Engineer and Owner will highlight various items of concern, typical problems encountered on similar projects, coordination issues, and related items.
- B. Attendance: The pre-installation conference shall be attended by the General Contractor, the Contractor doing the work of this section, other contractor trades as appropriate to the proper coordination of the work of this section, the Owner's



Representatives (at their option), the Engineer (at his option), and the Architect.

- C. Coordination: The Contractor shall notify the Architect of the Contractor's readiness to hold the pre-installation conference at least 14 days prior to the proposed meeting time, and mutually agreed upon meeting times arranged.

## 1.7 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 20 05 00, 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. Accessories:
  - 1. Wall Indicator Post: Wall mounted hand wheel, with position indicator, locking means, extension rod (length to suit application), and bright red factory enamel paint finish.
  - 2. Indicator Posts: Cast iron construction, with operating wrench, locking means, identification plates indicating valve open/shut, adjustable sleeve, sections to suit varying buried depths, tapped for supervisory device, extension rod, base to match valve used with, and bright red factory enamel paint finish.
  - 3. Automatic Ball Drip Valve: Straight or angle cast brass ball drip, 1/2 inch.
- D. Detector Backflow and Meter: Double check type backflow preventer with weighted clapper for bypassing small flows through meter, AHJ approved type UL listed and FM approved, with tapped bosses for meter connection, galvanized iron body, and complete with meter trim (including isolation valves, union, bypass backflow preventer, and connecting pipe/fittings). Meter shall be a magnetic turbine type meeting AWWA Class 1 standards, AHJ requirements, with register reading up to 10,000,000 gallons and having 1/2-inch connections.
- E. Backflow Preventer: Double check type: AHJ approved type, UL listed and FM approved, OS&Y isolation valves, with replaceable clapper rubbers, four corporation stops for testing, air vents on each check valve, and having galvanized iron check valve bodies and covers. Use compact type as necessary to suit space available as shown on plans.

## 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 FIRE DEPARTMENT CONNECTIONS

- A. Configuration: Wall or free-standing configuration as indicated (or required to suit the application). Wall type shall be flush mounted.

- B. Size and Connections: As required by AHJ.
- C. Construction: Cast brass construction with brass clappers, brass swivel couplings, and brass clapper pins. Clapper design shall allow for one or both inlets to be pressurized during operation. Provide each inlet with threaded brass cap, with pin lugs and chain attachment to FDC. Wall type shall have wall plate.
- D. Labeling: Words "AUTO SPKR" and "FIRE DEPARTMENT CONNECTION" (or as required by the AHJ). Provided added labeling to indicate areas/system served where the service is not readily obvious; and as required by the AHJ.
- E. Finish: Wall type shall have polished brass finish on all outdoor exposed components; free-standing type shall have rough brass finish.

## 2.9 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. Vaults: Shall be precast reinforced concrete type, having galvanized diamond plate lockable access cover(s), suitable for H-20 loading, sized as indicated or as required to accommodate all valves/piping shown (whichever is larger). Provide with concrete base and fully enclosed sides. Provide risers with height and quantity to allow.
- F. Specialties: Access doors, gauges, and related piping specialties; see Section 20 05 19.
- G. Hangers/Supports: See Section 20 05 29.
- H. Sleeves Seals: See Section 20 05 30.
- I. 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.
- J. 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.
- K. Labeling:
1. General: See Section 20 05 00 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.
- L. 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.
  2. FDC: Metal construction, with lettering type, information, and construction as required by the AHJ. Provide with accessories for mounting; fasteners and items exposed to weather shall be UV and corrosion resistant.

## **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 Supply: The fire sprinkler system shall be connected to the site water supply as indicated on the drawings. All underground site work related to the fire sprinkler system shall be reviewed by the Contractor doing the work of this Section, to verify that the installed piping conforms to acceptable professional practices and governing code. The Contractor doing the work of this section by virtue of connecting to this site piping is certifying that this site piping has been reviewed and is acceptable for connection to.

- C. 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.
- D. 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 20 05 00 for cutting requirements; structural Engineers approval is required prior to any such cutting or drilling.
- E. Escutcheons: Provide chrome plated escutcheon plates at exposed pipe penetrations of all ceilings, floors and walls.
- F. 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.
- G. 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.
- H. Fire Department Connections (FDC): Locate as approved by the AHJ and agreed to by the Architect/Engineer. Locations shown on drawings are preliminary only. Include in bid an additional 50 linear feet of FDC piping and two elbows to allow for an alternate location. Paint free standing FDC's (and the exposed connecting pipe) bright red (unless another color is required by the AHJ).
- I. 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.

- J. Labeling: Provide labeling of items per Section 20 05 00. 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 20 05 00.
- K. 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.
- L. 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.
- M. 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".
- N. 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).
- O. Hangers and Supports: Shall comply with NFPA 13 and Section 20 05 29. See also structural drawings for added limitations/requirements of supports and attachments to structure.
- P. 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 20.
- 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



## **SECTION 22 11 00 – FACILITY WATER DISTRIBUTION**

### **PART 1 GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 20 05 00 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. Domestic Water Expansion Tanks
- H. Water Service Connections
- I. Testing and Inspection
- J. 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 20 05 00.
- 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 20 05 00, 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. Pressure Reducing Valves: Conbraco/Apollo, Watts, Cla-Val, Bell & Gossett, Zurn/Wilkins.
- E. Thermostatic Mixing Valves: MCC Powers, Leonard, Symmons.
- F. Backflow Preventers: Conbraco/Apollo, Febco, Watts, Ames, Zurn/Wilkins.
- G. 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. Galvanized Steel Pipe and Fittings:
  - 1. Pipe: Seamless hot-dip galvanized steel pipe, per ASTM A 53, Type E, Grade B. Schedule 40 unless indicated otherwise.
  - 2. Fittings: Galvanized, malleable-iron, threaded, per ASME B16.3.
- C. 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.

## 2.3 PIPE AND FITTINGS - APPLICATIONS

- A. Domestic Water Piping - Above Ground: Type L or K copper with with soldered or flanged joints.
- 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. Trap Primer Piping: Type L or K "soft" or "hard" (bending temper) copper, with compression fittings or soldered joints.

## 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. 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).
- C. 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).
- D. 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 LFU5B (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).
- E. Thermostatic Mixing Valves - Master Mixing:
1. Type: Hot and cold water thermostatic mixing valve, thermostatic type, Powers “Hydroguard XP” Series (or approved).
  2. Construction: Lead free brass (or bronze) body construction with union inlets, combination strainer check-stops, piping connection arrangement to suit application and as indicated. Rated for 125 psi at 200 deg F.
  3. Listing: ASSE 1017 and CSA B125.
  4. Range: Adjustable from 90° F to 160° F, with an approach temperature of 5 deg F. Setting shall be lockable. For use with hot water from 120 to 180 deg F; and cold water from 40 to 80 deg F.
  5. Size: Valve shall be sized by manufacturer to handle indicated gpm with maximum 10 psi pressure drop (unless noted otherwise). Where gpm is not indicated, use following gpm’s according to tempered (i.e. mixed) water line size shown connecting to valve:

<u>Line Size</u>	<u>Maximum gpm</u>
1/2"	7
3/4"	11
1"	20

1-1/4"	34
1-1/2"	55

6. Finish: Rough brass.

- F. Thermostatic Mixing Valves - Individual Fixtures (1 to 2): Hot and cold water thermostatic mixing valve for serving 1 to 2 fixtures. Brass construction, with stainless steel internals, integral checks and locking nut to prevent unauthorized adjustment. Adjustable from 90 to 110 degrees F, with accuracy in accordance with ASSE 1016. Valve shall have capacity of at least 2 gpm at 20 psi differential, and control down to 0.5 gpm. MCC Powers "Hydroguard Series 480" (or approved).
- G. Thermostatic Mixing Valves - Individual Fixtures (3 to 6): Hot and cold water thermostatic mixing valve for serving 3 to 6 fixtures. Brass construction, with stainless steel internals, integral checks and temperature adjustment knob with locking feature to prevent unauthorized adjustment. Adjustable from 85 to 120 degrees F, with accuracy in accordance with ASSE 1017. Valve shall have capacity of at least 8 gpm at 20 psi differential, and control down to 0.5 gpm. MCC Powers "Hydroguard Series 490" (or approved).
- H. 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:
  - 1. 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. Water Flow Type: Activated by flow of water in line through the trap primer valve. Brass construction with integral air-gap backflow preventor, stainless steel screen, delivering 0.84 ounces of water at 20 psi with 5 seconds of water flow. Precision Plumbing Products "Prime-Pro" (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).

## 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 20 05 00. 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 20 05 00.
- 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 and 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.

### 3.3 VALVES

- A. Type: Ball type only.
- 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. 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.
- 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 20 05 19 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. 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 20 05 30 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

## **SECTION 22 11 23 – DOMESTIC WATER PUMPS**

### **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 20 05 00 apply to this Section.

#### **1.2 WORK INCLUDED**

- A. Wet Rotor Circulators

#### **1.3 SUBMITTALS**

- A. General: All submittals shall comply with Section 20 05 00.
- 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 20 05 00 prior to ordering materials.

### **PART 2 PRODUCTS**

#### **2.1 ACCEPTABLE MANUFACTURERS**

- A. Products shall comply with Section 20 05 00, 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. RPM: Pumps and motors shall operate at maximum of 1750 rpm unless indicated otherwise.
- C. Pump Capacity: Shall be no less than the values listed on the Mechanical Equipment Schedule on the drawings.
- D. 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.
- E. Motors: Shall comply with Section 20 05 00. 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.

- F. Domestic Water Applications: Pumps used on domestic water systems shall be of all-bronze construction, and NSF certified for domestic water use.
- G. Testing: All pumps shall be factory tested per the Hydraulic Institute standards and be thoroughly cleaned.
- H. Finish: Pumps shall have minimum one coat high grade machinery enamel finish, factory applied, manufacturer's standard color.
- I. Nameplate: Pumps shall have stamped metal nameplates identifying: manufacturer, model number, capacity (gpm and head), and date of manufacturer.

## 2.3 WET ROTOR 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

## **SECTION 22 13 00 – FACILITY SANITARY SEWERAGE**

### **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 20 05 00 apply to this Section.

#### **1.2 WORK INCLUDED**

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

#### **1.3 SUBMITTALS**

- A. General: Submittals shall comply with Section 20 05 00.
- 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. ASTM F 1412: Polyolefin Pipe and Fittings for Corrosive Waste Drainage Systems.
- GG. AWWA C509: Resilient-Seated Gate Valves for Water Supply Service.
- HH. AWWA C515: Standard for Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.
- II. CISPI 301: Hubless Iron Soil Pipe and Fittings for Sanitary and Drain, Waste, and Vent Piping Applications.
- JJ. 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 20 05 00, 2.1, Acceptable Manufacturers.

- B. Pipe and Fittings: Mueller, Cerro, Tyler, Charlotte Pipe and Foundry, AB & I Foundry, Spears Manufacturing, Cresline Northwest.
- C. Pipe and Fittings - Acid Resistant Applications: Enfield, Orion, Georg Fisher.
- D. No Hub Couplings: ANACO, Mission Rubber, Tyler, MG Coupling, Fernco, Clamp-All, Mifab.
- E. Cleanouts: Josam, Zurn, J.R. Smith, Wade.

## 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.

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 degree F. shall be no-hub cast iron, bell and spigot cast iron, or copper (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.
  6. No-Hub Couplings: Couplings on below ground piping shall be the heavy duty type.
- B. Cooling Condensate Drains: Copper DWV, copper, PVC DWV, or PVC.
- C. Miscellaneous Drains: Copper DWV, copper, PVC DWV, or PVC; except that for corrosive fluids (or corrosive fluid venting).

## 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.
- 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 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.
- B. PVC and ABS Expansion Coupling: Coupling constructed of PVC and rubber for use in PVC and ABS piping to accommodate up to 0.75-inch expansion/contraction; held in place with stainless steel bands; shall comply with ICC and IAPMO standards. ProVent "Ez Flex".
- C. Vent Caps: Galvanized cast iron vandal proof vent cap, with concealed allen key set screw. J.R. Smith Figure 1748 (or approved).

## **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 20 05 00. 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 20 05 00.
- 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. Expansion/Contraction: Provide offsets and expansion couplings to accommodate system expansion/contraction and for changes in building due to building shrinkage or other shifts. For wood framed construction of four stories or more; provide expansion couplings at each floor in waste and vent pipe risers.

### 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 provided extensions to floors above or to walls to allow access. Provide wall access covers or access doors for all wall cleanouts. See Section 20 05 19 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 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

## **SECTION 22 16 00 – FACILITY NATURAL GAS PIPING SYSTEM**

### **PART 1 GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 20 05 00 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: Provide submittals in accordance with Section 20 05 00.
- 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 20 05 00. See Section 20 05 00, paragraph 2.1 for Acceptable Manufacturer requirements.
- B. Pipe and Fittings: US Steel, Anvil International, Wheatland Tube, Weldbend, Exltube.
- C. Pipe and Fittings - Belowground: Performance Pipe, KWH Pipe, Perfection Corporation, Continental Industries.
- D. Valves: Milwaukee, Flowserve (Nordstrom), Stockham, Conbraco/Apollo, Nibco, Resun, ASCO.
- E. Regulators: Fisher, American Meter, Equimeter.
- F. Vent Caps: Clay & Bailey, OPW, Morrison, Beckett.

## 2.2 PIPE AND FITTINGS - ABOVEGROUND

- A. Pipe: Black steel pipe conforming to ASTM A 53, Grade A or 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.

## 2.4 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. 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.

## 2.5 ACCESSORIES

- A. Piping Specialties: See Section 20 05 19.
- 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 20 05 19. 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 20 05 00. 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 all equipment 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 or 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. 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.
  - G. Unions: Install unions in pipe connections to equipment and other items where it may be necessary to disconnect the item from piping for repairs or maintenance; and as indicated. Where flanged connections occur at equipment additional unions are not required unless indicated otherwise.
  - H. Equipment 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.
  - I. Regulators: Provide drip legs with removable caps upstream of all regulators; provide test tee with capped valve 10 pipe diameter downstream of all regulators.
  - 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.
  - K. Provide flexible connectors at crossing of building seismic or expansion joints. Install in a manner to allow for 1-inch movement in any direction.
  - L. Vents: Pipe regulator vent lines and all equipment gas train vents full size to outside of building; terminate with vent cap.
  - M. 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).

### 3.3 VALVES AND ACCESSORIES

- A. Type: Ball type; except that valves 3 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.

### 3.4 GAS SERVICE

- A. Service Application: Coordinate with gas utility for gas service to building. Contact gas utility and complete all required service application forms and documentation. Coordinate with Owner for any required signatures or service agreement authority. Coordinate scheduling with the utility for timely service to allow proper equipment start-up and to comply with overall project schedule.
- B. Gas Meter: Coordinate proper gas meter location with gas utility; location shown on plans is preliminary. Provide connection to outside utility gas meter, and gas piping from meter, up to and completely connected, to all equipment.
- C. Service Charges: Owner will pay direct to the utility all utility charges for gas service to the building.

### 3.5 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

## **SECTION 22 33 00 – DOMESTIC WATER HEATERS**

### **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 20 05 00 apply to this Section.

#### **1.2 WORK INCLUDED**

- A. Water Heaters
- B. Storage Tanks
- C. 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 20 05 00 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 20 05 00, Paragraph 2.1, Acceptable Manufacturers.
- B. Water Heaters – Tank Type: A. O. Smith, Rheem, Bradford-White, State, PVI.

- C. Water Heaters – Electric Instantaneous: Chronomite, Stiebel Eltron.

## 2.2 WATER HEATERS – ELECTRIC INSTANTANEOUS

- A. Type: Electric, point-of-use instantaneous type heater.
- B. Construction: Stainless steel or nichrome heating elements, celcon or copper or stainless steel waterways, with plastic (or steel) enclosure. Unit shall be UL listed and meet all applicable codes.
- C. Capacity: Shall have capacity as indicated on the plans. Unit shall be for use with 110 deg F outlet temperature (unless noted otherwise), flow rates from 0.5 to 3.0 gpm, and operate with as low as 25 psig inlet water pressure.

## 2.3 WATER HEATERS – GAS FIRED TANK TYPE

- A. Type: High efficiency condensing natural gas fired domestic hot water heater, ASME labeled. A.O. Smith "Cyclone" (or approved).
- 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. 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.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- A. General: Comply with Section 20 05 00. 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 20 05 00. 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

## **SECTION 22 40 00 – PLUMBING FIXTURES**

### **PART 1 GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 00 and Division 01 Specification Sections, apply to this Section.
- B. Requirements of Section 20 05 00 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 20 05 00.
- 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 20 05 00 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 20 05 00, 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.

F. Hand Wash Sinks: Eagle.

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.
- K. Floor Drains and Floor Receptors: J.R. Smith; Zurn; Josam; Mifab.
- L. Plumbing Brass: McGuire; American Standard; Brasscraft; Dearborn Brass; Chicago Faucet; Crane; Eljer; Frost; Kohler; Speakman; Symmons; T & S Brass; Elkay.
- M. Faucets: Chicago Faucet (no substitutions).
- N. Stops: McGuire; Brasscraft; ProFlo.
- O. Flush Valves: Sloan, Zurn, Toto.
- P. Hot Water Temperature Limiting Valve: Symmons, Watts, Chicago Faucet, Acorn Controls, Leonard, Cash Acme.

## 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-1C Water Closet – Floor mount - Tank Type - Accessible:

Watercloset: Kohler "Barrington" No. K-3578, vitreous china, elongated bowl, floor mounted, with 1-1/2" top spud, and 1.0 gallon flush.

Seat: Kohler "Lustra" No. K-4650 white plastic elongated seat, open-front and stainless steel self-sustaining check hinges.

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, 0.125 gallon flush, and beehive strainer.

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

ADA: Configure and install for ADA access. Verify with Architectural drawings for mounting heights and off center stall dimensions. Provide special carries as required.

P-2B Urinal - Wall Hung - Accessible:

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

D. Lavatories:

P-3A Lavatory – Countertop - ADA:

Lavatory: Kohler "Farmington", No. K-2905-4 19-1/4" x 16-1/4", cast iron, self-rimming oval lavatory with 4" faucet centers and integral overflow.

Plumbing Brass: Kohler No. K-7715 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. 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. 897-RCF 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.

G. Water Dispensers:

P-7A Valve 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 BIM 875.

H. 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.

I. 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.

J. 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 boilers leave grate off (turn over to Owner).

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 20 05 29 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. Shall be capable of supporting 500 lb load test per ANSI A112.19.2; Provide with rear anchoring lug on single units to comply. 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, cast brass slip nuts, size as required by Uniform Plumbing Code (unless a larger size is indicated), and configured to suit the application. Provide with cleanout where indicated or required by code.
- 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 type, chrome plated, UPC compliant, with low lead brass body, rated for minimum 125 psi operating pressure and temperature of water used with plus 20 deg F. Size and configuration to suit application. Provide with loose key where installed in areas with public access.
- E. Risers: Flexible braided steel type; rated for 125 psig.
- F. Escutcheons: See Section 20 05 19.
- 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 or Symmons "Maxline" Model 5-210.
- I. Sealant: See Section 20 05 30. Sealant at fixtures shall be the silicone type, color to match fixture.
- J. Refrigerator Valve Box: Guy Gray Model BIM875 stainless steel rough-in box with angle valve (1/2-inch inlet, 1/4-inch compression outlet).

## 2.5 FOOD SERVICE ITEMS & 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 20, 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, hand wash sinks, bathtubs, showers, whirlpools, bidets and at 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 20, 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 shall 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.

END OF SECTION

## **SECTION 23 09 33 – ELECTRIC AND ELECTRONIC CONTROL SYSTEM FOR HVAC**

### **PART 1 GENERAL**

#### **1.01 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 20 05 00 apply to this Section.

#### **1.02 WORK INCLUDED**

- A. Control System Design.
- B. Control System for Building Heating, Ventilation, Air Conditioning, Exhaust.
- C. Control Devices, Components, and Wiring.
- D. Testing, Adjustment, and Commissioning.
- E. Owner Training.

#### **1.03 SUBMITTALS**

- A. General: Shall comply with Section 20 05 00.
- B. Product Data: Submit product information on all items to be used.
- C. Shop Drawings: Submit a complete set of shop drawings prior to installation containing the following information: interconnect drawings showing all wiring and control connections; control panel details; arrangement of devices in panels; schedule of dampers with sizes and where used; sequence of operation for all equipment; location of all control devices on scaled building plans; and list of actuators with sizes and where used.
- D. Labeling: Submit list of proposed component labeling.
- E. Operation and Maintenance Manuals: See Section 20 02 00. In addition to the information required by that Section and Division 01, provide (for inclusion in the Manual) the following:
  - 1. System description.
  - 2. Complete sequence of operation.
  - 3. Reduced size (11" x 17") copies of record drawings.
  - 4. Submittal data on all products.
- F. Commissioning Plan and Report: See Section 20 08 00. Provide commissioning plan; including a checklist of control items to be reviewed and method of testing sequence of operation. Submit final report documenting tests performed and results.

#### **1.04 GENERAL REQUIREMENTS**

- A. Design and Installation: The entire control system shall be designed and installed by skilled control system designers, electricians and mechanics, all of whom are properly trained and qualified for the work they perform.



- B. Sole Responsibility: One single Contractor shall be responsible to design, furnish and install the complete Section 23 09 33 control system.
- C. Sequence: System shall have sequence of operation as specified in Section 23 09 93.

#### 1.05 WARRANTY

- A. Warranty: After completion of the installation of the control system and acceptance by the Owner, the system shall be warranted as free against defects in manufacturing, workmanship and materials for a period of two years from date of substantial completion. In addition, the system shall be warranted to provide the sequence of operation and basic features specified, with the accuracy and flexibility also specified. The system shall be repaired or replaced, including materials and labor, if in Owner's and Engineer's reasonable opinion, system is other than as warranted.

### **PART 2 PRODUCTS**

#### 2.01 ACCEPTABLE MANUFACTURERS

- A. Products shall comply with Section 20 05 00, Acceptable Manufacturers.
- B. Thermostats and Time Clocks (Non DDC): Honeywell, Paragon.
- C. Actuators: Belimo, Honeywell, Siemens, Johnson Controls.
- D. Dampers: Ruskin, Greenheck.
- E. Carbon Dioxide Sensors: Honeywell, Vaisla.
- F. Control Accessories: Idec, Hoffman, McDonnell, Tridelta, Edwards, Mamac, Penn, Belimo, Honeywell, Johnson Controls, Leviton, Arrow-Hart, Alerton.

#### 2.02 BASIC SYSTEM

- A. System Type: The system shall be an electronic or electric type. No form of DDC or computer based type of controls shall used.

#### 2.03 THERMOSTAT AND TIMECLOCK (NON DDC)

- A. Programmable Thermostat: Shall be 7-day programmable solid state type, specifically designed for commercial use. Unit (and related relay module, and controls) shall allow for 1st-stage economizer cooling, 2nd stage unit cooling, 1<sup>st</sup> stage heating, 2<sup>nd</sup> stage heating and provide other features as required by the sequence of operation. Thermostat shall have means to bypass time clock, have Auto-Cool-Off-Heat switching, setpoint adjustments, and time/day adjustments. Unit shall also have capability for averaging multiple remote thermostat sensors. Honeywell T7351 Series, other Honeywell series (as required to provide sequence and match unit furnished), or approved.
- B. Thermostat Sensor: Remote temperature sensor for use with programmable thermostat, specifically designed for commercial use. Unit shall have space temperature sensor, unoccupied mode pushbutton override with LED, and temperature setpoint adjustment. Honeywell T7771 Series, or approved.
- C. Logic module: Solid state control package to provide economizer functions. Shall include logic module, sensors, and accessories necessary to provide a

complete and operational system, and shall be compatible for use with specified HVAC equipment and programmable thermostat.

- D. Accessories: Provide duct temperature sensors required for mixed air applications; shall be the averaging type with a sensor element type so as to sense a representative sample of the medium being controlled. Provide sensors as required to work with economizer controls.
- E. General Time Clock: 365 day programmable timeclock, for control of up to four independent loads each with a different schedule, with 50 setpoints of programming. Each output able to be programmed as a maintained or momentary contact closure with duration of 1 to 59 seconds. Features shall include: Time of day scheduling, holiday programming, daylight savings time adjustment, leap year correction, manual override, and battery back-up (for one month operation without power). Unit shall have a NEMA 1 enclosure. Paragon EL74 (or approved).

#### 2.04 CONTROL DAMPERS

- A. Type: Dampers shall be parallel blade or opposed blade type, as selected by contractor to best suit application (unless a specific type is indicated).
- B. Leakage: Class 1A leakage rated in accordance with AMCA 511 (or better, as required by Code).
- 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). All materials in contact with the airstream shall be suitable for the conditions without deterioration. Provide special coatings as necessary to provide corrosion resistance. Frame shall be minimum 16 gauge.
- D. Blades: Single blade type, not exceeding 6 inches in width, 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).

#### 2.05 ACTUATORS

- A. Type: Actuators shall be a brushless DC motor type controlled by a microprocessor.
- B. Operation: Shall be compatible with control devices used with to provide specified sequence and system features. Run time shall be constant, independent of torque. Actuator shall have manual positioning mechanism and control direction of rotation switch accessible on its cover. Provide with auxiliary switches as required for sequence of operation. Actuator shall be proportional or two position type, as required for application.
- B. Sizing: Provide actuator with sufficient power and torque to suit items being controlled and allow proper operation against system pressures liable to be encountered. Actuator shall be capable of driving controlled items from full closed to full open in less than 15 seconds.

- C. Spring Return: All actuators shall spring return upon power interruption: The spring return position shall be a "fail safe" position as dictated by freeze, fire, temperature protection, energy saving, or safe operating requirements. Outside air dampers shall spring return closed; return air dampers shall spring return open. VAV terminal units and zone dampers do not require spring return actuators.
- D. Accessories: Units shall be complete with all linkages, brackets, and hardware required for mounting and to allow for proper control and operation.

## 2.06 SWITCHES

- A. Air Flow Switches: General Purpose utilizing differential air pressure, SPDT snap-acting contacts, adjustable range to suit application, neoprene diaphragm, all aluminum construction.
- B. Bypass Switch: Shall be momentary contact type push button. Install in standard wall box with stainless steel cover.
- C. Wall On/Off Switch: Standard wall box type switch, single or double pole, and contact type as required to suit application; with illuminated switch for when controlled item is on; volt/ampere ratings to suit application. Provide with stainless steel wall plate; label as to function.

## 2.07 CARBON DIOXIDE SENSOR – WALL

- A. Type: Wall mounted non-dispersive infrared (NDIR) type carbon dioxide sensor. Honeywell C7232A Series (or approved).
- B. Performance: Measuring range 0 to 2000 ppm CO<sub>2</sub>, accuracy plus or minus 5% 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. Display: LCD display showing measured CO<sub>2</sub> levels.
- D. Housing: ABS molded plastic housing, color white, with vent openings.
- E. Output: Shall provide 4 to 20 mA, and 0 to 10 Vdc outputs, selectable by output selection jumpers and SPST normally open relay output.

## 2.08 PRESSURE SENSOR/TRANSMITTERS

- A. 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.
- B. 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. Air velocity devices on inlet of air terminal units shall be furnished with units. 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.

## 2.09 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:
  - a. Start-stop speed selection.
  - b. Manual speed potentiometer.
  - c. Input fuses.
  - d. Insensitive to incoming power phase sequence.
  - e. Adjustable volts/Hertz.
  - f. 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.
  - g. Three-phase output voltage regulated to + 1% of rated voltage with +10% to -5% variations in plant power.
  - h. Standard off-the-shelf, NEMA B and synchronous motors (3600, 1800, 1200 rpm) usable without derating controller.
  - i. Automatic shutoff under output short circuit conditions or when load current exceeds 150% of maximum output amps (RMS).
  - j. Input fuses.
  - k. Line transient protection to prevent power line transients from harming the controller.
  - l. Relay contact to provide external signal for alarm and run condition.\*
  - m. Monitor lamps (or LCD display) indicating: power on, zero speed, enabled, unit failure (with type indicated).
  - n. Hand-Off-Auto switch.
  - o. Auto restart after power outage.
  - p. 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.
  - q. Input Disconnect (meeting NEC requirements for unit power disconnect).
  - r. Output Contactor - for positive motor disconnect.
  - s. Output Overloads - using individual phase bimetallic thermal sensors.
  - t. Ammeter - ampere scale depending upon drive rating.\*
  - u. Voltmeter - 0 to 500 volt (460 volt drives); 0 to 750 volts (575 volt drives).\*
  - v. Frequency Meter - 0 to 120 Hz scale.
  - w. 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.

## 2.10 ACCESSORIES

- A. Wiring and Conduit: Shall comply with Division 26 specifications and with code. Wiring that performs code required life safety shutdown of equipment or fire alarm interface shall comply with NFPA standards and local codes for fire alarm system wiring.
- B. Control Cabinet: Wall mounted, NEMA construction type to suit application, minimum 14 gauge sheet metal, hinged front door with latch. Size as required to house controls.
- C. Relays: Shall be rated for the application, with a minimum of two sets of Form C contacts, enclosed in a dust-proof enclosure. Relays shall have Hand-Off-Auto switch, and LED's (or pilot lights) to indicate the energized mode. Relays shall be rated for a minimum life of one million cycles. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less. Relays should be equipped with coil transient suppression devices to limit transients to 150% of rated coil voltage. Contact rating, and configuration selected to suit application.
- D. Duct Smoke Detector: Ionization or photoelectric type, with sampling tube (sized to match duct used on) 2 sets from C contacts rated at 10 amps (115 VAC) and 1 set from A contacts rated at 2 amps (30 VDC), and trouble contacts. For use with 115 VAC power. Suitable for temperatures 32 deg F to 140 deg F, and duct velocities up to 4,000 feet per minute. Unit shall be complete with plastic housing, clear plastic cover, gaskets, mounting hardware, visual indication of power and alarm, test/reset switch, and all accessories for proper operation. UL listed and complying with applicable codes and standards.
- E. Miscellaneous Components/Sensors/Transmitters/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.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. General: Provide all devices, sensors, relays, switches, dampers, actuators, conduit, tubing, wiring, motor starters and all other devices required to provide a complete integrated control system with the sequence of operation and features as specified. It is the Contractor's responsibility to coordinate with other trades for the installation of control devices in systems installed by others.
- B. Installation: Install all control components in accordance with manufacturer's instructions and recommendations and best professional practices.
- C. Coordination: Coordinate work with other trades to ensure that all trades have the information necessary so that they may properly install any necessary control components, interconnect with control components, and install their work to accommodate controls. Identify all items requiring ceiling or wall access doors (or other special requirements) to trade installing access doors or performing related work.

- D. Space Requirements and Locations: Carefully check space requirements and coordinate with other trades to ensure that items can be installed in the allotted spaces, including above finished suspended ceilings. Adjust locations of panels, equipment, devices, and the like, to accommodate work and prevent interferences. Determine the exact route and location of wiring, conduit and other control devices prior to beginning work.
- E. Mounting: Mount controls adjacent to associated equipment on vibration free elements on free standing fabricated supports; mount and locate for best access.
- F. Control Cabinets: All electrical devices, relays, and components shall be installed in protective covers (i.e. control cabinets), except where installed concealed above ceilings a cover is not required. Controls/devices shall be logically assembled in cabinet, with all devices and cabinet labeled.
- G. Thermostats: Room thermostats shall be mounted 4'-0" above finished floor unless indicated otherwise. Thermostats shall connect to the HVAC unit serving the space the thermostat is located in, unless indicated otherwise. Not all thermostats are shown on the drawings and those shown are preliminary only. Contractor shall indicate all final thermostat locations on submittal drawings. Contractor is responsible to coordinate locations to avoid tackboards, casework, and other interferences.
- H. Power: It shall be the responsibility of this Contractor to provide power for all control devices requiring power. Coordinate with the Division 26 Contractor to arrange for necessary power circuits. All control devices shall obtain power from circuits dedicated to control power.
- I. Wiring, Conduit and Electrical:
  - 1. General: Provide all electrical wiring and devices in accordance with applicable codes and Division 26 requirements.
  - 2. Conduit: All wiring shall be installed in conduit and in accordance with Division 26 specifications, except that low voltage wiring within ceiling plenum spaces, mechanical mezzanines, and attics may be installed without conduit. Wiring in walls shall be in conduit.
  - 3. Wire Labeling: Label or code wiring at each end to show location of the opposite end. Each point of all field terminal strips shall be permanently labeled or coded to show the instrument of item served. Color coded cable with cable diagrams may be used to accomplish cable identification and terminal strip.
  - 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.
  - 5. Workmanship: Install all conduit and wiring parallel to building lines, in neat bundles, supported at not less than 5 foot intervals.
- J. Component Labeling: All control components, except regular room thermostats, shall be equipped with name plates to identify each control component. Components in finished rooms shall be labeled as to generic item controlled for better user understanding; other devices shall be labeled with the same

designation which appears on the Control Diagrams. Contractor shall submit list of proposed labeling prior to installing. Reference Section 20 05 00.

- K. Thermostat Setpoints: Thermostat Setpoints (all adjustable) shall be 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

- L. Motor Starters: Shall be by Division 26; except for loads 1/2 hp and less which shall be by this Section.
- M. Device Duct Installation: All control devices installed in ductwork shall be positively anchored and attached to the ductwork by mechanical means (fasteners, straps, unistrut, etc).
- N. Miscellaneous Controls: Provide all miscellaneous control items as noted in the Contract Documents. Provide all necessary control wiring between items for proper control.

#### 3.04 OWNER INSTRUCTION

- A. Owner Instruction: Provide instruction to Owner on the operation and maintenance of the control system. Provide field demonstrations and show Owner the locations of all control devices; explain and demonstrate how system adjustments are made; explain and demonstrate system sequences of operation.

END OF SECTION

## **SECTION 23 09 93 – SEQUENCE OF OPERATION FOR HVAC CONTROLS**

### **PART 1 GENERAL**

#### **1.01 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 20 05 00 apply to this Section.

#### **1.02 WORK INCLUDED**

- A. Sequence of Operation

#### **1.03 SUBMITTALS**

- A. General: Shall comply with Section 20 05 00.
- B. Sequence: Submit complete description of sequence of operation. Sequence submitted shall not be a direct copy of the sequence specified herein, but shall be written to reflect the actual control sequence provided.
- C. Shop Drawings: Provide complete control system shop drawings; see Section 23 09 33.

### **PART 2 PRODUCTS**

#### **2.1 NOT APPLICABLE**

### **PART 3 EXECUTION**

#### **3.01 GENERAL**

- A. General: Provide complete control system with sequences of operation as specified. All mechanical equipment shall be automatically controlled by the Division 23 control system, unless specifically indicated otherwise. Where no sequence of operation is indicated submit a proposed sequence for Engineer review; such sequences shall match the intended equipment use, code, and ASHRAE standards for the type of equipment and application.
- B. Time Control: Control system shall provide time schedule control (i.e. occupied/unoccupied/ warm-up modes switching) for all mechanical equipment. Provide independent occupied/unoccupied schedules and optimum start (i.e. warm-up) cycle for each HVAC units (unless noted otherwise), all fans having time schedule, and all heaters. Except that exhaust fans serving adjacent restroom areas may share time schedules.
- C. Warm-up Control: Control system shall provide warm-up switching for all HVAC units and items indicated as having a warm-up cycle.
- D. Adjustability: All temperature setpoints and time control settings shall be adjustable.
- E. Thermostats: Various thermostats are not shown on the drawings but are required per the sequence of operation specified. Coordinate with Engineer for



location of all such thermostats prior to installing. Indicate proposed locations on submittals.

- F. Average Thermostats: Where average thermostats are indicated on plans combine and average temperature requirements from each sensor and use average requirements to control equipment.
- G. Miscellaneous Items: See plans for units with motorized dampers in the ducts and miscellaneous other items requiring control.

### 3.02 PACKAGED GAS HEAT/ELECTRIC COOLING UNITS

#### A. General:

- 1. Controls shall control the units cooling, heating, 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.

#### B. Occupied Mode:

- 1. Fan shall run continuously.
- 2. Control unit's cooling, heating and system dampers (economizer) in proper sequence to provide a supply air temperature that will satisfy space conditions.
  - a. Heating: Heating shall be activated as required to satisfy the space setpoint.
  - b. Cooling: Shall use outside air as the first stage of cooling. Economizer shall be dry bulb or enthalpy type, using Outside Air (OA) temperature sensor, mixed air temperature sensor and supply air 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 supply air temperature control scheme. Unit shall operate in the cooling mode as the final stage of cooling. Motorized relief dampers (where applicable) shall operate in unison with the OA dampers to progressively open as the OA dampers open; provide with an offset control so that the relief dampers do not begin opening until the OA dampers are at least 15% open.
- 3. Outside air 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 shall control the OA damper). CO2 controls shall open OA damper to maintain space CO2 level of 600 ppm. OA damper shall not close below the minimum airflow setting indicated on the plans; coordinate with balancer for minimum setting.

#### C. Unoccupied Mode: Fan shall not run continuously. Unit's fan and

heating/cooling shall cycle on and off as required to maintain setback temperatures. Outdoor air dampers shall be fully closed.

- 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.
- E. Mode Control: Units' mode of operation shall be determined by unit thermostat time schedule and time schedule override; warm-up mode shall be initiated by thermostat's optimum start controls.

### 3.03 EXHAUST FANS

- A. General: See "Control" column on Fan Schedule for which of the following control methods apply to each fan.
- B. Wall Switch: Fan shall be controlled by wall mounted on/off wall switch.
- C. Time Clock Control: Fan shall run from time clock control schedule; fan shall be on for the scheduled occupied period and be off otherwise.
- D. Thermostat: Fans shall run when temperature rises above setpoint, and shall be off once space temperature falls 2°F or more below setpoint.

### 3.04 PUMPS

- A. Domestic HW Circulation Pumps: Pump shall be enabled to operate by time clock 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.

### 3.05 ELECTRIC HEATERS

- A. General: Heater shall be controlled by heater's integral thermostat and integral night set-back relay; with HVAC unit's thermostat that serve the area or central timeclock providing occupied/unoccupied mode control.
- B. Occupied Mode: Heater shall be on once space temperature has fallen below setpoint, and shall be off once temperature has risen 2 deg F or more above setpoint.
- C. Unoccupied Mode: Heater shall be off.
- D. Warm-Up Mode: Heater shall be off.

### 3.06 MISCELLANEOUS CONTROLS

- A. Water Heaters: Shall be controlled by integral thermostat provided with unit. Set for temperature as noted in water heater schedule.
- B. Fire Alarm System Shutdown:
  - 1. Provide necessary conduit, wiring, and accessories to shutdown each unit upon activation of that unit's smoke detectors (Smoke detectors are by Division 23 unless specifically shown on the electrical plans and Division 26 specifications). 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 fire alarm shutdown of the system. 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. Upon reset of alarmed device, system shall automatically return to normal, provide time delay start of equipment to prevent excess load starting at the same time.

2. In addition to the above specified hardwired fire alarm shut-down (which pertains to equipment with smoke detectors), provide the following: Shut-down all air handling equipment when the building fire alarm system goes into alarm. Zone contacts in the fire alarm system are available for this purpose. This added 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. Reset shall be same as that specified for hard-wired unit smoke-detector shut-down.

### 3.07 KITCHEN HOOD MAKE-UP AIR UNIT

- A. General: Control unit's heating to provide a supply air temperature that will satisfy space conditions. Interlock unit with exhaust fan indicated on the plans so that unit is on when exhaust fan is on and off when exhaust fan is off.
- B. On:
  1. Fan: Supply fan shall run continuously.
  2. Heating: Modulate heating as required to provide a supply air temperature that will satisfy the space temperature setpoint.
  3. OA Damper: Full open when supply fan is on.
- C. Off: Unit supply fan shall be off; OA dampers shall be fully closed.
- D. Freezestat: Unit 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.

### 3.08 MISCELLANEOUS CONTROLS

- A. Water Heaters: Shall be controlled by integral thermostat provided with unit. Set for temperature as noted in water heater schedule.
- B. Fire Alarm System Shutdown:
  1. Provide necessary conduit, wiring, and accessories to shutdown each unit upon activation of that unit's smoke detectors (Smoke detectors are by Division 23 unless specifically shown on the electrical plans and Division 26 specifications). 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 fire alarm shutdown of the system. 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. Upon reset of alarmed device, system shall automatically return to normal, provide time delay start of equipment to prevent excess load starting at the same time.

2. In addition to the above specified hardwired fire alarm shut-down (which pertains to equipment with smoke detectors), provide the following: Shut-down all air handling equipment when the building fire alarm system goes into alarm. Zone contacts in the fire alarm system are available for this purpose. This added 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. Reset shall be same as that specified for hard-wired unit smoke-detector shut-down.
- C. Miscellaneous Items: See plans for units with motorized dampers in the ducts and miscellaneous other items requiring control.

END OF SECTION

## **SECTION 23 31 00 – HVAC DUCTS AND CASINGS**

### **PART 1 GENERAL**

#### **1.01 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 20 05 00 apply to this Section.

#### **1.02 WORK INCLUDED**

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

#### **1.03 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 23 35 00 - Special Exhaust Systems.

#### **1.04 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. Supply Duct: From fan to connection to air outlet 5%.
  - 2. All Systems - Return Duct: 5%.
  - 3. 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.

## 1.05 SUBMITTALS

- A. General: Comply with Section 20 05 00.
- 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.

## 1.06 DUCT PRESSURE CLASS

- A. Constant Volume Systems: Ductwork shall be constructed to the pressure class corresponding to the static pressure indicated for the fan which serves the duct system or 1-inch pressure class (plus or minus as appropriate), whichever is higher; unless noted otherwise.

## 1.07 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, 3<sup>rd</sup> Edition.
- 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**

### 2.01 ACCEPTABLE MANUFACTURERS

- A. Products shall comply with Section 20 05 00, Paragraph 2.01, 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.

## 2.02 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 20 05 29, 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 9x9 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.

## 2.03 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.
  3. Round-to-Round:
    - a. 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).

## 2.05 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.

## 2.06 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.

## 2.07 CASING FABRICATION

- A. Construct casing of galvanized panels joined by standing seams on outside of casing riveted or bolted on approximately 12 inch centers. Reinforce with steel angles and provide diagonal bracing. Tightly fit all joints and connections and seal with sealant.
- B. Provide 3 inch high reinforced concrete curb for casing walls and floor mounting. At floor, rivet panels on 8 inch centers to angles. Where floors are acoustically insulated, provide liner at 18 gauge galvanized expanded metal mesh, turned up 12 inch at sides with sheet metal shields.
- C. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors as indicated, or required for access to equipment for cleaning and inspection.

- D. Fabricate acoustic casing of galvanized steel. Provide 16 gauge back facing and 22 gauge perforated front facing with 3/32 inch diameter holes on 5/32 inch centers. Construct panels 3 inch thick packed with 4.5 lb/cu ft minimum glass fiber media, on inverted channels of 16 gauge.

## **PART 3 EXECUTION**

### **3.01 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 20 05 29 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 20 05 00). 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 20 05 00 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 with pressure Class 3" and greater: Seal Class A.
    - b. Ducts with pressure Class 2": Seal Class B.
    - c. 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. 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.

### 3.02 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.

### 3.03 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.

### 3.04 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.

### 3.05 COMMISSIONING

- A. The Products referenced in this section are to be commissioned per Division 01 and Section 20 08 00 - 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 20 08 00 and coordinate all commissioning activities with the Commissioning Consultant.

END OF SECTION

## **SECTION 23 33 00 – DUCT ACCESSORIES**

### **PART 1 GENERAL**

#### **1.01 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 20 05 00 apply to this Section.

#### **1.02 WORK INCLUDED**

- A. Manual Dampers
- B. Backdraft Dampers
- C. Turning Vanes
- D. Flexible Connectors
- E. Duct Access Doors
- F. Air Measuring Units
- G. Duct Thermometers

#### **1.03 QUALITY ASSURANCE**

- A. General: Comply with Section 20 05 00.
- 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.

#### **1.04 SUBMITTALS**

- A. General: Submittals shall comply with Section 20 05 00.
- B. Product Data: Submit product information on all items to be used.

#### **1.05 REFERENCES**

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

### **PART 2 PRODUCTS**

#### **2.01 ACCEPTABLE MANUFACTURERS**

- A. Products shall comply with Section 20 05 00, Paragraph 2.01, Acceptable Manufacturers.
- B. Manual Damper Hardware: Duro-Dyne, Young Regulator Co., Ventfabrics,

Krueger.

- C. Backdraft Dampers: Air Balance, Ruskin, Greenheck.
- D. Turning Vanes: Duro-Dyne, Aero-Dyne, Oil Capital Sheet Metal, Airsan.
- E. Flexible Connections: Ventfabrics, Duro-Dyne Elgen.
- F. Duct Access Doors: National Controlled Air, Ventfabrics, United-McGill, Kees, Ruskin, Vent Products.
- G. Air Measuring Units: Cambridge Filter Corp., Monitor Corp.
- H. Building Access Doors: J.R. Smith, Zurn, Acudor, Elmdoor, Kees, J.C. Industries.
- I. Duct Thermometers: Weksler, Weiss.

## 2.02 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).
- D. 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).

## 2.03 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).

#### 2.04 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.
- A. 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.

## 2.05 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.

## 2.06 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, 450 lbs x 450 lbs tensile strength.
  3. Outdoor Applications: Flexible woven glass fiber fabric with hypalon coating, ozone resistant, 24 oz/sq. yard, 225 lbs x 275 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.
- D. Temperature Rating: Suitable for temperatures from -40 to 200 deg F.
- E. Fire/Smoke Rating: Flame spread rating not over 25, and smoke developed rating not higher than 50; complying with IMC requirements and NFPA standards.

## 2.07 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).

## 2.08 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.

## 2.09 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.

## 2.10 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.

## 2.11 DUCT SMOKE DETECTORS

- A. Supplied by Division 26.

## PART 3 EXECUTION

### 3.01 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.
- D. 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.
- E. Initial Setting: Set and lock all dampers in the full open position prior to balancing.
- F. 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.
- G. 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).

### 3.02 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.

### 3.03 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.
- C. Acoustic: Use acoustic type turning vanes on duct systems serving performing arts, theater, libraries, and similar spaces requiring low noise levels.

### 3.04 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.

### 3.05 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 Section 23 09 33/Control Contractor 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.

### 3.06 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.

### 3.07 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.

### 3.08 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

## **SECTION 23 34 00 – FANS**

### **PART 1 GENERAL**

#### **1.01 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 20 05 00 apply to this Section.

#### **1.02 WORK INCLUDED**

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

#### **1.03 SUBMITTALS**

- A. General: Comply with Section 20 05 00.
- 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.

#### **1.04 QUALITY ASSURANCE**

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

#### **1.05 GENERAL REQUIREMENTS**

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

#### **1.06 REFERENCES**

- A. AMCA 99-0401: Classification of Spark Resistant Construction.
- B. AMCA 210: Laboratory Methods of Testing Fans for Ratings.
- C. IMC: International Mechanical Code.
- D. NFPA 96: Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- E. UL 762: Power Ventilators for Restaurant Exhaust Appliances.

### **PART 2 PRODUCTS**

#### **2.01 ACCEPTABLE MANUFACTURERS**

- A. General: Products shall comply with Section 20 05 00. See Section 20 05 00, paragraph 2.01 for Acceptable Manufacturer requirements.
- B. Exhaust Fans: CaptiveAire, Greenheck, Twin City, Penn Barry, Cook, Carnes.
- C. VFD's: ABB.
- D. Accessories: Fan manufacturers listed, NCA, Ruskin, Thybar, RPS.

## 2.02 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 20 05 00. 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.
- E. 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.
- F. Outlets and Inlets: Fans shall be furnished with attachment angles and/or flanges as required for attaching ductwork and/or flexible connections indicated.
- G. Fan Types: The type of each fan is indicated on the Fan Schedule, under the "Type" column, and corresponds to the types specified herein.
- H. Fan Arrangement and Drive: Shall be as indicated. Select motor and drive access side to allow best access and to suit available space.
- I. 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.
- J. 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.
- K. 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 and Ceiling Cabinet 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 0.025-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. For installation in fan roof curb (unless indicated otherwise).
4. Other Fans:
  - a. General: 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. Provide with flanges where needed for installation. Provide with coating where fan has internal coating (same type as indicated for the fan served).
  - b. Where Duct Velocity is Under 1000 Feet per Minute: Frame minimum 18 gauge thick, with minimum 0.025-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.
  - c. Where Duct Velocity is Equal or Greater Than 1000 Feet per Minute: Frame 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 15 cfm at 1-inch w.g. pressure differential for a 36-inch square damper.
- L. Weatherproof: Where installed exposed to weather, fans shall have weatherproof enclosure, preventing any wind driven water entry into unit or drive assembly.

## 2.06 ROOFTOP FANS

- A. Type: Centrifugal fan, for rooftop curb mounting, with down-blast discharge. Cook Model ACE, Greenheck CUBE (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.

#### 2.09 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.

## 2.10 IN-LINE FANS

- A. Type: Square housed, in-line centrifugal fan. Greenheck SQ, BSQ (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.
- H. 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

### 3.01 INSTALLATION

- A. General: Comply with Section 20 05 00. 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 20 05 48 for vibration isolation specifications.
- G. Sheaves: Provide sheave changes for all belt driven fans. Sheave changes shall meet Balancer and Engineer requirements.
- H. 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, cleaning, etc.) and inspection on products while stored to maintain new condition.
  - 3. Installed Products: Provide maintenance and inspection of products and operate fan systems until substantial completion or specified Owner Instruction has been provided (whichever is later). Maintenance shall include all manufacturer's recommended maintenance (i.e. 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. Fans shall not be operated until all construction activities that generate dust, dirt, fumes, or odors are complete. Fans shall not be placed into service until start-up has been completed.
- 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

## **SECTION 23 35 00 – SPECIAL EXHAUST SYSTEMS**

### **PART 1 GENERAL**

#### **1.01 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 20 05 00 apply to this Section.

#### **1.02 WORK INCLUDED**

- A. Kitchen Hood Exhaust Ductwork

#### **1.03 QUALITY ASSURANCE**

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

#### **1.04 SUBMITTALS**

- A. General: All submittals shall comply with Section 20 05 00.
- B. Product Data: Submit manufacturer's product data for all items to be used.

#### **1.05 REFERENCES**

- A. ACGIH: American Conference of Governmental Industrial Hygienists, Industrial Ventilation - A Manual of Recommended Practice, 20th Edition.
- B. NFPA 45: Fire Protection for Laboratories Using Chemicals.
- C. NFPA 91: Blower and Exhaust Systems for Dust, Stock and Vapor Removal or Conveying.
- D. NFPA 96: Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment, 1986 Edition.
- E. SMACNA: Round Industrial Duct Construction Standards, 1977 Edition.
- F. SMACNA-DCS: HVAC Duct Construction Standards.

### **PART 2 PRODUCTS**

#### **2.01 ACCEPTABLE MANUFACTURERS**

- A. Products shall comply with Section 20 05 00, Paragraph 2.01, Acceptable Manufacturers.

#### **2.03 KITCHEN HOOD**

- A. Hood: See Division 11.
- B. Ductwork: Shall be constructed of minimum 16 gauge type 302 or 304 stainless steel with all seams and joints having a liquid-tight continuous exterior weld, and complying with IMC and NFPA 96. Pressure class shall be minus 4-inch w.g. (unless noted otherwise).
- C. Access Doors: Factory fabricated weld-on style consisting of frame and access panel, grease and liquid tight, UL 1978 listed, constructed of stainless steel, with

high temperature gasket rated to 2300 deg F minimum. Ductmate "Ultimate Door II" (or approved).

**PART 3        EXECUTION**

**3.01    INSTALLATION**

- A.     General: Installation shall comply with code, manufacturers written installation instructions, and best construction practices.
- B.     Welded Galvanized Material: Power-wire brush clean all welds and paint with cold galvanizing paint (or hot dip galvanize assembly).

END OF SECTION

## **SECTION 23 37 00 – AIR OUTLETS AND INLETS**

### **PART 1 GENERAL**

#### **1.01 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 20 05 00 apply to this Section.

#### **1.02 WORK INCLUDED**

- A. GRD Outlets
- B. GRD Inlets
- C. Wall Caps

#### **1.03 DEFINITIONS**

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

#### **1.04 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.

#### **1.05 SUBMITTALS**

- A. General: Comply with Section 20 05 00.
- 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**

#### **2.01 ACCEPTABLE MANUFACTURERS**

- A. Products shall comply with Section 20 05 00, Paragraph 2.01, 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.

#### **2.02 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.

## 2.03 SUPPLY AIR OUTLETS

- A. Ceiling Diffuser (CD): Aluminum or steel construction, have louver face, for horizontal discharge and square neck. Louver face shall be fixed, and be available for one, two, three or four way discharge configurations. Core shall be easily removed with no tools required. Krueger SH, SH5 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.

## 2.05 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. 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.
- C. Wall Return Register (WRR): Same as WRG but with an opposed blade damper.
- 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.

## 2.06 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.
- D. Wall Exhaust Grille (WEG): Same as WRG.

## 2.07 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. Aluminum, 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).

## 2.08 MISCELLANEOUS

- A. Goosenecks: Shall be made of minimum 18 gauge galvanized steel, in accordance with SMACNA-DCS, and as shown on the drawings.
- B. Screen: 1/2-inch mesh, constructed of either 0.051-inch aluminum wire or 19 gauge galvanized steel wire.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. General: Install air outlets and inlets in locations indicated and so as to conform with building features and coordinated with other work. See hangers and supports specification Section for supports and additional requirements.
- B. 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.
- C. 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. Connect all ductwork to air inlets and outlets with fasteners, minimum one each side and in compliance with SMACNA-DCS. See ductwork specification Section for sealing and additional requirements.
- 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 20 05 30.
- F. Screened Openings: Provide screened openings (SO) on all duct openings where indicated and where openings do not have grilles or registers.

END OF SECTION

## **SECTION 23 74 23 –MAKE-UP AIR UNITS**

### **PART 1 GENERAL**

#### **1.01 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 23 05 00 apply to this Section.

#### **1.02 WORK INCLUDED**

- A. Make-up Air Units
- B. Unit Roof Curbs
- C. Start-up

#### **1.03 QUALITY ASSURANCE**

- A. Units shall be rated in accordance with recognized standards and meet Code requirements for motor and combustion efficiencies.
- B. Fan performance ratings shall be based on tests made in accordance with AMCA Standard 210.

#### **1.04 SUBMITTALS**

- A. General: Shall comply with Section 23 05 00.
- B. Product Data: Provide complete product information submittals on all units; include performance capacities, fan performance (cfm vs. esp); and information on all filters and accessories.

#### **1.05 GENERAL REQUIREMENTS**

- A. Standardization: All units shall be the product of the same manufacturer.
- B. Substituted Equipment: The drawings show design configuration based on a particular manufacturers equipment. 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.
- C. Factory Testing: The complete control system and all safety, burner and gas manifold functions shall be factory tested to assure proper operation and to simplify field commissioning.
- D. Seismic and Wind Loads: Units shall be designed for Seismic Design Category D, Component Importance Factor of 1.0, and wind loading of 100 mph.

### **PART 2 PRODUCTS**

#### **2.01 ACCEPTABLE MANUFACTURERS**

- A. Products shall comply with Section 23 05 00, Paragraph 2.01, Acceptable

Manufacturers.

- B. Furnaces: Trane, Ice, Reznor, Rapid, CaptiveAire.

## 2.02 MAKE-UP AIR UNIT

- A. Indirect gas fired make-up unit for outdoor rooftop application with capacity and configuration as shown on plans.
- B. Casing: The unit exterior casing shall be of minimum 18 gauge galvanized steel with enamel finish. The entire unit casing shall be insulated with minimum 1 inch thick 1.5-lb. fiberglass insulation with neoprene backing. The burner/heat exchanger section shall be stainless steel construction. An integral welded steel channel frame shall support the unit casing.
- C. Blower/Motor Section: The fan section and motor assembly shall be constructed in accordance with AMCA standards. The assembly shall be designed to house the fan, bearings, motor, and v-belts which shall be selected for at least 50% above the rated motor capacity. Blower shall be belt drive with variable frequency drive where indicated. The blower wheel shall be statically and dynamically balanced, and mounted on a turned, ground and polished shaft with rigid bearing supports.
- D. Filter /Outdoor Air Section: Shall have rear outside air inlet, with integral dampers, and filters. Actuators and Controls by Division 23. Filters shall be 2" pleated throwaway, with minimum square footage and MERV rating as noted on plans. Filter access shall be through a hinged side access door, requiring no tools to open.
- E. Burner: The burner shall be CGA/AGA approved for natural gas. The burner shall modulate with a single furnace turndown ratio of at least 20% up to 100%, and shall start on low fire and modulate to full fire as required. Unit controls type shall maintain the turndown, proper fuel-to-air ratios, and unit efficiencies. Unit controller shall be for use with the Division 23 control system, and shall adjust unit modulating gas valve to control furnace output. Burners shall be indirect gas-fired type, with separated combustion, and shall have forced draft capable of reduced load turndown specified. Primary heat exchanger shall be constructed of aluminized steel. Secondary heat exchanger shall be constructed of Polypropylene coated steel. Electronic ignition system with hot stick type ignition spark transformer, gas valve complete with all safety controls includes main gas valve, flame supervision, positive burner safety switch, pilot cock and adjustable main and pilot pressure regulators. Flame safeguard system and the fuel control system in compliance with U.L. listing.
- F. Electrical Control Panel: Shall be factory wired for single point field connection, and include: Magnetic motor starter with thermal overloads, on/off/auto selector switch, burner on, flame failure LED, blower on LED, line voltage/step transformers. Fuse blocks, terminal strip for field connection, electronic burner safety relay with main and pilot sensing, timer for purging the combustion chamber, automatic electric ignition system, fan, limit, draft and combustion air switches. All unit components requiring power or control shall be factory wired.
- G. Temperature Controls: Unit shall be for use with controls furnished by Division 23 for temperature control.
- H. VFD: Shall comply with VFD's specified in Section 23 09 33.

- I. Flue: Provided with extended flue, same as specified in Section 23 74 00.
- J. Warranty: 5 years.
- K. Factory fabricated heavy gauge steel curb, with horizontal base foot, top wood nailer wrapped over top with top of steel curb, and top gasket seal. Size, configuration, and capacity to match equipment served and roof slope installed on. Curb shall provide level watertight mounting surface for equipment served, and shall have provisions for seismic anchoring of unit to curb, and curb to building structure. Curb shall include seismic restraint reinforcing and calculations by a structural engineer licensed in the State of the project location showing forces imparted from the unit to the curb and from the curb to the roof structure as required by code and per requirements of Section 23 05 48.
- L. Adjustable Sheaves: All belt drive fans shall have adjustable sheaves (except where motors are 5 hp and larger, fixed sheaves may be used). Sheaves shall be selected so that they are at their midpoint at the design conditions.

### **PART 3 EXECUTION**

#### **3.01 INSTALLATION**

- A. Unit installation shall be in strict accordance with the manufacturer's requirements. Units shall be installed in locations shown on drawings. Units shall be level (or slightly sloped to drain) and aligned with building walls.
- B. Unit casing shall be sealed to eliminate all leakage.
- C. Unit shall be thoroughly cleaned of all debris and factory filter shall be removed prior to operation.
- D. Units shall not be operated until all construction activities that generate dust, dirt, fumes, or odors are complete; and the Engineer has reviewed the system and granted approval.
- E. Sheaves: Include in bid costs for sheave changes for all belt driven fans as required to suit balancer or Engineer requirements. If fewer fans require sheave changes a credit (i.e. deductive change order) will be issued.
- E. Change sheaves on belt driven fans as directed by the Engineer or Balancer. Include in bid costs for one sheave change for each belt driven fan. Coordinate with balancer for new sheave requirements.
- F. Provide two complete sets of spare belts for all belt driven fans, and one extra set of filters.

#### **3.02 START-UP**

- A. Prior to air balancing and testing, check fans for correct rotation, tighten belts to proper tension, adjust fan rpm to value shown on drawings, and lubricate bearings 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 thermostat settings to assure proper operation over the full design range. Provide start-up report, listing all checks performed.
- C. All air handling equipment shall be tested for proper fan operation, bearing

integrity, and unit performance.

END OF SECTION

## **SECTION 23 81 53 – PACKAGED GAS HEAT/ELECTRIC COOL**

### **PART 1 GENERAL**

#### **1.01 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 20 05 00 apply to this Section.

#### **1.02 WORK INCLUDED**

- A. Single Package Gas Heat/Electric Cool Units

#### **1.03 SUBMITTALS**

- A. General: Submittals shall comply with Section 20 05 00.
- B. Product Data: Submit product information on HVAC units, including performance data showing cooling capacity (as function of indoor and outdoor temperatures and airflow rates), heating capacity, fan performance, filter information, unit accessories, wiring diagram (distinguishing unit wiring from field wiring) and point of connection of all utilities.
- C. Installation: Submit unit installation instructions.

#### **1.04 QUALITY ASSURANCE**

- A. Listing: Units shall be UL listed and labeled.
- B. Performance Ratings: Units' cooling performance shall be rated in accordance with ANSI/AHRI 210/240. Units' heating performance shall be rated in accordance with ANSI/AHRI Z21.47.
- C. Codes: Unit and accessories shall conform to applicable codes and standards. Unit efficiency shall comply with code (and exceed code as indicated).
- D. Operating Ability: Unit and all components shall be able to withstand ambient temperatures from 0 deg F to 125 deg F, plus direct exposure to sun and weather elements without adverse affects. Unit shall be able to operate and produce cooled air between ambient temperatures of 45 deg F and 115 deg F. Unit shall be able to operate and produce heated air between ambient conditions of 0 deg F and 80 deg F. Unit shall be able to operate with supply air temperatures between 50 deg F and 125 deg F; and with room temperature setpoints between 65 deg F to 85 deg F.
- E. Electrical: Coordinate equipment electrical voltage/phase, minimum circuit amps, and overcurrent protection requirements with the Division 26 contractor prior to ordering.

#### **1.05 GENERAL REQUIREMENTS**

- A. Extended Warranties:
  - 1. Unit compressors shall be warranted by the manufacturer for five years. All labor and materials associated with compressor replacement (or repair) shall be warranted.



2. Gas fired heat exchanger shall be warranted by the manufacturer for ten years. All labor and materials associated with heat exchanger replacement (or repair) shall be warranted.
- B. Spare Parts:
  1. Belts: Provide two complete sets of spare belts for all belt driven fans.
  2. Filters: Provide two complete spare sets of filters for all units.
- C. Safety Labeling: Units shall have labeling to aid in the service of the unit to indicate caution areas, and hazards.
- D. Seismic:
  1. General: Units shall be constructed to withstand the forces that could be imparted to the unit and its components in a seismic event as required by code. This facility is not an essential facility.
  2. Anchoring Requirements: Coordinate with Section 23 05 48 to allow for seismic calculations for unit anchorage and forces imposed on anchors and on building.

#### 1.06 REFERENCES

- A. ANSI/AHRI 210/240: Performance Rating of Unitary Air Conditioning & Air-Source Heat Pump Equipment.
- B. ANSI/AHRI 270: Sound Performance Rating of Outdoor Unitary Equipment.
- C. ANSI Z21.47: Gas Fired Central Furnaces.
- D. ANSI/ASHRAE 52.2: Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
- E. ASTM B117: Standard Practice for Operating Salt Spray Apparatus.

## **PART 2 PRODUCTS**

### 2.01 ACCEPTABLE MANUFACTURERS

- A. Products shall comply with Section 20 05 00. See Section 20 05 00, paragraph 2.01 for Acceptable Manufacturer requirements.
- B. Units: Daikin, Carrier, Trane, JCI/York, Reznor.

### 2.02 PACKAGED GAS HEAT/ELECTRIC COOLING UNITS

- A. General:
  1. Type: Single packaged gas heating and electric air conditioning units for outdoor rooftop application.
  2. Factory Assembled Package: Units shall be fully factory assembled and shall be complete with casing, coils, fans, compressor(s), piping, wiring, disconnect, controls, gas burner, heat exchanger and all other accessories required to be ready for field connections and operation. Units shall be UL listed and labeled, and be designed for outdoor application. Units shall be constructed for installation on a roof curb providing full perimeter support and may utilized a pedestal support under condenser section.

3. Capacity: Units shall have minimum cooling and heating capacities as scheduled on the drawings at the conditions shown, and shall be rated in accordance with AHRI and ANSI standards.
4. Refrigerant: Units shall be for use with refrigerant R-410A, or R-407C, and shall be fully charged at the factory.
5. Fuel: Unit shall be for use with natural gas.

B. Unit Casing:

1. Construction: Galvanized steel, phosphatized, and finished with an air-dry paint coating durable enough to withstand a minimum of 672 consecutive-hour salt spray application in accordance with standard ASTM B 117. Structural members shall be heavy gauge with access doors and removable panels of heavy gauge steel. Roof panels shall be sloped to provide positive drainage of rain water/melting snow away from the cabinet.
2. Access Doors: Fully gasketed hinged doors with fluted knob fasteners and chained "tie-backs" to provide access to filters, heating section, return/exhaust air fan section, supply air fan section and evaporator coil section. Additional removable panels shall provide access to unit compressors, controls, and all other items requiring service.
3. Insulation: Minimum 1/2 inch thick foil faced fiberglass internal liner on all exterior panels in contact with the conditioned air stream.
4. Fasteners: All screws or holding devices shall be of cadmium plated construction to resist corrosion.
5. Unit base shall be watertight with heavy gauge formed load bearing members, formed recess and curb overhang. Unit lifting lugs shall accept chains or cables for rigging, and shall also serve as unit tie down points.

C. Supply and Exhaust Fans:

1. Fan Types: Forward curved centrifugal type belt driven. Complete fan assembly (fan mounted on shaft, bearings and in scroll housing) shall be dynamically balanced at factory.
2. Spring Isolation: Fans and motors shall be mounted on a common base assembly and isolated from unit with 2-inch deflection spring isolators. Provide thrust restraint isolation on the fan housing/fan board to assure smooth fan startup transition and operation.
3. Bearings: Fan shafts shall be mounted on grease lubricated ball bearings with extended grease lines to allow lubrication of bearings from filter housing area.
4. Motors: High efficiency type with a minimum service factor of 1.15. All drive components shall be readily accessible without the use of scaffolds or ladders, to facilitate periodic maintenance checks and for operator safety.
5. Exhaust Fan Dampers: Exhaust fans shall have backdraft dampers.
6. Adjustable Sheaves: All belt drive fans shall have adjustable sheaves (except where motors are 5 hp and larger, fixed sheaves may be used).

Adjustable sheaves shall be selected so that they are at their midpoint at the design conditions.

D. Gas Fired Heating Section

1. General: Gas-fired heating section as a completely assembled and factory-installed heating system integral to unit, UL or CSA approved specifically for application used in. Provide capability for threaded gas piping connection through bottom of unit.
2. Gas Burner: Forced-draft type burner with adjustable combustion air supply, gas valve, manual shut-off, direct spark or pilot ignition, and flame sensing monitoring electrode. Provide air proving switch to prevent burner operation when burner is open for maintenance or inspection. Burner shall be full modulation type with turn down ratio of at least 4 to 1.
3. Gas Burner Safety Controls: Provide safety controls as required by code and as required to prevent unsafe operation or damage to unit. Controls shall include: electronic flame safety controls for proving of combustion air prior to ignition sequence, pre-purge cycle, continuous electronic flame supervision, and time delay between first and second stage gas valve operation on two-stage heaters.
4. Combustion Blower: Centrifugal type fan with built-in thermal overload protection on motor and permanently lubricated bearings.
5. Heat Exchanger: Tubular two pass heat exchanger of manufactured of 16-gauge type 304 stainless steel primary surface and 18-gauge type 304 stainless steel secondary surface.

E. Evaporator Coil: Shall be constructed of aluminum fins mechanically bonded to copper tubes. Evaporator coil shall be inter-circuited to maintain active coil face area at part load conditions. Coil shall also utilize internally enhanced tubing for maximum heat transfer efficiency. Factory pressure and leak test coil at 300 psi (minimum). Provide pitched stainless steel drain pan to assure positive drainage of condensate from the unit casing, at evaporator coil, with drain connection to outside of unit and with PVC p-trap.

F. Condenser Coil: Constructed of aluminum fins mechanically bonded to copper tubes. Factory leak test coil under 450 psi pressure (minimum). Condenser coils shall be V-banked for cleaning ease. The coils shall not exceed 14 fins per inch density to ease cleaning, and prevent excessive air pressure drop across the condenser coil. Unit shall have subcooling circuit(s) integral with condenser coils to maximize efficiency and prevent premature flashing of liquid refrigerant.

G. Condenser Fans: Vertical discharge, direct drive propeller type fans with steel blades, and three phase motors. Fans shall be statically and dynamically balanced. Motors shall be permanently lubricated, with built-in current and thermal overload protection and weathertight slinger over motor bearings.

H. Compressors: Compressors may be scroll or reciprocating type.

1. Scroll Type: Industrial grade, energy efficient direct drive 3600 RPM maximum speed hermetic scroll type compressors. Motor shall be suction gas. Compressors shall have centrifugal oil pump with dirt separator, oil sight glass, and oil charging valve. Compressors shall have internal line break overcurrent protection and overtemperature protection,

internal high pressure relief or high pressure switch, and crankcase heaters. Compressors shall be mounted on vibration isolators.

2. Reciprocating Type: Semi-hermetic reciprocating industrial grade compressors with: single piece crankshafts, single piece connecting rods, aluminum pistons, rings to prevent gas leakage, high strength non-flexing ring type suction and discharge valves, spring loaded heads, replaceable cylinder liners, and sealing service immersed in oil. Provide removable discharge heads and hand hole covers, and discharge service valves. Provide with automatic capacity reduction equipment consisting of suction valve unloaders.
  3. Compressor Safeties: Shall include overcurrent protection, thermostatic motor winding temperature control to protect against excessive motor temperatures, incorrect phase sequence protection, phase loss protection, high and low pressure cutouts, reset relays, compressor lockout to prevent compressor operation at low ambient conditions, and evaporator frost protection.
- I. Refrigerant Circuit: Shall be fully factory piped and shall include a refrigerant line filter/drier, service gauge ports, and thermostatic expansion valve for each circuit.
- J. Electrical Power: Units shall be for use with power of voltage and phase as scheduled on the drawings. Units shall have single source power entry unless indicated otherwise. Units with single source power entry shall require only one field connection and power source. All necessary terminal blocks, fuse blocks, fuses, wiring, junction boxes and accessories shall be factory installed within the unit cabinet to provide power to all unit devices requiring power. Access panels to unit electrical power section shall be hinged with latches (or equivalent device), requiring no tools to open.
- K. Economizer – Factory:
1. General: Unit shall have economizer system manufactured by unit manufacturer to allow use of 100% outside air for economizer cooling. System shall have outside air and return air dampers, each operable from 0% to 100% of unit total airflow capacity. Dampers shall have linkage to allow return air damper to close as outside air damper opens. Outside air inlet shall have an aluminum mesh water entrapment filter and intake hood.
  2. Dampers: Economizer dampers shall be the low leak type, with polyvinyl gasketing on leading edges of damper blades and a leakage rate not to exceed 1.0% of nominal airflow at one inch w.c. static pressure. Leakage rate shall be determined in accordance with AMCA Standard 575.
  3. Relief: Unit shall have barometric relief damper to allow for pressure relief of building air when outside air damper is 100% open. Relief outlet shall have hood with birdscreen.
- M. Controls:
1. General: Unit shall have factory installed controls which allow for the 23 09 33 control system to control unit fan, cooling, heating, and economizer operations. Unit shall be furnished with all necessary relays, starters, wiring terminal strips, timers, safety devices, interface modules, etc. to

provide the sequence of operation as specified in 23 09 33 using the 23 09 33 control system, and allowing unit's safeties to protect unit components. Unit wiring shall be color coded and numbered corresponding to unit's wiring diagram. Access panels to unit controls shall be hinged with latches (or equivalent device) requiring no tools to open.

2. 23 09 33 Interface: Unit shall have terminal strip (and associated controls) for connection of 23 09 33 wiring. Unit controls shall allow for:
    - a. Fan operation when "common" and "fan" terminals are interconnected (by the 23 09 33 control system). For units with variable speed fans, unit shall have control terminals to accept a 4 to 20 mA signal from the 23 09 33 control system to allow the 23 09 33 control system to control fan speed.
    - b. Cooling operation when "common" and "compressor" terminals are connected (by the 23 09 33 control system). Provide "compressor 1", "compressor 2", etc. terminals to match number of compressor cooling stages for units with multiple stages of cooling.
    - c. Heating operation when "common" and "heater" terminals are connected (by the 23 09 33 control System). Provide "heater 1", "heater 2", etc. terminals to match number of heating stages for units with multiple stages of cooling. For units with modulating heat capability provide unit with terminals and controls to accept a 4 to 20 mA signal from the 23 09 33 control system to allow the 23 09 33 control system to control unit heating.
    - d. Economizer operation shall be by 23 09 33. Damper actuators and sensors shall be field installed on the unit by 23 09 33, and controlled by the 23 09 33 control system.
  3. Control Safeties: In addition to code required safeties, unit shall have safety controls to prevent operation that may be unsafe or damage the unit. Such safeties shall as a minimum include the following:
    - a. Heating: Pre-purge controls, proof of flame sensor, proof of combustion fan operation, and high temperature limit switch. Ignition system shall lock-out and require manual reset after 3 consecutive unsuccessful ignition attempts.
    - b. Cooling: Controls of all refrigeration system components, low refrigerant pressure safety, high refrigerant pressure safety.
  4. Ambient controls: Unit shall have all necessary safeties and controls to allow operation at the specified ambient and room conditions.
- N. Roof Curb: Provide vibration isolating seismic curb as specified in Section 23 05 48
- O. Filters:
1. General: Units shall be provided with filter racks for accommodating 2" thick filters. Access panels to filters shall be hinged, with latches (or equivalent device) requiring no tools to open.

2. Filter Type: Shall be pleated panel, disposable type, minimum 2" thick. Filter shall have MERV efficiency as scheduled on the drawings as evaluated by ASHRAE 52.2.

P. Accessories

1. Gas Flue Extensions: Provide manufacturers standard or custom fabricated welded stainless steel flue gas extension extending 3 feet higher than top of unit, with flue size as recommended by manufacturer. Provide drain weep hole at bottom at connection to unit.
2. Convenience Electrical Outlet: GFCI, 120V/15 Amp electrical outlet, for connection to power source separate from unit power. Outlet shall be mounted through unit cabinet, and have weatherproof hinged cover.
3. Electrical: Through the base electrical power connection.
4. Circuit Breaker and Disconnect: Thermal magnetic, molded case, HACR circuit breaker, wired from circuit breaker to unit terminal block. Provide with water tight enclosure having exterior access through a hinged cover. Circuit breaker shall provide unit overcurrent protection and unit disconnect in accordance with NEC, UL, and code requirements. Shall be sized to properly handle unit electrical load, including power exhaust (where power exhaust is used).
5. Smoke Detector: Ionization or photoelectric type, with sampling tube (sized to match unit application), 2 sets form C contacts rated at 10 amps (115 VAC), 1 set form A contacts rated at 2 amps (30 VDC). For use with 115 VAC (or 24 VAC) power. Suitable for temperatures 32 deg F to 140 deg F, and air velocities up to 4,000 feet per minute. Unit shall be complete with plastic housing, clear plastic cover, gaskets, mounting hardware, visual indication of power and alarm, test/reset switch, and all accessories for proper operation. UL listed and complying with applicable codes and standards. Install in unit to sense return air (unless indicated otherwise).
6. Gas Piping: Through the base gas piping.
7. Coil Guard: Provide factory-installed louvered steel coil guards around perimeter of condensing section to protect the condenser coils, refrigerant piping and control components. Louvered panels shall be fabricated from heavy gauge galvanized steel and be rigid enough to provide permanent protection for shipping and pre-/post- installation. Course wire mesh is not acceptable.
8. Phase Monitor: 3-phase electric power monitor which detects loss of phase, low voltage, or phase reversal and stops unit operation after a time delay to prevent nuisance tripping with auto reset, "normal" indicator light and "trip" indicator light.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. General: Comply with Section 20 05 00. 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. Location Verification: Install equipment at locations indicated in accordance with the Contract Documents. Prior to selecting unit installation locations and setting unit curb and unit, confirm that: unit curb properly matches building support structure; curb is level and dimensionally matches unit; installed duct locations match unit connection locations; manufacturer's pre-installation checklists have been completed; proper unit clearances and access will be provided; proper distances from plumbing vents and other vents; no adverse airflow conditions are present; and installation has been coordinated with other trades.
- C. Gasketing: Provide gasketing around top of unit curb and where duct connections mate to unit.
- D. Complete Connections: Connect and install all items shipped loose with units; provide and connect all utilities and accessories as required for proper unit operation.
- E. Refrigerant Charge: Units shall be checked for proper refrigerant charge and oil level and re-charged as necessary. Refrigerant shall be delivered to the site in factory charged containers and charged into the system through a filter/drier.
- F. Flue Extensions: Support rigidly from unit and so as to avoid transfer of heat and burning of paint on unit. Brace extension to accommodate wind forces.
- G. Sheaves: Provide sheave changes for all belt driven fans as required to suit balancer or Engineer requirements.
- H. Cleaning: Units shall be thoroughly cleaned (internally and externally) of all debris prior to operation. Units shall be clean and in new condition prior to Owner acceptance.
- I. 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. Operation Conditions: 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.

- J. 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.

### 3.02 START-UP

- A. Pre Start-Up Inspection: Inspect equipment and connecting systems to confirm equipment and connecting systems have been installed properly and are ready for start-up. As a minimum, check for: proper voltage and phases, correct system refrigerant charge, correct electrical connections, complete control connections, all unit safety devices properly set and connected, heaters operational, fans free to rotate and rotating correctly, fans lubricated, belts tightened to proper tension, coils clear of obstructions, and other items as listed by the manufacturer are properly provided/connected and operating to ensure safe and proper start-up. If items are discovered that prevent start-up to be completed, notify the installing Contractor and Engineer of issues. Coordinate and re-schedule start-up after items are corrected.
- B. Start-Up: Perform start-up in accordance with manufacturers written start-up procedures. Coordinate with any other trades needed to be present (i.e. balancer, control technician, etc.). Operate equipment in various modes to confirm proper operation. Observe proper operation of all unit components (heating, cooling, condenser fan, economizer, etc.). Observe unit to detect any unusual vibration, leakage, loose wiring, or other situations that could affect unit operation.
- C. Adjustments: Adjust and set unit components to allow for proper operation (i.e. adjust fan sheaves, adjust fan speeds, unit settings, etc.).

### 3.03 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 20 08 00.

END OF SECTION



## **SECTION 23 82 46 – ELECTRIC HEATERS**

### **PART 1 GENERAL**

#### **1.01 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 20 05 00 apply to this Section.

#### **1.02 WORK INCLUDED**

- A. Electric Heaters

#### **1.03 SUBMITTALS**

- A. General: Comply with Section 20 05 00.
- B. Product Data: Submit product information on all items.

#### **1.04 GENERAL REQUIREMENTS**

- A. Listing: All heaters shall be listed by an independent testing laboratory for the application indicated.
- B. Installation Verification: Prior to ordering units confirm finishes at heater location and type of installation and associated trim required; i.e. fully recessed, semi recessed, surface mount, etc.

### **PART 2 PRODUCTS**

#### **2.01 ACCEPTABLE MANUFACTURERS**

- A. Products: Shall comply with Section 20 05 00 Part 2.01 - Acceptable Manufacturers.
- B. Wall Electric Heaters: Q-Mark, Chromalox, Berko, Markel.

#### **2.02 ELECTRIC HEATERS**

- A. Type: Electric baseboard heater, architectural style, conventional appearance. Markel 3700 series.
- B. Enclosure: Enclosure shall be fabricated of minimum 12-gauge aluminum. Support brackets shall be of steel construction. Junction box enclosure to have provisions for incoming and outgoing wiring with clamp for restraining wiring without additional hardware. Ground wire pigtail shall be provided in each junction box for grounding.
- C. Size and Capacity: Length and heating capacity as indicated on the plans. Unit depth shall not exceed 3-inches; height shall not exceed 8.5-inches.
- D. Heating Element: The heating element wire shall consist of nichrome wire encased in magnesium oxide in a stainless steel tube. Provide with wire guard along heater outlet.
- E. Finish: Heater visible surfaces shall have factory applied off-white polyester powder coat paint finish.

- F. Electrical: Heater shall be for use with power of voltage and phase as indicated on plans.
- G. Controls:
  - 1. Safety: Heater shall have a linear thermal cut-out, factory installed; cutout shall automatically shut off heater in event of overheating and reactivate heater when temperatures return to normal.
  - 2. Thermostat: Heater shall have line voltage, integral (or wall mounted) electric thermostat for heater control.
  - 3. Contactor: Provide with contactor for remote time schedule control of unit where required by the control sequence.

### **PART 3 EXECUTION**

#### **3.01 INSTALLATION**

- A. General: Comply with Section 20 05 00. Install in accordance with manufacturer's written instructions, code, applicable standards and best construction practices.
- B. Coordination: Coordinate heater power and control requirements with other trades; confirm location of any required heater contactors, relays, thermostats, and similar devices. Provide any required wiring for proof of fan operation between fan devices and heater; wiring shall comply with the HVAC control portion of the specifications and Division 26.
- C. Location and Trim Verification: Install equipment at locations indicated in accordance with the Contract Documents. Review and confirm installation locations, that proper clearances are provided, unit controls are accessible, and installation has been coordinated with other trades.
- D. Complete Connections: Connect and install all items shipped loose with units; provide and connect all contactors, relays, wiring, interconnections and accessories as required for proper unit operation.
- E. Cleaning: Units shall be thoroughly cleaned (internally and externally) of all debris prior to operation. Units shall be clean and in new condition prior to Owner acceptance.
- F. Owner Instruction: Instruct Owner on equipment operation and maintenance.

#### **3.02 START-UP**

- A. Pre Start-Up Inspection: Inspect equipment and connecting systems to confirm equipment and connecting systems 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, complete control connections, all unit safety devices properly set and connected, coils clear of obstructions, and other items as listed by the manufacturer are properly provided/connected and operating to ensure safe and proper start-up. If items are discovered that prevent start-up to be completed, notify the installing Contractor and Engineer of issues. Coordinate and re-schedule start-up after items are corrected.
- B. Start-Up: Perform start-up in accordance with manufacturers written start-up procedures. Observe proper operation of all unit components.

- C. Adjustments: Adjust and set unit components to allow for proper operation. Observe unit to detect any unusual vibration, leakage, loose wiring, or other situations that could affect unit operation.

### 3.03 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 20 08 00.

END OF SECTION