

**HEATING, VENTILATING, AND AIR-CONDITIONING**

**23 0000 HEATING, VENTILATING, AND AIR-CONDITIONING**

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## SECTION 23 0501

### COMMON HVAC REQUIREMENTS

#### PART 1 - GENERAL

##### 1. RELATED DOCUMENTS

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

##### 2. SUMMARY

- A. Furnish labor, materials, and equipment necessary for completion of work as described in Contract Documents.
- B. It is the intent of these specifications that the systems specified herein are to be complete and operational before being turned over to the owner. During the bidding process, the contractor is to ask questions or call to the engineer's attention any items that are not shown or may be required to make the system complete and operational. Once the project is bid and the contractor has accepted the contract, it is his responsibility to furnish and install all equipment and parts necessary to provide a complete and operational system without additional cost to the owner.
- C. Furnish and install fire stopping materials to seal penetrations through fire rated structures and draft stops.
- D. Includes But Not Limited To:
  - 1. General procedures and requirements for HVAC.
- E. Related Sections:
  - 1. Section 23 0593: Testing, Adjusting, and Balancing for HVAC.

##### 3. SUBMITTALS

- A. Substitutions: By specific designation and description, standards are established for specialties and equipment. Other makes of specialties and equipment of equal quality will be considered provided such proposed substitutions are submitted to the Architect for his approval, complete with specification data showing how it meets the specifications, at least 5 working days prior to bid opening. A list of approved substitutions will be published as an addendum.
  - 1. Submit a single copy of Manufacturer's catalog data including Manufacturer's complete specification for each proposed substitution.
  - 2. The Architect or Engineer is to be the sole judge as to the quality of any material offered as an equal.
- B. Product Data, Shop Drawings: Within 30 days after award of contract, submit 10 sets of Manufacturer's catalog data for each manufactured item.
  - 1. Literature shall include enough information to show complete compliance with Contract Document requirements.
  - 2. Mark literature to indicate specific item with applicable data underlined.
  - 3. Information shall include but not be limited to capacities, ratings, type of material used, guarantee, and such dimensions as are necessary to check space requirements.
  - 4. When accepted, submittal shall be an addition to Contract Documents and shall be in equal force. No variation shall be permitted.
  - 5. Even though the submittals have been accepted by the Engineer, it does not relieve the contractor from meeting all of the requirements of the plans and specifications and providing a complete and operational system.

- C. Drawings of Record: One complete sets of blue line mechanical drawings shall be provided for the purpose of showing a complete picture of the work as actually installed.
  - 1. These drawings shall serve as work progress report sheets. Contractor shall make notations neat and legible therein daily as the work proceeds.
  - 2. The drawings shall be kept at the job at a location designated by the Mechanical Engineer.
  - 3. At completion of the project these "as-built" drawings shall be signed by the Contractor, dated, and returned to the Architect.
  
- D. Operating Instructions and Service Manual: The Mechanical Contractor shall prepare 2 copies of an Operation and Maintenance Manual for all mechanical systems and equipment used in this project. Manuals shall be bound in hard-backed binders and the front cover and spine of each binder shall indicate the name and location of the project. Use plastic tab indexes for all sections. Provide a section for each different type of equipment item. The following items shall be included in the manual, together with any other pertinent data. This list is not complete and is to be used as a guide.
  - 1. Provide a master index at the beginning of the manual showing all items included.
  - 2. The first section of the manual shall contain:
    - a. Names, addresses, and telephone numbers of Architect, Mechanical Engineer, Electrical Engineer, General Contractor, Plumbing Contractor, Sheet Metal Contractor, and Temperature Control Contractor.
    - b. List of Suppliers which shall include a complete list of each piece of equipment used with the name, address, and telephone number of vendor.
    - c. General Description of Systems including –
      - 1) Location of all major equipment
      - 2) Description of the various mechanical systems
      - 3) Description of operation and control of the mechanical systems
      - 4) Suggested maintenance schedule
    - d. Copy of contractor's written warranty
  - 3. Provide a copy of approved submittal literature for each piece of equipment.
  - 4. Provide maintenance and operation literature published by the manufacturer for each piece of equipment which includes: oiling, lubrication and greasing data; belt sizes, types and lengths; wiring diagrams; step-by-step procedure to follow in putting each piece of mechanical equipment in operation.
  - 5. Include parts numbers of all replaceable items.
  - 6. Provide control diagram and operation sequence, along with labeling of control piping and instruments to match diagram.
  - 7. Include a valve chart indicating valve locations.
  
- E. Include air balance and/or water balance reports.

#### **4. SUBMITTALS FOR COMMON HVAC REQUIREMENTS**

- A. Samples: Sealer and gauze proposed for sealing ductwork.
  
- B. Quality Assurance / Control:
  - 1. Manufacturer's installation manuals providing detailed instructions on assembly, joint sealing, and system pressure testing for leaks.
  - 2. Specification data on sealer and gauze proposed for sealing ductwork.
  
- C. Quality Assurance
  - 1. Requirements: Construction details not specifically called out in Contract Documents shall conform to applicable requirements of SMACNA HVAC Duct Construction Standards.
  - 2. Pre-Installation Conference: Schedule conference immediately before installation of ductwork.

## 5. QUALITY ASSURANCE

- A. Requirements of Regulatory Agencies:
  - 1. Perform work in accordance with applicable provisions of local and state Plumbing Code, Gas Ordinances, and adoptions thereof. Provide materials and labor necessary to comply with rules, regulations, and ordinances.
  - 2. In case of differences between building codes, state laws, local ordinances, utility company regulations, and Contract Documents, the most stringent shall govern. Promptly notify Architect in writing of such differences.
  
- B. Applicable Specifications: Referenced specifications, standards, and publications shall be of the issues in effect on date of Advertisement for Bid.
  - 1. "Heating, Ventilating and Air Conditioning Guide" published by the American Society of Heating and Air Conditioning Engineers.
  - 2. "Engineering Standards" published by the Heating, Piping, and Air Conditioning Contractors National Association.
  - 3. "2015 International Building Code", "2015 International Mechanical Code", "2015 International Plumbing Code" and "2015 International Fire Code" as published by the International Conference of Building Officials.
  - 4. "National Electrical Code" as published by the National Fire Protection Association.
  - 5. "2015 International Energy Conservation Code".
  
- C. Identification: Motor and equipment name plates as well as applicable UL and AGA labels shall be in place when Project is turned over to Owner.

## 6. INSPECTIONS AND PERMITS

- A. Pay for permits, fees, or charges for inspection or other services. Local and state codes and ordinances must be properly executed without expense to Owner and are considered as minimum requirements. Local and state codes and ordinances do not relieve the Contractor from work shown that exceeds minimum requirements.

## 7. ADDITIONAL WORK:

- A. Design is based on equipment as described in the drawing equipment schedule. Any change in foundation bases, electrical wiring, conduit connections, piping, controls and openings required by alternate equipment submitted and approved shall be paid for by this division. All work shall be in accordance with the requirements of the applicable sections.

## PART 2 - PRODUCTS FOR COMMON HVAC REQUIREMENTS

- A. Finishes, Where Applicable: Colors as selected by Architect.
  
- B. Duct Hangers:
  - 1. One inch 25 mm by 18 ga 1.27 mm galvanized steel straps or steel rods as shown on Drawings, and spaced not more than 96 inches 2 400 mm apart. Do not use wire hangers.
  - 2. Attaching screws at trusses shall be 2 inch 50 mm No. 10 round head wood screws. Nails not allowed.

## PART 3 - EXECUTION

### 1. EXAMINATION

- A. Site Inspection:
  - 1. Examine premises and understand the conditions which may affect performance of work of this Division before submitting proposals for this work.
  - 2. No subsequent allowance for time or money will be considered for any consequence related to failure to examine site conditions.

**B. Drawings:**

1. Mechanical drawings show general arrangement of piping, ductwork, equipment, etc, and do not attempt to show complete details of building construction which affect installation. This Contractor shall refer to architectural, structural, and electrical drawings for additional building detail which affect installation of his work.
  - a. Follow mechanical drawings as closely as actual building construction and work of other trades will permit.
  - b. No extra payments will be allowed where piping and/or ductwork must be offset to avoid other work or where minor changes are necessary to facilitate installation.
  - c. Everything shown on the mechanical drawings shall be the responsibility of Mechanical Contractor unless specifically noted otherwise.
2. Consider architectural and structural drawings part of this work insofar as these drawings furnish information relating to design and construction of building. These drawings take precedence over mechanical drawings.
3. Because of small scale of mechanical drawings, it is not possible to indicate all offsets, fittings, and accessories which may be required. Investigate structural and finish conditions affecting this work and arrange work accordingly, providing such fittings, valves, and accessories required to meet conditions. Do not scale drawings for locations of equipment or piping. Refer to large scale dimensioned drawings for exact locations.

- C.** Insure that items to be furnished fit space available. Make necessary field measurements to ascertain space requirements including those for connections and furnish and install equipment of size and shape so final installation shall suit true intent and meaning of Contract Documents.
1. If approval is received to use other than specified items, responsibility for specified capacities and insuring that items to be furnished will fit space available lies with this Division.
  2. If non-specified equipment is used and it will not fit job site conditions, this Contractor assumes responsibility for replacement with items named in Contract Documents.

**2. PREPARATION**

- A.** Cut carefully to minimize necessity for repairs to existing work. Do not cut beams, columns, or trusses.
1. Patch and repair walls, floors, ceilings, and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials.
  2. Each Section of this Division shall bear expense of cutting, patching, repairing, and replacing of work of other Sections required because of its fault, error, tardiness, or because of damage done by it.
  3. Cutting, patching, repairing, and replacing pavements, sidewalks, roads, and curbs to permit installation of work of this Division is responsibility of Section installing work.

**3. INSTALLATION**

- A.** Arrange pipes, ducts, and equipment to permit ready access to valves, unions, traps, starters, motors, control components, and to clear openings of doors and access panels.

**4. STORAGE AND PROTECTION OF MATERIALS:**

- A.** Provide storage space for storage of materials and assume complete responsibility for losses due to any cause whatsoever. Storage shall not interfere with traffic conditions in any public thoroughfare.
- B.** Protect completed work, work underway, and materials against loss or damage.
- C.** Close pipe openings with caps or plugs during installation. Cover fixtures and equipment and protect against dirt, or injury caused by water, chemical, or mechanical accident.

**5. EXCAVATION AND BACKFILL**

- A. Perform necessary excavation of whatever substance encountered for proper laying of all pipes and underground ducts.
  - 1. Excavated materials not required for fill shall be removed from site as directed by Engineer.
  - 2. Excavation shall be carried low enough to allow a minimum coverage over underground piping of 5'-0" or to be below local frost level.
  - 3. Excess excavation below required level shall be backfilled at Contractor's expense with earth, sand, or gravel as directed by Engineer. Tamp ground thoroughly.
  - 4. Ground adjacent to all excavations shall be graded to prevent water running into excavated areas.
- B. Backfill pipe trenches and allow for settlement.
  - 1. Backfill shall be mechanically compacted to same density as surrounding undisturbed earth.
  - 2. Cinders shall not be used in backfilling where steel or iron pipe is used.
  - 3. No backfilling shall be done until installation has been approved by the Engineer.

**6. COOPERATION**

- A. Cooperate with other crafts in coordination of work. Promptly respond when notified that construction is ready for installation of work under Division 23000. Contractor will be held responsible for any delays which might be caused by his negligence or failure to cooperate with the other Contractors or crafts.

**7. SUPERVISION**

- A. Provide a competent superintendent in charge of the work at all times. Anyone found incompetent shall be removed at once and replaced by someone satisfactory, when requested by the Architect.

**8. INSTALLATION CHECK:**

- A. An experienced, competent, and authorized representative of the manufacturer or supplier of each item of equipment indicated in the equipment schedule shall visit the project to inspect, check, adjust if necessary, and approve the equipment installation. In each case, the equipment supplier's representative shall be present when the equipment is placed in operation. The equipment supplier's representative shall revisit the project as often as necessary until all trouble is corrected and the equipment installation and operation is satisfactory to the Engineer.
- B. Each equipment supplier's representative shall furnish to the Owner, through the Engineer, a written report certifying the following:
  - 1. Equipment has been properly installed and lubricated.
  - 2. Equipment is in accurate alignment.
  - 3. Equipment is free from any undue stress imposed by connecting piping or anchor bolts.
  - 4. Equipment has been operated under full load conditions.
  - 5. Equipment operated satisfactorily.
- C. All costs for this installation check shall be included in the prices quoted by equipment suppliers.

**9. CLEANING EQUIPMENT AND PREMISES**

- A. Properly lubricate equipment before Owner's acceptance.
- B. Clean exposed piping, ductwork, equipment, and fixtures. Repair damaged finishes and leave everything in working order.
- C. Remove stickers from fixtures and adjust flush valves.

- D. At date of Substantial Completion, air filters shall be new, clean, and approved by Owner's representative.
- E. Trap elements shall be removed during cleaning and flushing period. Replace trap elements and adjust after cleaning and flushing period.

## 10. TESTS

- A. No piping work, fixtures, or equipment shall be concealed or covered until they have been inspected and approved by the inspector. Notify inspector when the work is ready for inspection.
- B. All work shall be completely installed, tested as required by Contract Documents and the city and county ordinances and shall be leak-tight before the inspection is requested.
- C. Tests shall be repeated to the satisfaction of those making the inspections.
- D. Water piping shall be flushed out, tested at 100 psi and left under pressure of supply main or a minimum of 40 psi for the balance of the construction period.

## 11. WARRANTY

- A. Contractor shall guarantee work under Division 23 to be free from inherent defects for a period of one year from acceptance.
  - 1. Contractor shall repair, revise or replace any and all such leaks, failure or inoperativeness due to defective work, materials, or parts free of charge for a period of one year from final acceptance, provided such defect is not due to carelessness in operation or maintenance.
  - 2. In addition, the Contractor shall furnish all refrigeration emergency repairs, emergency service and all refrigerant required due to defective workmanship, materials, or parts for a period of one year from final acceptance at no cost to the Owner, provided such repairs, service and refrigerant are not caused by lack of proper operation and maintenance.
- B. In addition to warranty specified in General Conditions, heating, cooling, and plumbing systems are to be free from noise in operation that may develop from failure to construct system in accordance with Contract Documents.

## 12. SYSTEM START-UP, OWNER'S INSTRUCTIONS

- A. Off-Season Start-up
  - 1. If Substantial Completion inspection occurs during heating season, schedule spring start-up of cooling systems. If inspection occurs during cooling season, schedule autumn start-up for heating systems.
  - 2. Notify Owner 7 days minimum before scheduled start-up.
  - 3. Time will be allowed to completely service, test, check, and off-season start systems. During allowed time, train Owner's representatives in operation and maintenance of system.
  - 4. At end of off-season start-up, furnish Owner with letter confirming that above work has been satisfactorily completed.
- B. Owner's Instructions
  - 1. Instruct building maintenance personnel and Owner Representative in operation and maintenance of mechanical systems utilizing Operation & Maintenance Manual when so doing.
  - 2. Minimum instruction periods shall be as follows –
    - a. Mechanical - Four hours.
    - b. Temperature Control - Four hours.
    - c. Refrigeration - Two hours.

3. Instruction periods shall occur after Substantial Completion inspection when systems are properly working and before final payment is made.
4. None of these instructional periods shall overlap another.

### **13. PROTECTION**

- A. Do not run heat pump, air handling units, fan coil units, or other pieces of equipment used for moving supply air without proper air filters installed properly in system.
- B. The mechanical systems are not designed to be used for temporary construction heat. If any equipment is to be started prior to testing and substantial completion, such equipment will be returned to new condition with full one year warranties, from date of substantial completion after any construction use. This includes, but is not necessarily limited to: Equipment, filters, ductwork, fixtures, etc.

### **14. COMMON HVAC REQUIREMENTS:**

#### **A. INSTALLATION**

1. During installation, protect open ends of ducts by covering with plastic sheet tied in place to prevent entrance of debris and dirt.
2. Make necessary allowances and provisions in installation of sheet metal ducts for structural conditions of building. Revisions in layout and configuration may be allowed, with prior written approval of Architect. Maintain required airflows in suggesting revisions.
3. Hangers And Supports:
  - a. Install pair of hangers close to each transverse joint and elsewhere as required by spacing indicated in table on Drawings.
  - b. Install upper ends of hanger securely to floor or roof construction above by method shown on Drawings.
  - c. Attach strap hangers to ducts with cadmium-plated screws. Use of pop rivets or other means will not be accepted.
  - d. Where hangers are secured to forms before concrete slabs are poured, cut off flush all nails, strap ends, and other projections after forms are removed.
  - e. Secure vertical ducts passing through floors by extending bracing angles to rest firmly on floors without loose blocking or shimming. Support vertical ducts, which do not pass through floors, by using bands bolted to walls, columns, etc. Size, spacing, and method of attachment to vertical ducts shall be same as specified for hanger bands on horizontal ducts.

#### **B. CLEANING**

1. Clean interior of duct systems before final completion.

**END OF SECTION**



**SECTION 23 0553**

**IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT**

**PART 1 - GENERAL**

**1. RELATED DOCUMENTS**

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

**2. SUMMARY**

- A. Furnish and install identification of equipment and piping as described in Contract Documents.
- B. Mechanical Contractor shall touch-up equipment where factory paint has been damaged. Repaint entire item where more than 20 percent of the surface is involved.
- C. Primary painting of walls, ceilings, ductwork, piping and plenums is covered in the general painting section of these Contract Documents.

**PART 2 - PRODUCTS**

**1. PAINT**

- A. Benjamin Moore Impervo or equivalent by Paint Manufacturer approved in Section 09 900.
- B. Use appropriate primer.

**2. LABELS**

- A. Black Formica with white reveal on engraving.

**3. CODED BANDS**

- A. Using colored bands and arrows to indicate supply and return, with colored reflective tape, color code all piping installed in this contract at not more than 20-foot intervals, at equipment, at walls, etc., in accordance with ANSI Standards.
- B. Approved Manufacturers:
  - 1. Seton
  - 2. Craftmark

**4. PIPE IDENTIFICATION**

- A. In addition to the colored bands, stencil with black paint in 1/2 inch high letters a symbol and directional arrow for all fluids handled or use Seaton coded and colored pipe markers and arrows to meet ANSI Standards.

**5. EQUIPMENT IDENTIFICATION**

- A. Provide an engraved plastic plate for each piece of equipment stating the name of the item, symbol number, area served, and capacity. Label all control components with plastic embossed mechanically attached labels. Sample:
  - 1. Supply Fan SF-1 - North Classrooms
  - 2. 10,000 CFM @ 2.5"

## 6. VALVE IDENTIFICATION

- A. Make a list of and tag all valves installed in this work.
  - 1. Valve tags shall be of brass, not less than 1"x2" size, hung with brass chains.
  - 2. Tag shall indicate plumbing or heating service.

## PART 3 - EXECUTION

### 1. APPLICATION

- A. Engraved Plates:
  - 1. Identify thermostats and control panels in mechanical rooms, furnaces, boilers and hot water heating specialties, duct furnaces, air handling units, electric duct heaters, and condensing units with following data engraved and fastened to equipment with screws –
    - a. Equipment mark noted on Drawings (i.e., SF-1)
    - b. Area served (i.e., North Classrooms)
    - c. Capacity (10,000 CFM @ 2.5)
- B. Stenciling:
  - 1. Locate identifying legends and directional arrows at following points on each piping system –
    - a. Adjacent to each item of equipment and special fitting.
    - b. At point of entry and exit where piping goes through wall.
    - c. On each riser and junction.
    - d. Every 50 feet on long continuous lines.
  - 2. Gas, & Valve Identification –
    - a. Identify specific pipe contents by stenciling pipe with written legend and placing of arrows to indicate direction of flow.
- C. Painting:
  - 1. Background Color - Provide by continuous painting of piping.

Symbol	Name	Color
NG	Natural Gas	Yellow
FS	Fire Sprinkler	Red

- 2. Identification stenciling and flow arrows shall be following colors for proper contrast:

<u>Arrows &amp; ID Stenciling</u>	<u>Color Shade of Pipe</u>
White	Red, Grays, & black
Black	Yellows, Oranges, Greens, & White

**END OF SECTION**

**SECTION 23 0593**

**TESTING, ADJUSTING, AND BALANCING**

**PART 1 - GENERAL**

**1. RELATED DOCUMENTS**

- A. Division 23 0501 - Common HVAC Requirements and Basic Mechanical Materials and Methods Sections apply to work of this section.

**2. SUMMARY SCOPE**

- A. This Section includes TAB to produce design objectives for the following:
  - 1. Air Systems.
    - a. Furnaces.
    - b. Exhaust Fans.
  - 2. Hydronic Piping Systems.
    - a. Primary - Secondary Systems
    - b. Boiler
    - c. Pumps

**3. SUBMITTALS**

- A. Agency Data:
  - 1. Submit proof that the proposed testing, adjusting, and balancing agency meets the qualifications specified below. The firm or individuals performing the work herein specified may not be the installing firm.
- B. Engineer and Technicians Data:
  - 1. Submit proof that the Test and Balance Engineer assigned to supervise the procedures, and the technicians proposed to perform the procedures meet the qualifications specified below.
- C. Procedures and Agenda: Submit a synopsis of the testing, adjusting, and balancing procedures and agenda proposed to be used for this project.
- D. Sample Forms: Submit sample forms, if other than those standard forms prepared by the AABC or NEBB are proposed.
- E. Certified Reports: Submit testing, adjusting, and balancing reports bearing the seal and signature of the Test and Balance Engineer. The reports shall be certified proof that the systems have been tested, adjusted, and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems. Follow the procedures and format specified below.
  - 1. Draft Reports: Upon completion of testing, adjusting, and balancing procedures, prepare draft reports on the approved forms. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in the same manner specified for the final reports. Submit 2 complete sets of draft reports. Only 1 complete set of draft reports will be returned.
  - 2. Final Report: Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit 4 complete sets of final reports.
  - 3. Report Format: Report forms shall be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind

report forms complete with schematic systems diagrams and other data. Divide the contents of the binder into the below listed systems divisions, separated by divider tabs:

- a. General Information and Summary
- b. Air Systems
- c. Temperature Control System Verification.

F. Report Contents: Provide the following minimum information, forms, and data:

1. General information and Summary: Inside cover sheet to identify testing, adjusting, balancing agency, Contractor, Owner, Engineer, and Project. Include addresses and contact names and telephone numbers. Also include a certification sheet containing the seal and name, address, telephone number, and signature of the Certified Test and Balance Engineer. Include in this division a listing of the instrumentation used for the procedures along with the instrument calibration sheet.
2. The remainder of the report shall contain the appropriate forms containing as a minimum, the information indicated on the standard report forms prepared by the AABC or NEBB, for each respective item and system. Prepare a schematic diagram for each item of equipment and system to accompany each respective report form. The report shall contain the following information, and all other data resulting from the testing, adjusting, and balancing work:
  - a. All nameplate and specification data for all air handling equipment and motors.
  - b. Actual metered running amperage for each phase of each motor on all pumps and air handling equipment.
  - c. Actual metered voltage at air handling equipment (phase-to-phase for all phases).
  - d. Fan RPM for each piece of air handling equipment.
  - e. Total actual CFM being handled by each piece of air handling equipment.
  - f. Actual CFM of systems by rooms.
3. Certify that all smoke and fire dampers operate properly and can be reset under actual system operating conditions.

G. Calibration Reports:

1. Submit proof that all required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of six months prior to starting the project.

#### 4. CERTIFICATION

A. Agency Qualifications:

1. Employ the services of a certified testing, adjusting, and balancing agency meeting the qualifications specified below, to be the single source of responsibility to test, adjust, and balance the building mechanical systems identified above, to produce the design objectives. Services shall include checking installations for conformity to design, measurement, and establishment of the fluid quantities of the mechanical systems as required to meet design specifications, recording and reporting the results, and operation of all systems to demonstrate satisfactory performance to the owner.
2. The testing, adjusting, and balancing agency certified by National Environmental Balancing Bureau (NEBB) or Associated Air Balance Council (AABC) in those testing and balancing disciplines required for this project, and having at least one person certified by NEBB or AABC as a Test and Balance supervisor, and a registered professional mechanical engineer, licensed in the state where the work will be performed.

B. Codes and Standard:

1. NEBB: "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."
2. AABC: "National Standards for Total System Balance."
3. ASHRAE: ASHRAE Handbook, 1984 Systems Volume, Chapter 37, Testing, Adjusting, and Balancing.

#### 5. PROJECT CONDITIONS

A. Systems Operation: Systems shall be fully operation and clean prior to beginning procedures.

## **6. SEQUENCING AND SCHEDULING**

- A. Test, adjust, and balance the air systems before hydronic, steam, and refrigerant systems within +10% to -5% of contract requirements.
- B. The report shall be approved by the Engineer. Test and balance shall be performed prior to substantial completion.

## **PART 2 - NOT USED**

## **PART 3 - EXECUTION**

### **1. PRELIMINARY PROCEDURES FOR AIR SYSTEM BALANCING**

- A. Before operating the system, perform these steps.
  - 1. Obtain design drawings and specifications and become thoroughly acquainted with the design intent.
  - 2. Obtain copies of approved shop drawings of all air handling equipment, outlets (supply, return, and exhaust) and temperature control diagrams.
  - 3. Compare design to installed equipment and field installations.
  - 4. Walk the system from the system air handling equipment to terminal units to determine variations of installation from design.
  - 5. Check filters for cleanliness and to determine if they are the type specified.
  - 6. Check dampers (both volume and fire) for correct and locked position. Check automatic operating and safety controls and devices to determine that they are properly connected, functioning, and at proper operating setpoint.
  - 7. Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a cross-check with required fan volumes.
  - 8. Determine best locations in main and branch ductwork for most accurate duct traverses.
  - 9. Place outlet dampers in the full open position.
  - 10. Prepare schematic diagrams of system "As-Built" ductwork and piping layouts to facilitate reporting.
  - 11. Lubricate all motors and bearings.
  - 12. Check fan belt tension.
  - 13. Check fan rotation.

### **2. PROCEDURES FOR HYDRONIC SYSTEMS**

- A. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:
  - 1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
  - 2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
  - 3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
  - 4. Report flow rates that are not within plus or minus 5 percent of design.
- B. Set calibrated balancing valves, if installed, at calculated presettings.
- C. Measure flow at all stations and adjust, where necessary, to obtain first balance.
  - 1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

- D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
- E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
  - 1. Determine the balancing station with the highest percentage over indicated flow.
  - 2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
  - 3. Record settings and mark balancing devices.
- F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
- G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

### **3. MEASUREMENTS**

- A. Provide all required instrumentation to obtain proper measurements, calibrated to the tolerances specified in the referenced standards. Instruments shall be properly maintained and protected against damage.
- B. Provide instruments meeting the specifications of the referenced standards.
- C. Use only those instruments which have the maximum field measuring accuracy and are best suited to the function being measured.
- D. Apply instrument as recommended by the manufacturer.
- E. Use instruments with minimum scale and maximum subdivisions and with scale ranges proper for the value being measured.
- F. When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5%. When measuring a single point, repeat readings until 2 consecutive identical values are obtained.
- G. Take all readings with the eye at the level of the indicated value to prevent parallax.
- H. Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuation readings.
- I. Take measurements in the system where best suited to the task.

### **4. PERFORMING TESTING, ADJUSTING, AND BALANCING**

- A. Perform testing and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards. Balancing of the air systems and hydronic systems shall be achieved by adjusting the automatic controls, balancing valves, dampers, air terminal devices, and the fan/motor drives within each system.
- B. Cut insulation, ductwork, and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.
- C. Patch insulation, ductwork, and housings, using materials identical to those removed.
- D. Seal ducts and piping, and test for and repair leaks.
- E. Seal insulation to re-establish integrity of the vapor barrier.
- F. Adjust timing relays of environmental equipment motor reduced voltage starters to the optimum

time period for the motor to come up to the maximum reduced voltage speed and then transition to the full voltage speed to prevent damage to motor, and to limit starting current spike to the lowest possible and practical.

- G. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.
- H. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

## **5. RECORD AND REPORT DATA**

- A. Record all data obtained during testing, adjusting, and balancing in accordance with, and on the forms recommended by the referenced standards, and as approved on the sample report forms.
- B. Prepare report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced.
- C. Report shall be certified and stamped by a registered professional mechanical engineer employed by the agency and licensed in the state where the work will be performed.
- D. Engineer is to provide a floor plan and test and balance contractor to include the plan in test and balance report and identify actual cfm on drawing or number the diffusers to match report.

## **6. DEMONSTRATION**

- A. If requested, testing, adjusting, and balancing agency shall conduct any or all of the field tests in the presence of the engineer.
- B. Agency shall include a maximum of one (1) call back to the project within the one year warranty period to make additional adjustments if requested by the engineer.

**END OF SECTION**

**SECTION 23 0712**

**MECHANICAL INSULATION AND FIRE STOPPING**

**PART 1 - GENERAL**

**1. RELATED DOCUMENTS**

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

**2. SUMMARY**

- A. Furnish and install mechanical insulation and fire stopping as described in Contract Documents including but not limited to the following:
  - 1. Ductwork Insulation
  - 2. Heating Piping Insulation
  - 3. Refrigerant Piping
  - 4. Fire Stopping

**3. QUALITY ASSURANCE**

- A. Insulation shall have composite (insulation, jacket or facing and adhesive used to adhere facing or jacket to insulation) fire and smoke hazard ratings as tested by Procedure ASTM E-84, NFPA 255 and UL 723 not exceeding: Flame Spread of 25 and Smoke Developed of 50.
- B. Insulation Contractor shall certify in writing, prior to installation, that all products to be used will meet the above criteria.
- C. Accessories, such as adhesives, mastics, cements, and tapes, for fittings shall have the same component ratings as listed above.
- D. Products, or their shipping cartons, shall bear a label indicating that flame and smoke ratings do not exceed above requirements.
- E. Any treatment of jacket or facings to impart flame and smoke safety shall be permanent.
- F. The use of water-soluble treatments is prohibited.

**END OF SECTION**



## SECTION 23 0715

### HOT WATER HEATING & RETURN PIPING INSULATION

#### PART 1 - GENERAL

##### 1. RELATED DOCUMENTS

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

##### 2. SUMMARY

- A. Furnish and install insulation on piping mains, branches, risers, fittings, and valves, pump bodies and flanges as described in Contract Documents.

#### PART 2 - PRODUCTS

##### 1. MATERIAL

- A. 3 lb./cu.ft. heavy density fiberglass with fire retardant vapor barrier jacket with self sealing laps. Thickness shall be 1-1/2 inches on heating supply and return lines.
- B. Approved Manufacturers:
  - 1. Owens-Corning Fiberglass heavy density with ASJ-SSL jacket
  - 2. Equals by Johns-Manville or CTM.
  - 3. Zeston covers for valves and fittings.

#### PART 3 - EXECUTION

##### 1. INSTALLATION

- A. Pipes:
  - 1. Install in accordance with manufacturer's directions on clean dry pipes.
  - 2. Butt joints firmly together.
  - 3. Seal vapor barrier longitudinal seam overlap with vapor barrier adhesive.
  - 4. Wrap butt joints with four inch strip of vapor barrier jacket material cemented with vapor barrier adhesive.
  - 5. Finish with bands applied at mid-section and at each end of insulation.
- B. Valves & Fittings:
  - 1. Insulate and finish by one of following methods:
    - a. With hydraulic setting insulating cement, or equal, to thickness equal to adjoining pipe insulation.
    - b. With segments of molded insulation securely wired in place.
    - c. With prefabricated covers made from molded pipe insulation finished with vapor barrier adhesive.
    - d. Zeston covers and factory applied insulation diapers.
  - 2. Finish fittings and valves with four ounce canvas and coat with vapor barrier adhesive or Zeston covers.
- C. Piping located outdoors and exposed to the weather shall be insulated as indicated above except the thickness shall be determined according to the worst weather extremes expected. The insulation shall then be protected with one of the following weatherproof finishes as indicated on contract drawings:
  - 1. Metal jacketing shall be 0.016" (0.4 mm) minimum aluminum or stainless steel with

moisture barrier, secured in accordance with the jacket manufacturer's recommendations. Joints shall be applied so they will shed water and shall be sealed completely.

2. UV resistant PVC jacketing may be applied in lieu of metal jacketing provided jacketing manufacturer's limitations with regard to pipe size, surface temperature, and thermal expansion and contraction are followed.

3. Fittings shall be insulated as prescribed above, jacketed with preformed fitting covers matching outer jacketing used on straight pipe sections, with all joints weather sealed.

4. On outdoor chilled water and refrigerant lines, the insulation system shall be completely vapor sealed before the weather-resistant jacket is applied. The outer jacket shall not compromise the vapor barrier by penetration of fasteners, etc. Vapor stops at butt joints shall be applied at every fourth pipe section joint and at each fitting to provide isolation of water incursion.

**END OF SECTION**

**SECTION 23 0716**

**DUCTWORK INSULATION**

**PART 1 - GENERAL**

**1. RELATED DOCUMENTS**

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, and Section 23 0501 apply to this Section.

**2. SUMMARY**

- A. Furnish and install insulation on air ducts outside building insulation envelope as described in Contract Documents.
- B. Furnish and install insulation on fresh air ducts and combustion air ducts within building insulation envelope as described in Contract Documents.
- C. Furnish and install insulation on other air ducts where indicated on Drawings.

**PART 2 - PRODUCTS**

**1. INSULATION**

- A. 1-1/2 inch thick fiberglass with aluminum foil scrim kraft facing and have a density of one lb/cu ft.
- B. Approved Manufacturers:
  - 1. Manville Microlite FSK
  - 2. CSG Type IV standard duct insulation
  - 3. Owens-Corning FRK
  - 4. Knauf (Duct Wrap FSK)

**PART 3 - EXECUTION**

**1. INSTALLATION**

- A. Install duct wrap in accordance with Manufacturer's recommendations.
- B. Do not compress insulation except in areas of structural interference.
- C. Completely seal joints.

**END OF SECTION**

**SECTION 23 0717**

**ROUND SUPPLY DUCT INSULATION**

**PART 1 - GENERAL**

**1. RELATED DOCUMENTS**

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

**2. SUMMARY**

- A. Furnish and install round supply duct insulation as described in Contract Documents.

**3. QUALITY ASSURANCE**

- A. Insulation shall be UL rated with FSK (foil-skrim-kraft) facing.

**PART 2 - PRODUCTS**

**1. MANUFACTURED UNITS**

- A. Fiberglass blanket insulation
- B. Approved Manufacturers:
  - 1. Johns-Manville R-4 Microlite (R-4 does not include the vapor barrier material).
  - 2. Owens-Corning faced duct wrap insulation FRK-25 ED-150
  - 3. Certainteed Standard Duct Wrap.

**PART 3 - EXECUTION**

**1. INSTALLATION**

- A. Insulate round air supply ducts.
- B. Facing shall overlap 2" at joints and shall be secured with outward clinch staples on 4" centers.
- C. Ducts over 30" in width shall have spot application of adhesive, weld pins or metal screws and caps on not more than 18" centers applied to underside.
- D. 3" wide vapor barrier paper shall be applied over seams and sealed with vapor barrier adhesive.
- E. Insulate attenuators.
- F. Insulate high and low pressure flex ducts.

**END OF SECTION**

**SECTION 23 0718**

**DUCT LINING**

**PART 1 - GENERAL**

**1. RELATED DOCUMENTS**

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, and Section 23 0501 apply to this Section.

**2. SUMMARY**

- A. Furnish and install acoustic lining in following above ground metal ductwork as described in Contract Documents unless detailed otherwise:
  - 1. Outside air
  - 2. Supply air
  - 3. Return air
  - 4. Mixed air
  - 5. Transfer air
  - 6. Relief air
  - 7. Elbows, fittings, and diffuser drops greater than 12 inches in length.

**3. SYSTEM DESCRIPTION**

- A. Duct dimensions shown on Drawings are for free area inside insulation. Allowance must be made for insulation, where applicable.

**4. RATINGS:**

- A. Material shall have maximum air friction correction factor of 1.10 at 1000 FPM velocity and have a minimum sound absorption coefficient NRC of .60.

**PART 2 - PRODUCTS**

**1. DUCT LINER**

- A. One inch thick, 1-1/2 lb density fiberglass, factory edge coated.
- B. Duct lining materials are to meet the requirements of UL 181 for mold, humidity, and erosion resistance.
- C. Approved Manufacturers:
  - 1. Certainteed Ultralite 150 Certa Edge Coat
  - 2. Knauf - Type M
  - 3. Manville - Lina-Coustic
  - 4. Owen Corning Fiberglas - Aeroflex

**2. ADHESIVE**

- A. Water Base Type:
  - 1. Cain - Hydrotak
  - 2. Duro Dyne - WSA
  - 3. Kingco - 10-568
  - 4. Miracle - PF-101
  - 5. Mon-Eco - 22-67
  - 6. Techno Adhesive - 133

- B. Solvent Base (non-flammable) Type:
  - 1. Cain - Safetak
  - 2. Duro Dyne - FPG
  - 3. Kingco - 15-137
  - 4. Miracle - PF-91
  - 5. Mon-Eco - 22-24
  - 6. Techno Adhesive - 'Non-Flam' 106
  
- C. Solvent Base (flammable) Type:
  - 1. Cain - HV200
  - 2. Duro Dyne - MPG
  - 3. Kingco - 15-146
  - 4. Miracle - PF-96
  - 5. Mon-Eco - 22-22
  - 6. Techno Adhesive - 'Flammable' 106

### 3. FASTENERS

- A. Adhesively secured fasteners not allowed.
  
- B. Approved Manufacturers:
  - 1. AGM Industries Inc - "DynaPoint" Series DD-9 pin
  - 2. Cain
  - 3. Duro Dyne
  - 4. Omark dished head "Insul-Pins"
  - 5. Grip nails may be used if each nail is installed by "Grip Nail Air Hammer" or by "Automatic Fastener Equipment" in accordance with Manufacturer's recommendations.

## PART 3 - EXECUTION

### 1. INSTALLATION

- A. Install mat finish surface on air stream side. Secure insulation to cleaned sheet metal duct with continuous 100% coat of adhesive and with 3/4 inch long mechanical fasteners 12 inches on center maximum unless detailed otherwise on Drawings. Pin all duct liner.
  
- B. Accurately cut liner and thoroughly coat ends with adhesive. Butt joints tightly. Top and bottom sections of insulation shall overlap sides. If liner is all one piece, folded corners shall be tight against metal. Ends shall butt tightly together.
  
- C. In casings and plenums further contain insulation with wire mesh.

### 2. FIELD QUALITY CONTROL

- A. If insulation is installed without longitudinal and end joints butted together, installation will be rejected and work removed and replaced with work that conforms to this Specification.
  
- B. Insulation shall be installed in accordance with Duct Liner Application Standard SMACNA Manual 15.

### 3. ADJUSTING, CLEANING

- A. Keep duct liner clean and free from dust. At completion of project, vacuum duct liner if it is dirty or dusty.

**END OF SECTION**

## SECTION 23 0720

### REFRIGERANT PIPING INSULATION

#### PART 1 - GENERAL

##### 1. RELATED DOCUMENTS

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

##### 2. SUMMARY

- A. Furnish and install insulation on above ground refrigerant suction piping and fittings, including thermal bulb, from thermal expansion valve as described in Contract Documents.

##### 3. QUALITY ASSURANCE

- A. Insulation shall have flame-spread rating of 25 or less and a smoke density rating of 50 or less as tested by ASTM E-84 method.
- B. Ratings:
  - 1. Upper rating of =210 deg. F.
  - 2. Lower rating of -110 deg. F.
  - 3. UV stabilized for ten year life.
  - 4. Thermal conductivity of 0.24.
  - 5. Water vapor transmission of .03 perms per inch.
  - 6. Material to be polyolefin food grade.

#### PART 2 - PRODUCTS

##### 1. FLEXIBLE FOAMED PIPE INSULATION

- A. Thickness:
  - 1. 1/2 inch for one inch outside diameter and smaller pipe.
  - 2. 3/4 inch for 1-1/8 through 2 inch outside diameter pipe.
  - 3. One inch for 2-1/8 inches outside diameter and larger pipe (two layers of 1/2 inch).
  - 4. One inch sheet for fittings as recommended by Manufacturer.
- B. Approved Manufacturers:
  - 1. Armaflex
  - 2. Halstead "Insul-tube"
  - 3. Rubatex
  - 4. Therma-Cel

##### 2. JOINT SEALER

- A. Approved Manufacturers:
  - 1. Armaflex 520
  - 2. BFG Construction Adhesive #105
  - 3. Therma-Cel 950.

##### 3. MANUFACTURED UNITS

- A. Nominal 3/4" wall thickness
- B. Approved Manufacturers:
  - 1. ImcoLock Pipe Insulation

2. or approved equal

### **PART 3 - EXECUTION**

#### **1. INSTALLATION**

- A. Install insulation in snug contact with pipe and in accordance with Manufacturer's recommendations.
- B. Insulation shall be slipped onto pipe prior to connection or applied after pipe is installed, at contractor's option.
- C. Close butt joints and miter joints.
  - 1. Approved Manufacturers:
    - a. IMCOA's Fuse-Seal joining system
    - b. or factory approved contact adhesive
- D. Insulation shall be installed according to manufacturer's recommended procedures.
- E. Exterior exposed Insulation shall be finished with two coats of factory approved finish. Color shall be selected by the Owner's representative.
- F. Stagger joints on layered insulation.
- G. Slip insulation on tubing before tubing sections and fittings are assembled keeping slitting of insulation to a minimum.
- H. Seal joints in insulation.
- I. Insulate flexible pipe connectors.
- J. Insulate thermal expansion valves with insulating tape.
- K. Insulation exposed outside building shall have "slit" joint seams placed on bottom of pipe.
- L. Insulate fittings with sheet insulation and as recommended by Manufacturer.

**END OF SECTION**



**SECTION 23 0800**

**FIRE STOPPING**

**PART 1 - GENERAL**

**1. RELATED DOCUMENTS**

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

**2. SUMMARY**

- A. Furnish and install fire stopping as described in Contract Documents.

**3. QUALITY ASSURANCE**

- A. Fire stopping material shall meet ASTM E814, E84 and be UL listed.

**PART 2 - PRODUCTS**

**1. MANUFACTURED UNITS**

- A. Material shall be flexible, long lasting, intumescent acrylic seal to accommodate vibration and building movement.
- B. Caulk simple penetrations with gaps of 1/4" or less with:
  - 1. Dow Corning Fire Stop Sealant
  - 2. Pensil 300
- C. Caulk multiple penetrations and/or penetrations with gaps in excess of 1/4" with:
  - 1. Dow Corning Fire Stop Foam
  - 2. Pensil 200
  - 3. IPC flame safe FS-1900
  - 4. Tremco "Tremstop 1A"

**PART 3 - EXECUTION**

**1. INSTALLATION**

- A. Follow manufacturer's installation instructions explicitly.
- B. Seal penetrations of ductwork, piping, and other mechanical equipment through one-hour and two-hour rated partitions as shown on Architectural and Mechanical Drawings.
- C. Install fire stopping material on clean surfaces to assure adherence.

**END OF SECTION**

## SECTION 23 2115

### HOT WATER HEATING SYSTEM

#### PART 1 - GENERAL

##### 1. RELATED DOCUMENTS

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

##### 2. SUMMARY

- A. Furnish and install system of supply and return piping, boiler water make-up lines, and boiler drain lines as described in Contract Documents.

#### PART 2 - NOT USED

#### PART 3 - EXECUTION

##### 1. INSTALLATION

- A. Ends of all pipe shall be reamed out before being made up into fittings.
- B. Use graphite and oil applied to male threads only in making up all pipe joint fittings.
- C. Install unions on downstream side of shut-off valves and specialty valves and meters. Also install unions on both ends of radiation piping where piping goes from floor level into steel pipe troughs in floor slab.
- D. Use teflon tape for lubricating threads on all threaded connections.

##### 2. PIPING GRADE

- A. Heating supply and return lines are to be graded up 1 inch to 40 feet, in the direction of flow with the high and low points in every case being in the boiler room to permit drainage.
- B. Provide an automatic air eliminator at the high of each circuit and on the heating coils.
- C. If it is necessary to change the grade of a flow main due to an obstruction, the high point shall be vented with an automatic air vent.
- D. All runouts shall be taken off the top of the main and at least three elbow joints used on the spring piece to provide for expansion and contraction.

##### 3. CLEANING SYSTEM

- A. Thoroughly clean all equipment, piping and all other material controlled under this contract free from rust, scale, and other dirt before any painting or covering is done or the system is put into operation.
- B. The heating system shall be thoroughly cleaned by operating at 10 psi for at least 6 hours.
  - 1. At end of run, the boiler is to be filled to the top with water and any film of oil or grease is to be washed over the top.
  - 2. Drain the boiler completely and refill to proper level with fresh water.
  - 3. Repeat this process three (3) times.
  - 4. Use 1 pound tri-sodium phosphate for every 100 gallons of water during cleaning operation.

**4. FIELD QUALITY CONTROL**

- A. Piping systems shall be subjected to the following tests and no piping shall be covered or concealed until it has been so tested, inspected, and approved by the Architect and any local inspector having jurisdiction.
1. Heating piping shall be hydrostatically tested at 50 psi in excess of maximum working pressures, 100 psi minimum.
  2. Without connecting equipment items rated below 100 psi, pressure test system at 100 psi for two hours. Correct leaks and defective work and repeat test until no leaks appear.
  3. When so directed by Architect or Engineer, the Contractor shall conduct an operating test on any piece of equipment to demonstrate its capacity and/or operating characteristics.

**END OF SECTION**

**SECTION 23 2116**

**HOT WATER HEATING SYSTEM SPECIALTIES**

**PART 1 - GENERAL**

**1. RELATED DOCUMENTS**

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

**2. SUMMARY**

- A. Furnish and install hot water heating specialties as described in Contract Documents.

**PART 2 - PRODUCTS**

**1. MANUAL AIR VALVES**

- A. On each coil or piece of equipment wherever an air pocket can form.
- B. On each high point of piping or as shown on plans.
- C. Approved Manufacturers:
  - 1. Hoffman #500 or equal complete with #550 air chamber.

**2. AUTOMATIC AIR ELIMINATORS**

- A. Furnish and install at the high point of each zone piping, or wherever an air pocket can form because of obstructions in the piping, a 3/4" float operated automatic air eliminator, Hoffman #79.

**3. BALANCING FITTINGS**

- A. Automatic flow regulator kits complete with ball valve and strainer with capacity shown. Provide P/T test valves.
  - 1. Approved Manufacturers:
    - a. Griswold
    - b. Auto flow
- B. Manual balance valves with capacity shown. Provide with PT gage taps.
  - 1. Approved Manufacturers:
    - a. Bell & Gossett circuit setters
    - b. Armstrong

**4. COMPRESSION TANKS**

- A. Welded steel compression tanks of sizes shown, ASME Code for 30 lb. W.P., made of steel plate.
- B. Provide a water column with water gauge and gauge cocks on ends of tanks.
- C. Tanks to be furnished with three 3/4 inch I.P.S. female thread connections, one at either end and one in the middle.
- D. Approved Manufacturers
  - 1. B&G

## 5. AIR SEPARATORS

- A. Furnish and install as shown on plans, air separator with tangential nozzles. The air separator shall be fitted with an NPT vent connection to facilitate installation of piping to connect a compression tank.
- B. An NPT tapping shall be provided on the bottom of the air separator to facilitate blowdown.
- C. The air separator shall also be equipped with a steel system strainer with a free area of not less than four times the cross sectional area of the connecting piping.
- D. Air separators shall be fabricated steel with flanged connections, designed and constricted for 165 psig @ 375F, and in accordance with Section VIII Division I of ASME Boiler & Pressure Vessel Code.
- E. Approved Manufacturers
  - 1. B&G Rollairtrol
  - 2. Armstrong VAS

## 6. PRESSURE GAUGES

- A. Cases shall be black enameled cast aluminum with back flange for surface or line mounting.
- B. Gauges shall be of the repairable type with sturdy brass movements and phosphor bronze tubes.
- C. Range shall be selected so that normal operating pressure shall be approximately at the center of the dial.
- D. 3-1/2 inch figure bourdon tube type pressure gauge.
- E. Install on inlet of each pressure gauge a No. 38, 1/4 inch consolidated brass "T" handle gauge cock.
- F. Approved Manufacturers:
  - 1. U. S. Gauge
  - 2. Trerice

## 7. BOILER FITTINGS & COMPRESSION TANK FITTINGS

- A. Boiler fittings as detailed on plans.
  - 1. Approved Manufacturers:
    - a. Bell & Gossett Airtrol
- B. Compression Tank Fittings:
  - 1. Install according to detail and manufacturer's instructions.
  - 2. Fitted for diameter tanks shown.
  - 3. Tank fittings to be connected with 1 inch black pipes pitched up to tanks.
  - 4. Compression tanks fitted with 3/4 inch drain piped to floor of boiler room to permit draining of tanks.
  - 5. Approved Manufacturers:
    - a. Bell & Gossett ATFL Airtrol

## 8. SELF-FILLING VALVES

- A. 3/4 inch reducing valves (self-filling)
- B. Brass body and bronze interior

- C. Install on water service to boiler.
  
- D. Approved Manufacturers:
  - 1. Bell & Gossett No. 12
  - 2. Or equal

**9. BOILER RELIEF VALVE**

- A. ASME Code relief valve.
  
- B. Approved Manufacturers:
  - 1. Bell & Gossett
  - 2. Or Equal

**10. THERMOMETERS AND ACCESSORIES**

- A. Red reading, mercury, separable socket, 7 inch cast, adjustable with 3 1/2 inch stem.
  
- B. Range: Heating 30 degrees to 240 degrees F.
  
- C. Provide other accessories as shown.
  
- D. Approved Manufacturers:
  - 1. Weiss
  - 2. Trerice
  - 3. Palmer

**PART 3 - EXECUTION**

**1. INSTALLATION**

- A. Install pressure gauges on each side of each pump and elsewhere as shown on plans.
  
- B. Install "T" handle gauge cock on the inlet of each pressure gauge.

**END OF SECTION**

**SECTION 23 2123**

**CIRCULATING PUMPS AND ACCESSORIES**

**PART 1 - GENERAL**

**1. RELATED DOCUMENTS**

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 22 0501 apply to this Section.

**2. SUMMARY**

- A. Furnish and install circulating water pumps and accessories as described in the Contract Documents.

**PART 2 - PRODUCTS**

**1. GRUNDFOS MAGNA3 (D) MATERIAL OF CONSTRUCTION:**

- 1. Pump housing: Cast iron EN-GJL-250 / EN1561 or stainless steel EN 1.4308
- 2. Impeller: Composite PES-GF30
- 3. Neck ring: Stainless steel EN 1.4301
- 4. Secondary seals: EPDM
- 5. Thrust bearing Aluminium oxide/carbon
- 6. Stator housing: Aluminium
- 7. Rotor can: PPS
- 8. Shaft: Ceramics or Stainless steel EN 1.4404 (dependent on motor size)
- 9. Shaft Stainless steel (terminal-connected versions) EN 1.4404

**2. PUMP SUCTION DIFFUSERS:**

- A. Match system pipe size and pump inlet size shall be furnished and installed where shown on drawings.
- B. Angle type body with inlet vanes and combination diffuser-strainer-orifice cylinder.
- C. Approved Manufacturers:
  - 1. Bell & Gossett
  - 2. Armstrong
  - 3. Or approved equal

**3. TRIPLE DUTY VALVES**

- A. Place on each pump discharge. Valve serves as a non-slam check valve with spring loaded disk check, calibrated adjustable and lockable balance valve and full shutoff valve with memory stop. Valve shall be back-seated so as to allow repacking under full line pressure.
- B. Cast iron body
- C. Bronze disk and seat with stainless steel stems and springs.
- D. Teflon packing
- E. Maximum valve working pressure of 175 psig and a maximum operating temperature of 300 deg. F.
- F. Approved Manufacturers:
  - 1. Bell & Gossett

#### 4. EXPANSION JOINT PUMP CONNECTORS

- A. Precision machine molded neoprene and nylon construction internal reinforced by means of steel wire.
- B. Cadmium steel floating flanges tapped to mate with 150# ASA companion flanges.
- C. Capable of operating at a temperature of 20 deg. F. thru 220 deg. F. and at a pressure ranging from 10" HG vacuum thru 150 psi working pressure.
- D. Capable of 15 deg. angular deflection.
- E. Twin quiet-sphere design with control rods.
- F. Approved Manufacturers:
  - 1. Vibration Mountings & Controls, Inc.
  - 2. Metraflex

#### 5. IN-LINE CIRCULATORS

- A. Bronze fitted with ceramic seal, spring coupling, and 1750-rpm, drip-proof motor with overload protection.
- B. Substantially supported in piping with a full size leg to floor.
- C. Approved Manufacturers:
  - 1. Bell & Gossett
  - 2. Armstrong
  - 3. Grundfos

### PART 3 - EXECUTION

#### 1. INSTALLATION

- A. Install equipment in accordance with manufacturers instructions.
- B. Align pump and motor shafts in accordance with manufacturers requirements before starting equipment. Provide report in the M&O manual regarding pump alignment.
- C. Remove start-up filter screen on suction diffuser after system has been cleaned and flushed. Leave main filter screen in place.

**END OF SECTION**



## SECTION 23 2300

### REFRIGERANT PIPING SYSTEMS

#### PART 1 - GENERAL

##### 1. RELATED DOCUMENTS

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

##### 2. SUMMARY

- A. Furnish and install piping for refrigeration systems as described in Contract Documents.

##### 3. QUALITY ASSURANCE

- A. Qualifications:
  - 1. Refrigerant piping shall be installed by a refrigeration contractor licensed by State.

#### PART 2 - PRODUCTS

##### 1. REFRIGERANT PIPING

- A. Meet requirements of ASTM B 280-88, "Specification for Seamless Copper Tube for Air Conditioning & Refrigeration Field Service", hard drawn straight lengths.
- B. Do not use pre-charged refrigerant lines.

##### 2. REFRIGERANT FITTINGS

- A. Wrought copper with long radius elbows.
- B. Approved Manufacturers:
  - 1. Mueller Streamline
  - 2. Nibco Inc
  - 3. Grinnell
  - 4. Elkhart Products Corp

##### 3. SUCTION LINE TRAPS

- A. Manufactured standard one-piece traps.

##### 4. CONNECTION MATERIAL

- A. Brazing Rods:
  - 1. Copper to Copper Connections:
  - 2. AWS Classification BCuP-4 Copper Phosphorus (6% silver).
  - 3. AWS Classification BCuP-5 Copper Phosphorus (15% silver).
  - 4. Copper to Brass or Copper to Steel Connections:
  - 5. AWS Classification BAg-5 Silver (45% silver).
  - 6. Do not use rods containing Cadmium.

##### 5. FLUX

- A. Approved Manufacturers:
  - 1. "Stay-Silv white brazing flux" by J W Harris Co
  - 2. High quality silver solder flux by Handy & Harmon

## **1. INSTALLATION**

- A. Do not install refrigerant piping underground or in tunnels.
- B. Slope suction lines down toward compressor one inch/10 feet. Locate traps at vertical rises against flow in suction lines.
- C. Refrigeration system connections shall be copper-to-copper, copper-to-brass, or copper-to-steel type properly cleaned and brazed with specified rods. Use flux only where necessary.
  - 1. No soft solder (tin, lead, antimony) connections will be allowed in system.
- D. Braze valve, sight glass, and flexible connections.
- E. Circulate dry nitrogen through tubes being brazed to eliminate formation of copper oxide during brazing operation.

## **2. FIELD QUALITY CONTROL**

- A. Make evacuation and leak tests in presence of Architect's Engineer after completing refrigeration piping systems. Positive pressure test will not suffice for procedure outlined below.
  - 1. Draw vacuum on each entire system with vacuum pump to 200 microns using vacuum gauge calibrated in microns. Do not use cooling compressor to evacuate system nor operate it while system is under high vacuum. Isolate compressor from system piping using shut-off valves prior to pulling vacuum.
  - 2. Break vacuum with freon to be used and re-establish vacuum test. Vacuum shall hold for 24 hours at 200 microns without compressor running.
  - 3. Conduct tests at 70 deg F ambient temperature minimum.
  - 4. Do not run systems until above tests have been made and systems started up as specified. Inform Owner's Representative of status of systems at time of final inspection and schedule start-up and testing if prevented by outdoor conditions before this time.
  - 5. After testing, fully charge system with refrigerant and conduct test with Halide Leak Detector.

**END OF SECTION**

**SECTION 23 2310**

**REFRIGERANT SPECIALTIES**

**PART 1 - GENERAL**

**1. RELATED DOCUMENTS**

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

**2. SUMMARY**

- A. Furnish and install refrigeration specialties as described in Contract Documents except for expansion valves on 2 through 5 ton condensing units.

**PART 2 - PRODUCTS**

**1. EXPANSION VALVES**

- A. For pressure type distributors, externally equalized with stainless steel diaphragm, and same refrigerant in thermostatic elements as in system.
- B. Size valves to provide full rated capacity of cooling coil served. Coordinate selection with evaporator coil and condensing unit.
- C. Approved Manufacturers:
  - 1. Alco
  - 2. Henry
  - 3. Mueller
  - 4. Parker
  - 5. Singer
  - 6. Sporlan

**2. FILTER-DRIER**

- A. On lines 3/4 inch outside diameter and larger, filter-drier shall be replaceable core type with Schraeder type valve.
- B. On lines smaller than 3/4 inch outside diameter, filter-drier shall be sealed type using flared copper fittings.
- C. Size shall be full line size.
- D. Approved Manufacturers:
  - 1. Alco
  - 2. Mueller
  - 3. Parker
  - 4. Sporlan
  - 5. Virginia

**3. SIGHT GLASS**

- A. Combination moisture and liquid indicator with protection cap.
- B. Sight glass shall be full line size.
- C. Sight glass connections shall be solid copper or brass, no copper-coated steel sight glasses

- D. Approved Manufacturers:
  - 1. Alco
  - 2. Mueller
  - 3. Parker
  - 4. Superior
  - 5. Virginia

#### **4. MANUAL REFRIGERANT SHUT-OFF VALVE**

- A. Ball valves designed for refrigeration service and full line size.
- B. Valve shall have cap seals.
- C. Valves with hand wheels are not acceptable.
- D. Provide service valve on each liquid and suction line at compressor.
- E. If service valves come as integral part of condensing unit, additional service valves shall not be required.
- F. Approved Manufacturers:
  - 1. ConBraCo (Apollo)
  - 2. Henry
  - 3. Mueller
  - 4. Superior
  - 5. Virginia

### **PART 3 - EXECUTION**

#### **1. INSTALLATION**

- A. Install valves and specialties in accessible locations. Install refrigeration distributors and suction outlet at same end of coil.

**END OF SECTION**

## SECTION 23 2311

### REFRIGERANT PIPE COVER

#### PART 1 - GENERAL

##### 1. RELATED DOCUMENTS

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, and Section 23 0501 apply to this Section.

#### PART 2 - PRODUCTS

##### 1. BASIC COVER

- A. Basic refrigerant line cover shall be 18 gauge steel, hot-dipped galvanized steel meeting the requirements of ASTM A361-85.
- B. Pop rivet attachments will not be allowed.
- C. All fastening devices shall be plated screws. Arrange covers so they may be taken apart for service.

##### 2. MANUFACTURED OUTER COVER

- A. Refrigerant line covers at exterior walls shall be 24 ga steel, hot-dipped galvanized meeting requirements of ASTM A361-85, "Specification for Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process for Roofing and Siding", 1.25 oz/sq ft and complete with accessories recommended by Manufacturer for proper installation.
  - 1. Approved Manufacturers –
    - a. AEP / Span, Dallas, TX or San Diego, CA
    - b. Idose Aluminum Products, Allentown, PA
    - c. Berridge Manufacturing Co., Houston, TX
    - d. Copper Sales Inc., Minneapolis, MN
    - e. Engineered Components Inc., Stafford (Houston), TX
    - f. Fashion Inc., Lenaxa, KS
    - g. Alumax Building Specialties, Mesquite, TX
    - h. MM Systems Corp., Tucker, GA
    - i. Merchant & Evans Industries Inc., Burlington, NJ
    - j. Reynolds Metals Company, Richmond VA
- B. Finish:
  - 1. Fluoropolymer Resin-base finish for coil coating components. Thermo cured two coat system consisting of primer and top coat factory applied over properly pretreated metal.
  - 2. Color as selected by Engineer from Manufacturer's standard colors.
  - 3. Approved Manufacturers –
    - a. Equal to Duranar 200 by PPG or Fluoropon by Desoto containing 70% minimum Kynar 500 by Pennwalt Corp.

#### PART 3 - INSTALLATION

- 1. Do not use pop rivets. All fastening devices shall be plated screws and arranged so covers may be taken off for service.
- 2. Provide access opening for viewing the sight glass on the refrigerant line.

**END OF SECTION**

**SECTION 23 2510**

**GLYCOL SYSTEM**

**PART 1 - GENERAL**

**1. RELATED DOCUMENTS**

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

**2. SUMMARY**

- A. Furnish and install glycol system as described in Contract Documents.

**PART 2 - PRODUCTS**

**1. MATERIALS**

- A. Hot water system shall be a 50% glycol and water system. Furnish and install a manual glycol pump and fill system and fill the chiller, coils and piping system with the solution.
- B. Coils, pumps, boiler and piping have been sized to handle the 50% solution.
- C. Glycol shall be of a permanent type with rust inhibitors and shall have an identifying odor and color.
  - 1. Approved Manufacturer:
    - a. Dowtherm Type SR-1.

**PART 3 - EXECUTION**

- 1. Provide warning stickers on equipment and piping indicating the solution in system.

**END OF SECTION**

## SECTION 23 3114

### LOW-PRESSURE STEEL DUCTWORK

#### PART 1 - GENERAL

##### 1. RELATED DOCUMENTS

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

##### 2. SUMMARY

- A. Furnish and install above-grade ductwork and related items as described in Contract Documents.

#### PART 2 - PRODUCTS

##### 1. DUCTS

- A. Fabricate of zinc-coated lockforming quality steel sheets meeting requirements of ASTM 653A/653M, "Specification for Sheet Steel Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock Forming Quality", with G 60 coating.
- B. Use of aluminum, non-metallic, or round ducts is not permitted. [Specification writer: Use of aluminum ducts in areas with high chlorine content (eg.: ventilation for pools, spas, etc.) should be considered on a per job basis.]

##### 2. DUCT JOINTS

- A. Ducts with sides up to and including 36 inches shall be as detailed in the SMACNA manual.
- B. Duct sizes over 36 inches shall be fabricated using SMACNA T-24 flange joints or pre-fabricated systems as follows:
  - 1. Ducts with sides over 36 inches to 48 inches:
    - a. transverse duct joint system by Ductmate/25, Nexus, Ward, or WDCI (Lite) (SMACNA "E" or "G" Type connection).
  - 2. Ducts 48 inches & larger:
    - a. Ductmate/35, Nexus, or WDCI (Heavy) (SMACNA "J" Type connection).
  - 3. Approved Manufacturers:
    - a. Ductmate Industries Inc, 10760 Bay Meadows Drive, Sandy, UT 84092 (801) 571-5308
    - b. Nexus, Exanno Corp, P O Box 729, Buffalo, NY 14206 (716) 849-0545
    - c. Ward Industries Inc, 1661 Lebanon Church Road, Pittsburg, PA 15236 (800) 466-9374
    - d. WDCI, P O Box 10868, Pittsburg, PA 15236 (800) 245-3188

##### 3. ACCESS DOORS IN DUCTS

- A. At each manual outside air damper and at each motorized damper, install factory built insulated access door with hinges and sash locks. Locate doors within 6 inches of installed dampers. Construction shall be galvanized sheet metal, 24 ga minimum.
- B. Fire and smoke damper access doors shall have a minimum clear opening of 12" x 12" or as specified on Drawings to easily service fire or smoke damper. Doors shall be within 6 inches of fire and smoke dampers and in Mechanical Room if possible.

- C. Identify each door with 1/2" high letters reading "smoke damper" or "fire damper".
  
- D. Approved Manufacturers:
  - 1. AirBalance - Fire/Seal #FSA 100
  - 2. Air Control Products - HAD-10
  - 3. Cesco-Advanced Air - HAD-10
  - 4. Elgen - Model 85 A
  - 5. Kees Inc - ADH-D.
  - 6. Louvers & Dampers - #SMD-G-F
  - 7. Nailor-Hart Industries Inc - Series 0831
  - 8. National Controlled Air Inc - Model AD-FL-1

#### 4. FLEXIBLE EQUIPMENT CONNECTIONS

- A. 30 oz closely woven UL approved glass fabric, double coated with neoprene.
  
- B. Fire retardant, waterproof, air-tight, resistant to acids and grease, and withstand constant temperatures of 250 deg F.
  
- C. Approved Manufacturers:
  - 1. Cain - N-100
  - 2. Duro Dyne - MFN
  - 3. Elgen - ZLN
  - 4. Ventfabrics - Ventglas

#### 5. CONCEALED CEILING DAMPER REGULATORS

- A. Approved Manufacturers:
  - 1. Cain
  - 2. Duro Dyne
  - 3. Metco Inc
  - 4. Vent-Lock - #666
  - 5. Young - #303

#### 6. VOLUME DAMPERS

- A. In Main Ducts:
  - 1. 16 gauge galvanized steel, opposed blade type with 3/8 inch pins and end bearings. Blades shall have 1/8 inch clearance all around.
  - 2. Damper shall operate within acoustical duct liner.
  - 3. Provide channel spacer equal to thickness of duct liner.
  - 4. Approved Manufacturers:
    - a. Air Balance - Model AC-2
    - b. Air Control Products - CD-OB
    - c. American Warming - VC-2-AA
    - d. Greenheck - VCD-1100
    - e. NCA, Safe Air
    - f. Vent Products - 5100
  
- B. In Sheet Metal Branch Ducts:
  - 1. Extruded aluminum, opposed blade type. When in open position, shall not extend beyond damper frame.
  - 2. Maximum blade length 12 inches.
  - 3. Damper Regulator shall be concealed type with operation from bottom or with 90 deg miter gear assembly from side.
  - 4. Approved Manufacturers:
    - a. Air Control Products - TCD-OB
    - b. Air Guide - OB
    - c. Arrow - OBDAF-207



- d. CESCO - CDA
- e. Reliable Metals - OBD-RO
- f. Tuttle & Bailey - A7RDDM
- g. Safe Air
- h. Young - 820-AC

- C. Dampers above removable ceiling and in Mechanical Rooms shall have locking quadrant on bottom or side of duct. Otherwise, provide concealed ceiling damper regulator and cover plate.

## 7. MOTORIZED OUTSIDE AIR DAMPERS

- A. Damper Blades:
  - 1. 18 gauge galvanized steel or equivalent aluminum with replaceable rubber blade edges, 9 inches wide maximum.
  - 2. End seals shall be flexible metal compression type.
  - 3. Opposed blade type.
- B. Make provision for damper actuators and actuator linkages to be mounted external of air flow.
- C. Approved Manufacturers & Models:
  - 1. Air Balance - AC-2
  - 2. American Warming - VC-2-AAVA
  - 3. Arrow - OBDAF-207
  - 4. Greenheck - VCD-2100
  - 5. Honeywell - D641
  - 6. Johnson - D1300
  - 7. Louvers & Dampers - TSD400
  - 8. Ruskin - CD36 or CD60
  - 9. Safe Air - 610
  - 10. Vent Products - 5800

## 8. BACKDRAFT DAMPER

- A. Backdraft blades shall be nonmetallic and shall be neoprene coated fiberglass.
- B. Stop shall be galvanized steel screen or expanded metal, 1/2 inch mesh.
- C. Frame shall be galvanized steel or extruded aluminum alloy.
- D. Approved Models & Manufacturers:
  - 1. Air Control Products - FBD
  - 2. American Warming - BD-15
  - 3. CESCO - FBD 101
  - 4. Ruskin - NMS2
  - 5. Safe Air

## 9. DUCT HANGERS

- A. 1" x 18 gauge galvanized steel straps or steel rods as shown on Drawings, and spaced not more than 8 feet apart. Do not use wire hangers.
- B. Attaching screws at trusses shall be 1-1/2 inch No. 10 round head wood screws. Nails not allowed.

## 10. DUCT SEALER

- A. Cain - Duct Butter or Butter Tak
- B. Design Polymerics - DP 1010

- C. DSC - Stretch Coat
- D. Duro Dyne - S2
- E. Hardcast - #601 Iron-Grip or Peel-N-Seal Tape
  - 1. Kingco - 15-325
  - 2. Mon-Eco - 44-41
  - 3. Trans-Continental Equipment Co - Multipurpose Duct Sealant
  - 4. United - Sheet Metal duct-sealer

### **PART 3 - EXECUTION**

#### **1. INSTALLATION**

- A. Ducts:
  - 1. Straight and smooth on inside with joints neatly finished unless otherwise directed.
  - 2. Duct panels through 48 inch dimension having acoustic duct liner need not be crossbroken or beaded.
  - 3. Crossbreak unlined ducts and duct panels larger than 48 inch or bead 12 inches on center.
  - 4. Securely anchor ducts to building structure with specified duct hangers attached with screws. Do not hang more than one duct from a duct hanger.
  - 5. Brace and install ducts so they shall be free of vibration under all conditions of operation.
  - 6. Ducts shall not bear on top of structural members.
  - 7. Make duct take-offs to branches, registers, grilles, and diffusers as detailed on Drawings.
  - 8. Ducts shall be large enough to accommodate inside acoustic duct liner. Dimensions shown on Drawings are net clear inside dimensions after duct liner has been installed.
  - 9. Properly flash where ducts protrude above roof.
  - 10. Install internal ends of slip joints in direction of flow. Make joints air tight using specified duct sealer.
  - 11. Cover horizontal and longitudinal joints on exterior ducts with two layers of Hardcast tape installed with Hardcast HC-20 adhesive according to Manufacturer's recommendations.
  - 12. Paint ductwork visible through registers, grilles, and diffusers flat black.
- B. Install flexible inlet and outlet duct connections to each furnace, fan, fan coil unit, and air handling unit.
- C. Install concealed ceiling damper regulators.
  - 1. Paint cover plates to match ceiling tile.
  - 2. Damper regulators will not be required for dampers located directly above removable ceilings or in Mechanical Rooms.
- D. Provide each take-off with an adjustable volume damper to balance that branch.
  - 1. Anchor dampers securely to duct.
  - 2. Install dampers in main ducts within insulation.
  - 3. Dampers in branch ducts shall fit against sheet metal walls, bottom and top of duct, and be securely fastened. Cut duct liner to allow damper to fit against sheet metal.
  - 4. Where concealed ceiling damper regulators are installed, provide a cover plate.
- E. Install grilles, registers, and diffusers. Level floor registers and anchor securely into floor.
- F. Air Turns:
  - 1. Permanently installed, consisting of single thickness curved metal blades with one inch straight trailing edge to permit air to make abrupt turn without appreciable turbulence, in 90 degree elbows of above ground supply and return ductwork.
  - 2. 4-1/2 inch wide minimum vane rail. Do not use junior vane rails.
  - 3. Double thickness vanes not acceptable.
  - 4. Quiet and free from vibration when system is in operation. See SMACNA Manual
  - 5. .

- G. Install motorized dampers

**END OF SECTION**

**SECTION 23 3123**

**UNDERGROUND DUCTWORK**

**PART 1 - GENERAL**

**1. RELATED DOCUMENTS**

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

**2. SUMMARY**

- A. Furnish and install underground ductwork as described in Contract Documents.

**PART 2 - PRODUCTS**

**1. DUCTWORK**

- A. Fiberglass-reinforced plastic duct system by Peabody Spunstrand Inc, 810 AGC Building, 1200 Westlake Avenue N, Seattle, WA 98109 (206) 282-5449
  - 1. Duct Tape - Sealtite PS401 sealing tape by Spunstrand Inc.
- B. PVS or PVC coated galvanized steel duct with 4 mil thick coating on outside and on inside.
  - 1. Duct shall have and bear mark of approval of building code (ICBO, BOCA, etc) in authority for this Project.
  - 2. Gauges shall be as follows and be marked on each duct section. Corrugate ducts 14 inches in diameter and larger.

<u>Size</u>	<u>Gauge</u>	
4" to 8"	26	
9" to 12"		24
14" to 22"	22	
24" to 28"	20	
30" to 40"	18	

- 3. Make duct connections with Hardcast tape.

**2. JOINT SLEEVES**

- A. Galvanized sheet metal. Galvanizing shall meet requirements of ASTM A 527-85, "Specification for Sheet Steel Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock Forming Quality", G 60.

<u>Size</u>	<u>Gauge</u>	<u>Width</u>
4" to 12"	26	4"
14" to 24"	24	4"
26" to 36"	22	6"

**3. METAL BOOTS**

- A. 20 gauge galvanized steel. Galvanizing shall meet requirements of ASTM A 527-85, "Specification for Sheet Steel Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock Forming Quality", G 60.

**PART 3 - EXECUTION**

**1. INSTALLATION**

- A. Spunstrand:

1. Join duct sections with galvanized sheet metal sleeve inside of duct secured with sheet metal screws.
  2. Wipe joint area clean and apply one layer of tape. Tape shall cover all screw heads.
  3. Construct sheet metal boot with 1-1/2 inch flange to fit against duct. Attach boot with self-tapping sheet metal screws, pulling boot flange snug to duct surface and tape joints. Tape shall cover screw heads.
  4. Encase boot completely in concrete, covering well around and below taped joint.
- B. PVS or PVC Covered Duct:
1. Install 6 mil polyethylene vapor barrier around duct.
  2. Fittings shall be PVS or PVC.
  3. Join duct sections, fittings, and boots with sheet metal screws as detailed on Drawings.
  4. Wrap duct connections, including boot connections to ducts, with 2 layers of hardcast tape installed with Hardcast HC-20 adhesive in accordance with Manufacturer's recommendations. Cover screw heads with tape.
  5. Encase boot completely in concrete, covering well around and below taped joint.
  6. Where PVS or PVC coating has been scratched, scuffed, or peeled during shipping or installation, cover exposed metal with coating compound recommended by Manufacturer and in accordance with his recommendations.

**END OF SECTION**

**SECTION 23 3400**

**EXHAUST FANS**

**PART 1 - GENERAL**

**1. RELATED DOCUMENTS**

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

**2. SUMMARY**

- A. Furnish and install exhaust fans as described in Contract Documents.

**3. QUALITY ASSURANCES**

- A. Requirements of Regulatory Agencies:
  - 1. Bear AMCA seal and UL label.

**PART 2 - PRODUCTS**

**1. CEILING MOUNTED EXHAUST FANS**

- A. Acoustically insulated housings.
- B. Sound level rating of 4.6 sones maximum for fan RPM and CFM listed on Drawings.
- C. Include chatterproof integral back-draft damper with no metal to metal contact.
- D. True centrifugal wheels.
- E. Entire fan, motor, and wheel assembly shall be easily removable without disturbing housing.
- F. Suitably ground motors and mount on rubber-in shear vibration isolators.
- G. Provide wall or roof cap, as required.
- H. Approved Manufacturers:
  - 1. Cook-Gemini
  - 2. Greenheck Sp
  - 3. Pace
  - 4. Penn Zephyr

**PART 3 - EXECUTION**

**1. INSTALLATION**

- A. Anchor fan units securely to structure or curb.

**END OF SECTION**

**SECTION 23 3713**

**AIR OUTLETS & INLETS**

**PART 1 - GENERAL**

**1. RELATED DOCUMENTS**

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

**2. SUMMARY**

- A. Furnish and install wall supply registers, transfer grilles, return air grilles, soffit grilles, ceiling diffusers, louvers connected to ductwork, and registers as described in Contract Documents.

**PART 2 - PRODUCTS**

**1. GRILLES & REGISTERS**

- A. Approved Manufacturers:
  - 1. Price
  - 2. Anemostat
  - 3. Krueger
  - 4. Titus
  - 5. Tuttle & Bailey

**2. SPIN-IN FITTINGS**

- A. Low pressure round take-offs to diffusers shall be made with spin-in fittings. They shall incorporate a manual balancing damper. The damper shall be spring loaded and a positive locking wing nut shall secure the damper position.
- B. Approved Manufacturers:
  - 1. Sheet metal fittings: Genflex DB-1DEL, Hercules

**3. LOUVERS**

- A. Extruded aluminum, with blades welded or screwed into frames and 1/2 inch mesh 16 gauge aluminum bird screen.
- B. Frames shall have mitered corners.
- C. Louvers shall be recessed, flanged, stationary, or removable as noted on Drawings.
- D. Approved Manufacturers:
  - 1. Airolite
  - 2. American Warming
  - 3. Arrow
  - 4. Industrial Louvers
  - 5. Ruskin
  - 6. Vent Products

**PART 3 - EXECUTION**

**1. INSTALLATION**

- A. Anchor securely into openings.

- B. Install with screws to match color and finish of grilles and registers.
- C. Touch-up any scratched finish surfaces.
- D. Install in accordance with manufacturer's instructions.
- E. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.
- F. Install diffusers to ductwork with air tight connection.
- G. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.
- H. Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09 9000.

**END OF SECTION**



**SECTION 23 4100**

**DISPOSABLE FILTERS**

**PART 1 - GENERAL**

**1. RELATED DOCUMENTS**

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

**2. SUMMARY**

- A. Furnish and install filters used in mechanical equipment.

**PART 2 - PRODUCTS**

**1. FURNACE FILTERS**

- A. Filters shall be two inch thick throw-away type as recommended by Furnace Manufacturer.

**END OF SECTION**

## **SECTION 23 4145**

### **FURNACE AIR PIPING**

#### **PART 1 - GENERAL**

##### **1. RELATED DOCUMENTS**

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

##### **2. SUMMARY**

- A. Furnish and install furnace vent piping and combustion air intake piping as described in Contract Documents.

#### **PART 2 - PRODUCTS**

##### **1. AIR PIPING**

- A. Schedule 40 pipe and fittings meeting requirements of one of following:
  - 1. ASTM D 1785-89, "Specification for Poly(Vinyl Chloride)(PVC) Plastic Pipe, Schedules 40, 80, and 120."
  - 2. ASTM D 2661-89, " Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Drain, Waste, and Vent Pipe and fittings."
  - 3. ASTM D 2665-89a, "Specification for Poly(Vinyl Chloride)(PVC) Plastic Drain, Waste, and Vent Pipe and Fittings."

##### **2. PRIMER & CEMENT**

- A. Meet requirements of ASTM D 2564-88, "Specification for Solvent Cements for Poly(Vinyl Chloride)(PVC) Plastic Pipe and Fittings."

#### **PART 3 - EXECUTION**

##### **1. INSTALLATION**

- A. Do not combine furnace drain piping with cooling coil drain piping.
- B. Run individual vent and individual combustion intake piping from each furnace to outdoors with location and formation recommended by Furnace Manufacturer. Slope lines downward toward furnaces.
- C. Slope combustion chamber drain downward to funnel drain. Anchor to wall with wall clamps, allowing free movement through clamp for expansion.
- D. Use vent terminal kit or clamping system provided by Furnace Manufacturer. Install vent and combustion air intake piping at clearance and distances required by Furnace Manufacturer.
- E. Attach factory-supplied neoprene coupling to furnace combustion-air inlet connection and secure with clamp.
- F. Ensure that factory-supplied perforated metal disc is installed in flexible coupling, unless its removal is required.

**END OF SECTION**

## SECTION 23 5317

### HIGH EFFICIENCY HEATING WATER BOILERS

#### PART 1 - GENERAL

##### 1. RELATED DOCUMENTS

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

##### 2. SUMMARY

- A. Furnish and install domestic hot water boilers as described in Contract Documents.

##### 3. QUALITY ASSURANCE

- A. Unit shall operate with a minimum efficiency of no less than 93% in accordance with ANSI Z21.10.3B. 1986.

##### 4. WARRANTY

- A. Warranty/Service: Heat exchanger/combustion chamber assembly shall be warranted against failure from any mechanical or thermal shock for a period of three years. Pressure vessel and exhaust manifold shall be warranted against failure or leakage for a period of 10 years. All other components shall be unconditionally warranted for a period of one year from date of startup.

#### PART 2 - PRODUCTS

##### 1. MANUFACTURED UNITS

- A. Water heater shall be of gas fired, condensing fire tube design with a modulating power burner and positive pressure discharge.
  - 1. Heat exchanger/combustion chamber shall incorporate a helical fire tube design that will be self supporting, baffle free and warranted to withstand thermal shock.
  - 2. Heat exchanger shall be ASME stamped for a working pressure not less than 150 PSIG.
  - 3. Unit shall have ASME approved temperature/relief valve with a setting of 150 PSIG.
  - 4. Exhaust manifold shall be of corrosion resistant porcelain enameled cast iron, with a 6 inch diameter flue connection.
  - 5. Exhaust manifold shall have a drain for elimination of condensation.
- B. Flame monitoring system shall incorporate a UL recognized combustion safeguard system utilizing interrupted spark ignition and a rectification type flame sensor. An electro-hydraulic double seated safety shut off valve shall be an inherent part of the gas train.
- C. Water heater shall incorporate dual over temperature protection. Remote fault alarm, sensor failure detection, and auxiliary equipment contacts shall be standard equipment.
- D. Boiler shall operate on 120/1/60.
- E. Mode of Operation:
  - 1. Heater shall be complete with all operating controls self contained. Control of discharge water temperature shall be set through an internal setpoint with an adjustment of 100F to 190F. Unit shall maintain discharge temperature within specified range through load variations from 0 to 100%. Note: Do not set water temperature above 120 deg. F.
  - 2. Heater shall be capable of maintaining the outlet temperature with an accuracy of +/- 4F. This will be accomplished by modulation of firing rate from 100% to 14% of rated input.

This control accuracy shall be capable of being maintained over a heater output range of 100 to 190 F.

- F. Approved Manufacturers:
  - 1. Aerco
  - 2. or approved equal

### **PART 3 - EXECUTION**

#### **1. INSTALLATION**

- A. All aspects of installation of water heating plant shall be in strict accordance with manufacturer's instructions.
- B. Materials used shall conform with manufacturer's recommendations and shall include porcelainized Aerco vent for heater vent connector.

#### **2. FIELD QUALITY ASSURANCE**

- A. Contractor shall provide the services of a factory authorized representative to supervise all phases of equipment startup. A letter of compliance with all factory recommendations and installation instructions shall be submitted with operating and maintenance instructions.

**END OF SECTION**

**SECTION 23 5417**

**HIGH EFFICIENCY NATURAL GAS FURNACE**

**PART 1 - GENERAL**

**1. RELATED DOCUMENTS**

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, and Section 23 0501 apply to this Section.

**2. SUMMARY**

- A. Furnish and install gas fired condensing high efficiency furnace as described in Contract Documents.

**PART 2 - PRODUCTS**

**1. MANUFACTURED UNITS**

- A. Fabrication:
  - 1. Furnaces shall be factory assembled units certified by AGA complete with blower section, furnace section, condensing coil, steel casing, piped, and wired.
  - 2. Blower section shall consist of cabinet, blower, and motor.
  - 3. Cabinet shall be of 22 gauge minimum cold rolled steel and have finish coat of baked-on enamel.
  - 4. Blower shall be Class 1, full DIDW, statically and dynamically balanced.
  - 5. Filters shall be one inch thick pleated throw-away type as furnished by furnace manufacturer.
  - 6. Provide furnace with accessory side mounted filter box frame and factory available bottom closure.
  - 7. Automatic controls:
    - a. 100% cut-off safety pilot
    - b. Manual gas shut-off valve
    - c. Operating automatic gas valve
    - d. Solid state type fan and thermal limit controls
    - e. 24 volt transformer
    - f. Electronic ignition system
    - g. Pressure switch safety for induced draft fan
- B. Units:
  - 1. Blower shall be driven by motor with adjustable pitch V-belt drive or by a multi-speed direct driven motor.
  - 2. Furnace section shall be enclosed in 22 gauge minimum enameled steel casing lined with foil covered insulation.
  - 3. Heat exchanger shall be ceramic or glass coated, stainless steel, or 18 gauge aluminized steel with 20 year minimum limited warranty.
  - 4. Units shall be rated at 93% minimum AFUE (Annual Fuel Utilization Efficiency) calculated in accordance with DOE test procedures.
  - 5. 2" or 3" intake and exhaust lines to outside with factory furnished combination flue/intake assembly for roof or sidewall.
- C. Provide with Web enabled 7 day programmable thermostat equal to Honeywell Prestige.
- D. Approved Manufacturers:
  - 1. Rheem
  - 2. Ruud

**1. FIELD QUALITY CONTROL**

- A. Quality Assurance: Furnace manufacturer's representative shall start up and check out furnace equipment as follows:
1. Verify proper gas orifice sizing for altitude.
  2. Clock gas meter for rated input.
  3. Verify and set gas pressure at furnace.
  4. Check and measure temperature rise.
  5. Check safety controls for proper operation.

**END OF SECTION**

**SECTION 23 5540**

**ELECTRIC RADIANT WALL HEATERS**

**PART 1 - GENERAL**

**1. RELATED DOCUMENTS**

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, and Section 23 0501 apply to this Section.

**2. SUMMARY**

- A. Furnish and install wall heaters as described in Contract Documents.

**3. QUALITY ASSURANCE**

- A. Units shall be UL listed and comply with NEC.

**PART 2 - PRODUCTS**

**1. MANUFACTURED UNITS**

- A. Fan type for recess mounting in wall.
- B. 20 gauge minimum sheet metal casing.
- C. Heating element shall be encased in steel finned casting and protected by thermal switch.
- D. Fan motor shall be heavy duty enclosed and permanently lubricated.
- E. Fan shall be precision balanced and fan-motor assembly mounted to be vibration free.
- F. Units shall be controlled automatically by integral thermostat when heater is in "ON" position.
- G. Heater shall have built-in fan delay.
- H. Finish - Baked-on enamel.
- I. Approved Manufacturers:
  - 1. Q' Mark
  - 2. Berko
  - 3. Thermador
  - 4. Markel

**END OF SECTION**

**SECTION 23 5721**

**RADIANT SNOWMELT**

**PART 1 - GENERAL**

**1. RELATED DOCUMENTS**

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.
- B. Examine all other portions of the contract documents for work or other terms and conditions related to the work of this section. Provide all work here under, as required for the support and accommodation of related work.

**2. SUMMARY**

- A. All labor, materials, transportation, equipment and services to install hydronic radiant heating system where indicated on drawings supplied for the project.

**PART 2 - PRODUCTS**

**1. SHOP DRAWINGS**

- A. Shop drawings, or descriptions of materials, and details of installation shall be submitted for approval as specified under TERMS AND CONDITIONS of contract document. No fabrication shall be performed until approval is obtained.

**2. ALL COMPONENTS**

- A. Components of the buried tubing system shall be provided by one manufacturer, including: tube, fittings, manifolds, and other ancillary items required for a complete installation, as manufactured by Wirsbo Company, REHAU or approved equal.

**3. WARRANTY**

- A. Tube shall carry a twenty (20) year non-prorated warranty against failure due to defect in material and workmanship. Manifolds and other ancillary components shall be warranted for eighteen (18) months from date of shipment.

**4. MATERIALS**

- A. Tube:
  - 1. Tube shall be cross-linked polyethylene, with maximum working pressure/temperature of 100 psi @ 180F. These temperatures and pressure ratings shall be issued by hydrostatic stress board of PPI (Plastic Pipe Institute). PPI is a division of SPI (Society of Plastics Industry).
  - 2. The tube shall be manufactured in accordance with ASTM standard specification F 876. The tube shall be listed to ASTM by independent third party testing laboratory.
  - 3. The tube shall be of cross-linked polyethylene manufactured by the "Engel Method." The tube shall have an oxygen diffusion barrier capable of limiting oxygen diffusion through the tube to no greater than .10g/m<sup>3</sup> /day @ 104F water temperature.
  - 4. The tube dimensions shall be:
    - a. 3/4" nominal inside diameter (7/8" outside diameter), in accordance with ASTM standard specification, as above, or
    - b. 5/8" nominal inside diameter (3/4" outside diameter), in accordance with ASTM standard specification, as above, or



- c. 1/2" nominal inside diameter (5/8" outside diameter), in accordance with ASTM standard specification, as above, or
  - d. 3/8" nominal inside diameter (1/2" outside diameter), in accordance with ASTM standard specification, as above
  5. The minimum bend radius for cold bending of the tube shall not be less than six (6) times the outside diameter. Bends with a radius less than stated shall require the use of a bend support as supplied by the tube manufacturer.
- B. Manifolds:
1. Manifolds shall be of cast brass construction, manufactured of alloys to prevent dezincification, and shall have integral circuit balancing valves. Manifolds shall be able to vent air from the system, and shall be provided with support brackets and tube bend supports. Manifolds shall be isolated from supply and return tubing with valves that are suitable for isolation and balancing.
- C. Fittings:
1. Fittings shall be manufactured of dezincification resistant brass. These fittings must be supplied by the tube manufacturer. The fittings shall consist of a compression fitting with insert, compression ring and a compression nut.
- D. Supply and return piping to manifolds:
1. Piping shall be metal pipe or cross-linked polyethylene tube with an integral oxygen diffusion barrier. Cross-linked polyethylene tube should only be used when specifically approved by the local building inspector for supply and return piping applications.
  2. Fittings shall be compatible to the piping material used. Fittings used with the cross-linked polyethylene tube shall not permit excessive oxygen permeation.
- E. Snow Detector and Melting Control 664, Pulse Width Modulation:
1. The system water temperature shall be based on the outdoor temperature and feedback from sensors located in the snow melting slabs.
  2. The control shall have an adjustable minimum supply water temperature setting to help prevent condensation of the flue gases and subsequent corrosion and blockage of the boiler's heat exchanger and chimney.
  3. The control shall have the option to directly operate a variable speed injection pump, a mixing valve with a floating action actuator motor, or a 4-20 mA device.
  4. The control shall have the ability to limit the amount of cool water being returned to the boiler through the mixing device in order to prevent low boiler operating temperatures and flue gas condensation.
  5. The control shall have the ability to directly control the supply temperature of one of two boiler stages or to send a boiler enable signal to another boiler operating control to allow for a staging control to be connected.
  6. The control shall have the option of an automatic differential calculation for the operation of one or two boiler stages in order to prevent short cycling.
  7. The control shall have an option to rotate the firing sequence of the boilers and the option for rotating the boiler firing sequence shall be based on the boilers' accumulated running hours.
  8. The control shall use proportional, integral and derivative (PID) logic when staging boiler stages.
  9. The control shall have four separate lockable access levels to limit the number of adjustments available to various users.
  10. The control shall have a test button that activates a pre-programmed test sequence testing all of the control's outputs.
  11. The control shall show a number of current sensor temperatures depending on the access level that has been selected.
  12. The control shall continuously monitor its temperature sensors and provide an error message upon a control or sensor failure.
  13. The control shall record and display various device running hours and minimum and maximum temperatures depending on the access level that has been selected.

14. During extended periods of inactivity, the pumps and valves that are operated by the control shall be periodically exercised to prevent seizure during long idle periods.
15. The control shall have the ability to operate two zones of snow melting.
16. The control shall have three levels of priority when operating two zones of snow melting.
17. The control shall have the ability to use a snow/ice sensor in order to automatically detect snow or ice and begin operation of the system. The system shall continue to run until the sensor is dry or the control is manually stopped.
18. The control shall have the ability to be manually started with an adjustable running time that counts down and automatically stops the system.
19. The control shall have the option of connecting a remote display module to allow for remote monitoring and adjustment of the control.
20. The control shall have the option of connecting a remote start/stop module to allow for starting and stopping of the system.
21. The control shall not operate the system to provide heat to the snow melting zones when it enters into either a warm weather shut down (WWSD) or a cold weather cut off (CWCO) mode.
22. Approved Sensors:
  - a. Outdoor Sensor 070.
  - b. Snow/Ice Sensor 090, 65 foot Wire.

### **PART 3 - EXECUTION**

#### **1. INSTALLATION**

- A. Hydronic radiant heat tubing loops shall be installed in accordance with the manufacturer's recommendations and the details as shown on the contract drawings.
- B. All fittings should be accessible for maintenance. Tubing loops shall be installed without splices, as a minimum, from the point at which the tubing enters the panel to the point at which it exits the panel.
- C. Installation shall follow the shop drawings for tubing layout, tube spacing, manifold configuration, manifold location, and controls. All notes on the drawing shall be followed.
- D. The tubing system shall be pressurized, with water or air, in accordance with applicable codes, or to a pressure of 60 psig 24 hours prior to encasement in the radiant panel. The tubing system shall remain at this pressure during the panel installation and for a minimum of 24 hours thereafter to ensure system integrity. The contractor shall provide the water or air for the pressurization of the tubing system. The contractor assumes all liabilities for suitable safety precautions and testing, including the use of compressed air, when applicable.
- E. At start up time, the contractor shall: follow the manufacturer's recommendations for system water and temperature balancing, record balance settings at each manifold location, and deliver to the owner a complete record of these settings for inclusion in the operation and maintenance manuals.

**END OF SECTION**

## SECTION 23 6213

### AIR-COOLED CONDENSING UNITS

#### PART 1 - GENERAL

##### 1. RELATED DOCUMENTS

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, and Section 23 0501 apply to this Section.

##### 2. SUMMARY

- A. Furnish and install condensing units as described in Contract Documents.

##### 3. WARRANTY

- A. Five-year warranty on compressors.
  - 1. Warranty time frame shall be five years from date of "start-up". "Start-up" date shall be recorded on warranty certificate for each unit.

#### PART 2 - PRODUCTS

##### 1. TWO TON THROUGH FIVE TON UNITS

- A. Condenser coil shall have aluminum plate fins mechanically bonded to seamless copper tubes.
  - 1. Provide coil guard for unit.
- B. Fans shall be direct driven propeller upflow type.
  - 1. Fan motor shall be single or two speed, thermostatically controlled, permanently lubricated, and designed with permanent protection and ball bearings.
  - 2. Motors shall be resiliently mounted.
  - 3. Each fan shall have a safety guard.
- C. Units shall be operable down to 0 deg F outdoor temperature.
- D. Compressor shall be of hermetic design with the following features. Each condenser unit shall have only one compressor.
  - 1. Externally mounted brass service valves with charging connections.
  - 2. Crankcase heater.
  - 3. Resilient rubber mounts.
  - 4. Compressor motor overload protection.
  - 5. Single speed
- E. Controls:
  - 1. Factory wired and located in separate enclosure.
  - 2. Safety devices shall consist of high and low pressure cutout and condenser fan motor overload devices.
  - 3. Unit shall have anti-cycle timers to prevent units from starting up again for five minutes after any power interruption.
- F. Casing:
  - 1. Fully weatherproof for outdoor installation. Finish shall be weather resistant.
  - 2. Openings shall be provided for power and refrigerant connections.
  - 3. Panels shall be removable for servicing.
- G. Expansion Valves:

1. Stainless steel diaphragm and same refrigerant in thermostatic elements as in system. Externally or internally equalized as required by evaporator/condensing system.
  2. Size valves to provide full rated capacity of cooling coil served.
  3. Furnished by evaporator coil/condensing unit supplier and coordinated to provide bleed holes for system pressure equalization, if required.
- H. Condensing units shall use R-410A refrigerant. Only one liquid line, one suction line, and one power connection shall be made to each compressor. Provide charging valves.
- I. SEER rating as defined by ARI shall be not less than 13.0.
- J. Set each unit on neoprene isolation pads located at each corner and sized 4" x 4" x 3/4" high minimum.
- K. Approved Manufacturers:
1. York
  2. Carrier
  3. Lennox
  4. Trane

### **PART 3 - EXECUTION**

#### **1. INSTALLATION**

- A. Set condensing units as detailed on the drawings.

#### **2. FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service:
- B. Condensing units shall be started up, checked out, and adjusted by Condensing Unit Manufacturer's authorized factory trained service mechanic.
- C. Mechanic shall use check-out sheet provided by Manufacturer, complete and sign all items on sheet, and submit to Architect.

**END OF SECTION**

**END OF DIVISION**