

DIVISION 23: HEATING, VENTILATING, AND AIR-CONDITIONING

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SECTION 23 05 01 – COMMON HVAC REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 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.

1.3 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.

1.4 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.

1.5 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. "2018 International Building Code", "2018 International Mechanical Code", "2018 International Plumbing Code" and "2018 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. "2018 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.

1.6 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.

1.7 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

3.1 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.

3.2 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.

3.3 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.

3.4 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.

3.5 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.

3.6 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.

3.7 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.

3.8 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.

3.9 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.

3.10 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.

3.11 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.

3.12 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.

3.13 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.

3.14 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 23 05 01

SECTION 23 05 53 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 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

2.1 PAINT

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

2.2 LABELS

- A. Black Formica with white reveal on engraving.

2.3 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

2.4 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.

2.5 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"

2.6 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

3.1 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. Hot Water Heating, 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
HWH	Hot Water Heating	Green
NG	Natural Gas	Yellow

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

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

- D. Colored plastic bands and arrows
 - 1. Colored bands and arrows may be used instead of painting. If used on insulated pipe they shall be installed by wrapping the arrows completely around the pipe and sticking back on itself at each end of the identification label to prevent the labels from coming loose.

END OF SECTION 23 05 53

SECTION 23 05 93 – TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Division 23 0100 - Common HVAC Requirements and Basic Mechanical Materials and Methods Sections apply to work of this section.

1.2 SUMMARY SCOPE

- A. This Section includes TAB to produce design objectives for the following:
 - 1. Air Systems.
 - a. Exhaust Fans.
 - b. Rooftop ERV systems

1.3 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 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.

1.4 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.

1.5 PROJECT CONDITIONS

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

1.6 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

3.1 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.

3.2 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.

3.2 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.

3.3 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.

3.4 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 23 05 93

SECTION 23 07 12 – MECHANICAL INSULATION AND FIRE STOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 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. Boilers, Tanks, Headers, and Breechings
 4. Refrigerant Piping

1.3 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 23 07 12

SECTION 23 07 14 - PREMOLDED ONE PIECE PVC FITTINGS AND INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Furnish and install premolded one piece PVC fittings insulation as described in Contract Documents.

1.3 QUALITY ASSURANCE

- A. Fittings shall be UL rated 25/50 PVC.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Approved Manufacturers:
 - 1. Zeston

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Where factory premolded one piece PVC insulating fitting covers are to be used, proper factory precut Hi-Lo Temp insulation shall be applied to the fitting. Ends of Hi-Lo Temp insulation shall be tucked snugly into throat of fitting and edges adjacent to pipe covering tufted and tucked in. Fully insulate pipe fittings. One piece PVC fitting cover is then secured by stapling, tack fastening, banding or taping ends to adjacent pipe covering.
- B. Cold:
 - 1. Chilled water systems shall be insulated as "A" above and have all seam edges of cover sealed with Zeston's vapor barrier adhesive or equal.
 - 2. Circumferential edges of cover shall be wrapped with Zeston's vapor barrier pressure sensitive color matched Z tape.
 - 3. Tape shall extend over adjacent pipe insulation and have an overlap on itself at least 2" on downward side.
- C. Hot:
 - 1. On fittings where temperature exceeds 250 degrees F., two layers of factory precut Hi-Lo Temp insulation inserts shall be applied with a few wrappings of twine on first layer, to be sure there are no voids or hot spots. Fitting cover shall then be applied over Hi-Lo Temp insulation as described above in "A."

END OF SECTION 23 07 14

SECTION 23 07 15 – HOT WATER HEATING & RETURN PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 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

2.1 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

3.1 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 23 07 15

SECTION 23 07 16 - DUCTWORK INSULATION

PART 1 - GENERAL

1.1 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.

1.2 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

2.1 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

3.1 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 23 07 16

SECTION 23 07 17 – ROUND SUPPLY DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 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

3.1 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 23 07 17

SECTION 23 07 18 - DUCT LINING

PART 1 - GENERAL

1.1 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.

1.2 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.

1.3 SYSTEM DESCRIPTION

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

1.4 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

2.1 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

2.2 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

2.3 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

3.1 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.

3.2 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.

3.3 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 23 07 18

SECTION 23 07 20 - REFRIGERANT PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 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.

1.3 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

2.1 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

2.2 JOINT SEALER

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

2.3 MANUFACTURED UNITS

- A. Nominal 3/4" wall thickness

- B. Approved Manufacturers:
 - 1. ImcoLock Pipe Insulation
 - 2. or approved equal

PART 3 - EXECUTION

3.1 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 23 07 20

SECTION 23 08 00 – FIRE STOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 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

3.1 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 23 08 00

SECTION 23 21 13 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

- A. This Section includes piping, special-duty valves, makeup water for these systems; blowdown drain lines; and condensate drain piping.

1.3 DEFINITIONS

- A. CPVC: Chlorinated polyvinyl chloride.
- B. PVC: Polyvinyl chloride.

1.4 SUBMITTALS

- A. Product Data: For each type of special-duty valve indicated. Include flow and pressure drop curves based on manufacturer's testing for diverting fittings, calibrated balancing valves, and automatic flow-control valves.
- B. Shop Drawings: Detail fabrication of pipe anchors, hangers, special pipe support assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
- C. Welding Certificates: Copies of certificates for welding procedures and personnel.
- D. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Failed test results and corrective action taken to achieve requirements.
- E. Maintenance Data: For hydronic specialties and special-duty valves to include in maintenance manuals specified in Division 23.
- F. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to the ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

- C To assure uniformity and compatibility of piping components in grooved end piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied by the same manufacturer as the grooved components.

1.6 COORDINATION

- A. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate pipe sleeve installations for foundation wall penetrations.
- C. Coordinate piping installation with roof curbs, equipment supports, and roof penetrations.
- D. Coordinate pipe fitting pressure classes with products specified in related Sections.
- E. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 3 Sections.
- F. Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Division 7 Section "Through-Penetration Firestop Systems" for fire and smoke wall and floor assemblies.

1.7 EXTRA MATERIALS

- A. Water Treatment Chemicals: Furnish sufficient chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Grooved Mechanical-Joint Fittings and Couplings:
 - a. Central Sprinkler Company; Central Grooved Piping Products.
 - b. Grinnell Mechanical Products.
 - c. Victaulic Company of America.
 - 2. Calibrated Balancing Valves:
 - a. Armstrong Pumps, Inc.
 - b. Flow Design, Inc.
 - c. Gerand Engineering Company.
 - d. Griswold Controls.
 - e. ITT Bell & Gossett; ITT Fluid Technology Corp.
 - f. Taco, Inc.
 - g. Tour Andersson supplied by Victaulic
 - 3. Pressure-Reducing Valves:

- a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Conbraco Industries, Inc.
 - d. ITT Bell & Gossett; ITT Fluid Technology Corp.
 - e. Spence Engineering Company, Inc.
 - f. Watts Industries, Inc.; Watts Regulators.
4. Safety Valves:
- a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Conbraco Industries, Inc.
 - d. ITT McDonnell & Miller Div.; ITT Fluid Technology Corp.
 - e. Kunkle Valve Division.
 - f. Spence Engineering Company, Inc.
5. Automatic Flow-Control Valves:
- a. Flow Design, Inc.
 - b. Griswold Controls.
6. Expansion Tanks:
- a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. ITT Bell & Gossett; ITT Fluid Technology Corp.
 - d. Taco, Inc.
7. Air Separators and Air Purgers:
- a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. ITT Bell & Gossett; ITT Fluid Technology Corp.
 - d. Taco, Inc.

2.2 PIPING MATERIALS

- A. General: Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

2.3 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
- C. DWV Copper Tubing: ASTM B 306, Type DWV.
- D. Wrought-Copper Fittings: ASME B16.22.
- E. Wrought-Copper Unions: ASME B16.22.
- F. Solder Filler Metals: ASTM B 32, 95-5 tin antimony.
- G. Brazing Filler Metals: AWS A5.8, Classification BAg-1 (silver).

2.4 VALVES

- A. Gate, globe, check, ball, and butterfly valves are specified in Division 23 Section "Valves."
- B. Refer to Part 3 "Valve Applications" Article for applications of each valve.

- C. Calibrated Balancing Valves, NPS 2 and Smaller: Bronze body, ball type, 125-psig working pressure, 250 deg F maximum operating temperature, and having threaded ends. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain set position.
- D. Automatic Flow-Control Valves: Gray-iron body, factory set to maintain constant flow with plus or minus 5 percent over system pressure fluctuations, and equipped with a readout kit including flow meter, probes, hoses, flow charts, and carrying case. Each valve shall have an identification tag attached by chain, and be factory marked with the zone identification, valve number, and flow rate. Valve shall be line size and one of the following designs:
 - 1. Gray-iron or brass body, designed for 175 psig at 200 deg F with stainless-steel piston and spring.
 - 2. Brass or ferrous-metal body, designed for 300 psig at 250 deg F with corrosion-resistant, tamperproof, self-cleaning, piston-spring assembly easily removable for inspection or replacement.
 - 3. Combination assemblies, including bronze ball valve and brass alloy control valve, with stainless-steel piston and spring, fitted with pressure and temperature test valves, and designed for 300 psig at 250 deg F.

2.5 HYDRONIC SPECIALTIES

- A. Manual Air Vent: Bronze body and nonferrous internal parts; 150-psig working pressure; 225 deg F operating temperature; manually operated with screwdriver or thumbscrew; with NPS 1/8 discharge connection and NPS 1/2 inlet connection.
- B. Automatic Air Vent: Designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150-psig working pressure; 240 deg F operating temperature; with NPS 1/4 discharge connection and NPS 1/2 inlet connection.
- C. Expansion Tanks: Welded carbon steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Separate air charge from system water to maintain design expansion capacity by a flexible bladder securely sealed into tank. Include drain fitting and taps for pressure gage and air-charging fitting. Support vertical tanks with steel legs or base; support horizontal tanks with steel saddles. Factory fabricate and test tank with taps and supports installed and labeled according to the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
- D. Tangential-Type Air Separators: Welded black steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 deg F maximum operating temperature; perforated stainless-steel air collector tube designed to direct released air into expansion tank; tangential inlet and outlet connections; threaded connections for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger; threaded blowdown connection. Provide units in sizes for full-system flow capacity.
- E. In-Line Air Separators: One-piece cast iron with an integral weir designed to decelerate system flow to maximize air separation at a working pressure up to 175 psig and liquid temperature up to 300 deg F.
- F. Air Purgers: Cast-iron body with internal baffles that slow the water velocity to separate the air from solution and divert it to the vent for quick removal. Maximum working pressure of 150 psig and temperature of 250 deg F.
- G. Bypass Chemical Feeder: Welded steel construction; 125-psig working pressure; 5-

gal. capacity; with fill funnel and inlet, outlet, and drain valves.

1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.
- H. Diverting Fittings: 125-psig working pressure; 250 deg F maximum operating temperature; cast-iron body with threaded ends, or wrought copper with soldered ends. Indicate flow direction on fitting.
- I. Y-Pattern Strainers: 125-psig working pressure; cast-iron body (ASTM A 126, Class B), flanged ends for NPS 2-1/2 and larger, threaded connections for NPS 2 and smaller, bolted cover, perforated stainless-steel basket, and bottom drain connection.
- J. Grooved Y-Pattern Strainer: 2 inch through 18 inch sizes, 300 PSI Y-Type Strainer shall consist of ductile iron body, ASTM A-536, Grade 65-45-12, Type 304 stainless steel perforated metal removable baskets with 1/16" (1,6mm) diameter perforations 2"-3" strainer sizes, 1/8" (3,2mm) diameter perforations 4"-12" strainer sizes, and 0.156" (4mm) diameter perforations 14" -18" strainer sizes. Strainer basket shall be accessed by removal of mechanical coupling.
- K. Basket Strainers: 125-psig working pressure; high-tensile cast-iron body (ASTM A 126, Class B), flanged-end connections, bolted cover, perforated stainless-steel basket, and bottom drain connection.
- L. T-Pattern Strainers: 750-psig working pressure; ductile-iron or malleable-iron body, grooved-end connections, stainless-steel basket with 57 percent free area; removable access coupling and end cap for strainer maintenance.
- M. Grooved T-Pattern Strainer: 2" through 12" sizes, 300 PSI T-Type Strainer shall consist of ductile iron (ASTM A-536, Grade 65-45-12) body, Type 304 stainless steel frame and mesh removable basket with No. 12 mesh, 2"-3" strainer sizes, or No. 6 mesh, 4"-12" strainer sizes, 57% free open area. Strainer basket shall be accessed by removal of mechanical coupling.
- N. Flexible Connectors: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150-psig minimum working pressure and 250 deg F maximum operating temperature. Connectors shall have flanged- or threaded-end connections to match equipment connected and shall be capable of 3/4-inch misalignment.
- O. Spherical, Rubber, Flexible Connectors: Fiber-reinforced rubber body with steel flanges drilled to align with Classes 150 and 300 steel flanges; operating temperatures up to 250 deg F and pressures up to 150 psig.
- P. Packed, Slip, Expansion Joints: 150-psig minimum working pressure, steel pipe fitting consisting of telescoping body and slip-pipe sections, packing ring, packing, limit rods, flanged ends, and chrome-plated finish on slip-pipe telescoping section.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Floor Heat Water, NPS 2 and Smaller: Aboveground, use Type L drawn-temper copper tubing with soldered joints or Schedule 40 steel pipe with threaded joints. Belowground or within slabs, use Type K annealed-temper copper tubing with soldered joints. Use the fewest possible joints belowground and within floor slabs.

- B. Condensate Drain Lines: Type L drawn-temper copper tubing with soldered joints or Schedule 40, PVC pipe with solvent-welded joints.

3.2 VALVE APPLICATIONS

- A. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:
 - 1. Shutoff Duty: Gate, ball, and butterfly valves.
 - 2. Throttling Duty: Globe, ball, and butterfly valves.
- B. Install shutoff duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, unless only one piece of equipment is connected in the branch line. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.
- C. Install calibrated balancing valves in the return water line of each heating or cooling element and elsewhere as required to facilitate system balancing.
- D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- E. Install safety valves on hot-water generators and elsewhere as required by the ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to floor. Comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for installation requirements.
- F. Install pressure-reducing valves on hot-water generators and elsewhere as required to regulate system pressure.

3.3 PIPING INSTALLATIONS

- A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for basic piping installation requirements.
- B. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- C. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- D. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- E. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- F. Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.
- G. Install strainers on supply side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

- H. Anchor piping for proper direction of expansion and contraction.

3.4 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports." Comply with requirements below for maximum spacing of supports.
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
 - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer. cal runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

- A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for joint construction requirements for soldered and brazed joints in copper tubing; threaded, welded, and flanged joints in steel piping; and solvent-welded joints for PVC and CPVC piping.

3.6 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Install automatic air vents in mechanical equipment rooms only at high points of system piping, at heat-transfer coils, and elsewhere as required for system air venting.
- C. Install dip-tube fittings in boiler outlet. Install piping to expansion tank with a 2 percent upward slope toward tank. Connect boiler-outlet piping.
- D. Install in-line air separators in pump suction lines. Install piping to compression tank with a 2 percent upward slope toward tank. Install drain valve on units NPS 2 and larger.
- E. Install combination air separator and strainer in pump suction lines. Install piping to compression tank with a 2 percent upward slope toward tank. Install blowdown piping with gate valve; extend to nearest drain.
- F. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches above floor. Install feeder in bypass line, off main, using globe valves on each side of feeder and in the main between bypass connections. Pipe drain, with ball valve, to nearest equipment drain.
- G. Install expansion tanks above air separator. Install gage glass and cocks on end of tank. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
 - 1. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, and fittings, plus weight of a full tank of water. Do not overload building components and structural members.
- H. Install expansion tanks on floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system design requirements.

3.7 TERMINAL EQUIPMENT CONNECTIONS

- A. Size for supply and return piping connections shall be same as for equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If multiple, parallel control valves are installed, only one bypass is required.
- D. Install ports for pressure and temperature gages at coil inlet connections.

3.8 CHEMICAL TREATMENT

- A. Perform an analysis of supply water to determine the type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the following water characteristics:
- B. Fill system and perform initial chemical treatment.

3.9 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
 - 1. Leave joints, including welds, uninsulated and exposed for examination during test.
 - 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 - 3. Flush system with clean water. Clean strainers.
 - 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
 - 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
 - 6. Grooved pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing.
 - 7. The grooved couplings gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified.
 - 8. Grooved couplings installation shall be complete when visual metal-to-metal contact is reached.

3.10 GROOVED PIPING TRAINING

- A. A factory trained representative (direct employee) of the grooved coupling supplier shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and product installation.

PART 4 - Testing

- A. Perform the following tests on hydronic piping:
 - 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.

2. While filling system, use vents installed at high points of system to release trapped air. Use drains installed at low points for complete draining of liquid.
3. Check expansion tanks to determine that they are not air bound and that system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

4.1 ADJUSTING

- A. Mark calibrated nameplates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.
- B. Perform these adjustments before operating the system:
 1. Open valves to fully open position. Close coil bypass valves.
 2. Check pump for proper direction of rotation.
 3. Set automatic fill valves for required system pressure.
 4. Check air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
 5. Set temperature controls so all coils are calling for full flow.
 6. Check operation of automatic bypass valves.
 7. Check and set operating temperatures of boilers, chillers, and cooling towers to design requirements.
 8. Lubricate motors and bearings.

4.2 CLEANING

- A. Flush hydronic piping systems with clean water. Remove and clean or replace strainer screens. After cleaning and flushing hydronic piping systems, but before balancing, remove disposable fine-mesh strainers in pump suction diffusers.

END OF SECTION 23 21 13

SECTION 23 21 15 – HOT WATER HEATING SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 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

3.1 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.

3.2 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.

3.3 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.

3.4 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 23 21 15

SECTION 23 21 16 – HOT WATER HEATING SYSTEM SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

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

PART 2 - PRODUCTS

2.1 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.

2.2 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.

2.3 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

2.4 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

2.5 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

2.6 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

2.7 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

2.8 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

2.9 BOILER RELIEF VALVE

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

2.10 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

3.1 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 23 21 16

SECTION 23 21 23 – CIRCULATING PUMPS AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 22 0100 apply to this Section.

1.2 SUMMARY

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

PART 2 - PRODUCTS

2.1 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

3.1 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 23 21 23

SECTION 23 21 25 - CLEANING AND FLUSHING WATER CIRCULATING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

- A. Furnish labor and materials to thoroughly clean water circulating systems as described in Contract Documents.
- B. Mechanical contractor shall procure the services of an independent treatment contractor as described in this specification.

1.3 QUALITY ASSURANCE

- A. System Additives: This Contractor shall not add any water treatment chemicals or "stop-leak" compounds to the system.

PART 2 - EXECUTION

2.1 FIELD QUALITY ASSURANCE

- A. Water circulating systems for project shall be thoroughly cleaned before placing in operation to rid system of dirt, piping compound, mill scale, oil, and other materials foreign to water being circulated.
- B. During construction extreme care shall be exercised to prevent dirt and other foreign matter from entering pipe or other parts of system. Pipe stored on project shall have open ends capped and equipment shall have openings fully protected. Before erection, each piece of pipe, fittings, or valve shall be visually examined and dirt removed.
- C. Hydronic Closed Loop Cleaning
 1. Prior to any introduction of fluids to the closed loop system the Mechanical Contractor shall close isolation valves at each heat pump and open the bypass valve to prevent flow through the strainer, flow control device and heat pump during the initial flushing and subsequent cleaning. The side stream filter bag shall be removed during the initial flushing process.
 2. The Mechanical Contractor shall fill each hydronic system with clean fresh water prior to cleaning and thoroughly leak check system piping. A cleaning and passivating agent supplied by the Chemical Treatment Contractor shall be added to the system at the direction of the Treatment Contractor during the leak check process to minimize initial corrosion. If the system is filled multiple times during the leak check and repair process the Mechanical Contractor shall coordinate with the Treatment Contractor to maintain this initial protection. The Treatment Contractor is responsible for providing chemical for up to two refills of the system. If additional chemical is required due to multiple refillings the Mechanical Contractor shall be responsible for the additional time and chemical.
 3. Following leak check the closed system shall be flushed by the Mechanical Contractor until the leaving water runs clear. All primary runs shall be flushed at their ends to obtain maximum sweep of debris from the system. The inlet

screens on the circulating pumps must be kept clear during this initial cleaning process and inspected following cleaning. When flushing is complete the system is to be left full.

4. Prior to flushing the Mechanical Contractor shall coordinate with Treatment Contractor so that the Treatment Contractor can be available immediately following flush and final refill to add cleaning chemical within 4 hours to prevent initial corrosion.
5. Following initial flushing the Chemical Treatment Contractor shall refill all systems with cleaning and passivating agents raising the PH to a minimum of 10, circulate and flush until thoroughly clean. All primary piping runs shall be flushed at the ends during this cleaning process. When boiler operation is available the loop temperature should be raised to 110 to 120° to accelerate cleaning. Cleaning with availability of boiler operation should be anticipated to last 7 to 10 days or longer depending on initial loop conditions. If boiler operation is unavailable loop cleaning duration should be expected to double. The Chemical Treatment Contractor shall verify and adjust cleaning chemistry, and inspect side stream filter bags at a minimum of every two days, exception for weekends. Filter bags shall be changed as required during this cleaning process. Cleaning shall continue until these bags no longer show signs of debris.
6. Following cleaning process the Treatment Contractor shall close the bypass valves at each heat pump and open isolation valves for normal operation and check for leaks of local piping connections. Any leaks found shall be referred to the Mechanical Contractor for repair. The bypass valve handle shall be removed and tied to the valve. The system shall then be charged with final operating chemical to control long term corrosion and a clean bag filter shall be installed in the system.
7. The Treatment Contractor shall provide final inspection report for inclusion in the Operation and Maintenance Manual. Additionally the Treatment Contractor shall take loop samples approximately 12 months following completion, add or adjust chemical as required and provide a post construction report to the owner prior to warranty closeout. Chemical required is the responsibility of the Treatment Contractor.

END OF SECTION 23 21 25

SECTION 23 23 00 - REFRIGERANT PIPING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

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

1.3 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 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.

2.2 REFRIGERANT FITTINGS

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

2.3 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.

2.4 FLUX

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

PART 3 - EXECUTION

3.1 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.

3.2 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 23 23 00

SECTION 23 23 10 - REFRIGERANT SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 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

2.1 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

2.2 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

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

2.4 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

3.1 INSTALLATION

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

END OF SECTION 23 23 10

SECTION 23 23 11 - REFRIGERANT PIPE COVER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, and Section 23 0100 apply to this Section.

PART 2 - PRODUCTS

2.1 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.

2.2 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 Fluropon by Desoto containing 70% minimum Kynar 500 by Pennwalt Corp.

PART 3 - INSTALLATION

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

END OF SECTION 23 23 11

SECTION 23 31 14 - LOW-PRESSURE STEEL DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

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

PART 2 - PRODUCTS

2.1 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.]

2.2 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

2.3 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

2.4 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

2.5 CONCEALED CEILING DAMPER REGULATORS

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

2.6 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.

2.7 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

2.8 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

2.9 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.

2.10 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

3.1 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

- G. Install motorized dampers

END OF SECTION 23 31 14

SECTION 23 34 00 - EXHAUST FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 QUALITY ASSURANCES

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

PART 2 - PRODUCTS

2.1 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
 - 5. Twin City

PART 3 - EXECUTION

3.1 INSTALLATION

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

END OF SECTION 23 34 00

SECTION 23 37 13 - AIR OUTLETS & INLETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 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

2.1 GRILLES & REGISTERS

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

2.2 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

PART 3 - EXECUTION

3.1 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 23 37 13

SECTION 23 53 15 – HEATING BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Furnish and install heating boilers as described in Contract Documents.

1.3 QUALITY ASSURANCE

- A. Boiler shall be AGA design certified for a minimum boiler efficiency of 80% and bear appropriate seal.
- B. Boiler shall meet requirements of ASME Boiler and Pressure Vessel Code for 160 psi working pressure and shall bear ASME seal and registration number of National Board of Boiler and Pressure Vessel Inspectors.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Equipped for natural gas.
- B. Designed specifically for hot water heating systems and specifically designated as such by manufacturer.
- C. Atmospheric type using titanium stainless steel burners.
- D. Shall not require blower motors to supply combustion air or to create venting action.
- E. Fuel-air mixture shall be factory set for maximum combustion efficiency and shall be tamper-proof in the field.
- F. Completely assembled with a built-in draft diverter.
- G. Heat Exchanger: Boiler shall be of straight tube design and shall have no blind passages or concealed pockets. Water containing parts shall be designed so they are continually scoured to prevent any build-up of sludge that would necessitate periodic blow down.
 - 1. Inspection covers permitting inspection of wet internal surfaces shall be provided on headers at each end and held in place by corrosion resistant steel cap screws. Waterways shall be copper or bear fused ceramic coating to positively protect boiler from corrosion.
 - 2. Entire wet section of boiler shall be removable and replaceable without damage or disassembly of combustion chamber and/or burner sections.
 - 3. Water tubes shall be made of integral-finned copper tubing of 7/8 inch I.D. x .065 wall thickness with fins of .40 inch minimum height spaced at 7 fins per inch. The tubes shall be rolled directly into an ASME header of grey cast iron protected by a ceramic coating fused into the metal at not less than 1300 deg. F. Non-metallic gaskets shall be exterior to jacket structure and combustion chamber to avoid

deterioration from heat. Complete heat transfer section shall be hydrostatically tested at 400 psi, be ASME inspected and approved, and protected by an ASME pressure relief valve.

- H. Combustion Chamber and Jacket: Combustion chamber shall be lined with a castable refractory approved for service temperatures at not less than 2100 deg. F. Outer jacket shall be unitized shell and frame construction fabricated of galvanized steel and finished with acrylic thermoset paint baked on at not less than 325 deg. F.
- I. Controls: Ignition safeguards shall be provided as follows:
 - 1. System 9 - Standard on natural gas units:
 - a. Electronic pilot flame supervision
 - b. Main gas shutdown 1 second after pilot failure
 - c. Automatic pilot ignition on start-up
 - d. Automatic pilot re-ignition if pilot is extinguished
 - e. Solid state components.
- J. Firing Option: Boiler shall be provided with 4-stage firing with automatic temperature reset control.
- K. Multimatic Sequence Control System for Input Modulation: Teledyne Laars Multimatic Sequence Control System is an electronic package that provides central control for a heating system. Simple wiring connections between panel and boilers will change individual boilers into a single, cohesive step control heating system.
 - 1. The heart of Teledyne Laars' Multimatic Sequence Control System is a versatile control panel made up of a solid state signal center with throttling range adjustment and system temperature reset ratio adjustment and a proportional staging control of four stages.
 - 2. Provide with Outdoor Reset: Multimatic Sequence Control System shall come with an electronic immersion sensor for mounting in system water line and an electronic outdoor temperature sensor.
- L. Approved Manufacturers:
 - 1. HTP
 - 2. Teledyne Laars
 - 3. or approved equal

END OF SECTION 23 53 15

SECTION 23 57 22 – RADIANT FLOOR HEAT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 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.

1.2 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

2.1 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.

2.2 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, or approved equal.

2.3 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. Refer to Wirsbo's General Conditions for the complete context of Wirsbo's "Limited Warranty".

2.4 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, as manufactured by Wirsbo Company. 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/m³ /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. Controls:
- 1. Provide whole house controller equal to Tekmar C403 controller.
 - 2. Controller to control boiler, pumps, mixing valves and zone controls.

PART 3 - EXECUTION

3.1 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 23 57 22

SECTION 23 72 23 – ENERGY RECOVERY VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Includes But Not Limited To:
 - 1. Furnish and install air-to-air Energy Recovery Ventilation (Energy Recovery Ventilator) units as described in Contract Documents
- B. Related Requirements:
 - 1. Section 23 0501: 'Common HVAC Requirements'.
 - 2. Section 23 3114: 'Low-Pressure Metal Ducts'.
 - 3. Section 23 4100: 'Air filters'.

1.2 REFERENCES

- A. Reference Standard:
 - 1. American National Standards Institute (ANSI) / American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
 - a. ANSI/ASHRAE 84-2013, 'Method of Testing Air-to-Air Heat/Energy Exchangers'.
 - 2. National Fire Protection Association / American National Standards Institute:
 - a. NFPA 90A: 'Standard for the Installation of Air-Conditioning and Ventilating Systems' (2018 Edition).
 - b. NFPA 90B: 'Standard for the Installation of Warm Air Heating and Air-Conditioning Systems' 2018 Edition).

1.3 QUALITY ASSURANCE

- A. Regulatory Agency Sustainability Approvals:
 - 1. ASHRAE Compliance:
 - a. Capacity ratings for air-to-air energy recovery equipment shall comply with ANSI/ASHRAE 84, 'Method of Testing Air-to-Air Heat Exchangers'.

1.4 WARRANTY

- A. Special Warranty:
 - 1. Warranty energy transfer element for ten years from date of substantial completion of Project.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Category Four Approved Manufactures. See Section 01 6200 for definitions of Categories:
 - 1. RenewAire LLC, Madison, WI www.renewaire.com.
 - 2. Greenheck Fan Corporation, Schofield, WI, www.greenheck.com.

3. S&P USA Ventilation System, LLC, Jacksonville, FL, www.solerpalau-usa.com.

2.2 MANUFACTURED UNITS

A. Energy Recovery Units:

1. Basis of Design Product:
 - a. Basis of design for this Project is Energy Recovery Ventilation by RenewAire (model number(s) as shown on Contract Drawings).
 - b. Approved Equivalent Product:
 - 1) Energy Recovery Module Model ECV by Greenheck.
 - 2) Total Recovery Model TRC by S&P USA Ventilation System.
2. Performance:
 - a. Capacities:
 - 1) Element rated by Manufacturer using method described in ANSI/ASHRAE 84. Exceed 70 percent temperature efficiency.
 - 2) Applicable for range of ventilation up to 1100 CFM in each air stream without disposition of dust in elements.
3. Construction:
 - a. Fixed plate element.
 - b. 20 ga (0.95 mm) galvanized steel case with lapped corners.
 - c. Leveling legs.
 - d. Access door to blowers, energy transfer elements, and filters.
 - 1) Gasketed to provide air tight seal.
 - 2) Insulated with 1/4 inch (6.4 mm) Rubatex.
 - 3) Attached to unit using stainless steel fasteners.
4. Duct Openings: Four each 1/2 inch (12.7 mm) by 1/2 inch (12.7 mm) square duct collars suitable for connection to duct work.
5. Duct Openings: Four each 12 inch (305 mm) round duct collars suitable for connection to duct work.
6. Blowers:
 - a. Forward curved blades directionally driven by open, drip-proof PSC motor rated for continuous duty.
 - b. Motor: 2-3/4 horse power, 115 VAC, single phase, 60 hertz.
 - c. Baked enamel finish.
7. 24 VAC control voltage.

2.3 SOURCE QUALITY CONTROL

A. Tests:

1. Provide evidence of independent testing of core by Underwriters Laboratory (UL), verifying maximum flame spread index (FSI) of 25 and maximum smoke development index (SDI) of 50. Meet NFPA 90A and NFPA 90B requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Basis of Design Product:

1. RenewAire:
 - a. Mount Energy Recovery Units on roof.

- B. Approved Equivalent Product (Greenheck and S&P USA Ventilation System):
 - 1. Suspend Energy Recovery Units from structure.
 - 2. Coordinate with other Trades to ensure scheduled performance with Contract Drawings and specified performance is met and any installation changes required but not limited to following:
 - a. Structural supports for units.
 - b. Ductwork sizes and connection locations.
 - c. Service clearances.
 - d. Interference with existing or planned ductwork, piping, conduit, or wiring.
 - e. Electric power requirements and wire-conduit and over-current protection sizes.
 - f. Low voltage controls as shown on Contract Drawings.
 - 3. Installer responsible for any additional costs incurred by other affected Trades and Consulting Engineer for work of this section.

END OF SECTION 23 72 23

SECTION 23 81 29 - VRF SYSTEM (LG)

PART 1 - HEAT PUMP OUTDOOR UNIT:

1.1 GENERAL

- A. The outdoor unit shall be used with VRF components of the same manufacturer consisting of the outdoor unit, indoor units, factory designed and supplied Y-branches and/or Headers, and controls.
- B. System components shall be of the same manufacturer or as recommended by the manufacturer of the VRF equipment.
- C. Unit control boards shall perform all functions required to effectively and efficiently operate the VRF system and communicate in a daisy chain configuration from outdoor unit to indoor units via RS485.
- D. The outdoor unit shall be completely factory assembled, piped and wired.
- E. Each outdoor unit shall be run tested at the factory.
- F. The sum of connected nominal capacity of all indoor air handlers shall range from 50% to 130% of outdoor unit nominal capacity to ensure the VRF system will have sufficient capacity to handle the building space loads at peak design when accounting for building diversity.
- G. Outdoor unit shall have a tested sound rating no higher than 51 dB(A) per outdoor unit frame tested per KSA0701. The outdoor unit frame shall include three quiet/nighttime operation settings of 46, 43, and 40 dBA.
- H. All refrigerant lines from the outdoor unit to the indoor units shall be field insulated.
- I. The outdoor unit shall have an accumulator.
- J. The outdoor unit shall have a high pressure safety switch
- K. The outdoor unit shall have over-current protection.
- L. The outdoor unit shall use a Cyclon type double tube subcooling heat exchanger.
- M. The outdoor unit shall have the ability to operate with an elevation difference of up to 164 feet above or 131 feet below the indoor units.
- N. The outdoor unit shall allow up to a total equivalent refrigerant piping length of 984 feet.
- O. The maximum equivalent piping length from outdoor unit to indoor unit shall be up to 574 feet without traps.
- P. The outdoor unit shall be capable of operating in heating only mode down to -4°F and up to 61°F ambient wet bulb without additional low ambient controls.
- Q. The outdoor unit shall be capable of operating in cooling only mode down to 23°F and up to 118°F ambient dry bulb.
- R. The outdoor unit shall have an oil separator for the compressor and controls to ensure sufficient oil supply is maintained for the compressor.

- S. Shall use R410A refrigerant.
- T. Each outdoor unit frame shall have a removable service panel with no more than 3 screws to allow access to service tool connection, DIP switches, auto addressing, error codes, printed circuit boards, inverter circuit, and refrigeration circuit components.

1.2 FRAME:

- A. Shall be constructed with galvanized steel, bonderized and be finished with powder coat baked enamel paint.

1.3 COMPRESSOR:

- A. All 208/230V, 1 phase outdoor unit frames shall be equipped with one hermetic digitally controlled inverter driven rotary compressor.
- B. A crankcase heater shall be factory mounted on the compressor.
- C. The outdoor unit compressor shall have an inverter to modulate capacity. The frequency of the inverter compressor shall be completely variable from 25 to 90Hz in cooling mode and 25 to 100Hz in heating mode.
- D. The compressor shall be equipped with an internal thermal overload.
- E. The compressor shall be mounted to avoid the transmission of vibration.

1.4 FAN:

- A. All outdoor unit frames shall be furnished with two direct drive, variable speed polymeric propeller type fans.
- B. All fan motors shall have inherent protection, have permanently lubricated bearings, and be variable speed with a maximum speed up to 700 rpm in cooling mode and up to 750 rpm in heating mode.
- C. All fans shall be provided with a raised guard to limit contact with moving parts.
- D. The outdoor unit shall have horizontal discharge airflow.

1.5 COIL:

- A. The outdoor coil shall be of nonferrous construction with louvered fins on copper tubing.
- B. The coil fins shall have a factory applied corrosion resistant GoldFin™ material with hydrophilic coating.
- C. The coil shall be protected with an integral metal guard.
- D. Refrigerant flow from the outdoor unit shall be controlled by means of a digitally controlled inverter driven rotary compressor.

1.6 ELECTRICAL:

- A. The outdoor unit electrical power shall be 208/230V, 60 Hz, 1 phase.
- B. The outdoor unit shall be capable of operation within voltage limits of +/- 10% rated

voltage.

- C. The outdoor unit shall be controlled by integral microprocessors.
- D. The control circuit between the indoor units and the outdoor unit shall be 24VDC completed using a 2-conductor, stranded, shielded cable for the RS485 daisy chain communication.

PART 2 - HIGH STATIC CEILING-CONCEALED DUCTED INDOOR UNIT

2.1 GENERAL:

- A. High static ceiling concealed duct indoor unit shall mount fully concealed within the ceiling.
- B. Shall be designed for use with R410a refrigerant.
- C. Shall be installed with heat pump or simultaneous heating and cooling heat pump VRF systems of the same manufacturer.
- D. The indoor unit shall communicate with the outdoor unit via RS485 daisy chain communication.
- E. Field installed ductwork shall not exceed the external static pressure limitation of the high static ducted indoor unit.

2.2 INDOOR UNIT:

- A. The indoor unit shall be factory assembled, wired and run tested.
- B. The indoor unit shall be factory wired and piped with its own electronic expansion device, control circuit board, fan and motor.
- C. The indoor unit shall have
 - 1. Self-diagnostic function
 - 2. Auto restart function
- D. Indoor unit refrigerant circuit shall be filled with a dry nitrogen gas charge from the factory.

2.3 UNIT CABINET:

- A. The cabinet shall be ceiling-concealed and ducted.

2.4 FILTER:

- A. Return air shall be filtered with a factory supplied removable, washable filter.
- B. Return filter box with high-efficiency filter shall be field provided (by contractor) and installed not to exceed external static pressure limitation of the high static ducted indoor unit.

2.5 FAN:

- A. The indoor unit fan shall be no more than one assembly with two Sirocco fans direct driven by a single motor.

- B. The indoor fan shall be statically and dynamically balanced.
- C. Motor shall have permanently lubricated bearings.
- D. In cooling mode, the indoor fan shall have the following settings; Low, Med, and High.
- E. In heating mode, the indoor fan shall have the following settings; Low, Med, and High.

2.6 COIL:

- A. The indoor unit coil shall be nonferrous with louvered fins on copper tubing for maximum efficiency.
- B. The tubing shall have inner grooves for high efficiency heat exchange.
- C. The coils shall be pressure tested at the factory.
- D. A condensate drain pan shall be factory installed below the coil.
- E. All refrigerant lines to the indoor units shall be field insulated.

2.7 CONDENSATE PUMP:

- A. The unit shall include a factory installed condensate pump that will be able to raise drain water 27 inches above the bottom of the indoor unit.

2.8 ELECTRICAL:

- A. The unit electrical power shall be 208/230 volts, 1-phase, 60 Hz.
- B. The indoor unit shall be capable of operation within voltage limits of +/-10% rated voltage.

2.9 CONTROLS:

- A. Unit shall use controls provided by the manufacturer to perform all functions necessary to operate the system effectively and efficiently and communicate with the outdoor unit over an RS485 daisy chain.

END OF SECTION 23 81 29