

DIVISION 23: HEATING, VENTILATING, AND AIR-CONDITIONING

23 0000 HEATING, VENTILATING, AND AIR-CONDITIONING

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SECTION 23 0501 – COMMON HVAC REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and other Division 01 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 6 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, HVAC 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.
- F. Include Start-up Reports.

1.4 SUBMITTALS FOR COMMON HVAC REQUIREMENTS

- A. 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 proposed for sealing ductwork.
- B. 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", and "2018 International Fire Code" as published by the International Conference of Building Officials.
 4. 2017 Idaho Plumbing Code as published by the International Association of Plumbing and Mechanical Officials.
 5. "National Electrical Code" as published by the National Fire Protection Association.
 6. "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 - NOT USED

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 site visit 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. 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.
- 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.

3.3 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 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.

3.6 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 Engineer.

3.7 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.

3.8 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 exposed ductwork.
- D. At date of Substantial Completion, air filters shall be new, clean, and approved by Owner's representative.

3.9 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. Heating/cooling 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.

3.10 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.

3.11 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 - Two hours.
 - b. Temperature Control - 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.

END OF SECTION 23 0501

SECTION 23 0502 - DEMOLITION AND REPAIR

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. Under this section remove obsolete piping and mechanical equipment and relocate, reconnect or replace existing piping affected by demolition or new construction. Remove concealed piping abandoned due to demolition or new construction, or cap piping flush with existing surfaces.

1.3 DRAWINGS AND EXISTING CONDITIONS

- A. All relocations, reconnections and removals are not necessarily indicated on the drawings. As such, the Contractor shall make adequate allowance in his proposal for this work as no extra charges will be allowed for these items.

PART 2 - NOT USED

PART 3 - EXECUTION

3.1 TEMPORARY CONNECTIONS

- A. Where existing piping must remain in service to supply occupied areas during construction, provide temporary piping, connections, and equipment to maintain service to such areas. All shall be performed in a neat and safe manner to prevent injury to the building or its occupants.

3.2 EXISTING CONDITIONS

- A. All required drilling, cutting, block-outs and demolition work required for the removal and/or installation of the mechanical system is the responsibility of this Contractor.
- B. No joists, beams, girders, trusses or columns shall be cut by any Contractor without written permission from the Architect.
- C. The patching, repair, and finishing to existing or new surfaces is the responsibility of this Contractor, unless specifically called for under sections of specifications covering these materials.
- D. Disconnect all equipment that is to be removed or relocated. Relocate any existing equipment that obstructs new construction.

3.3 EXISTING TO REMAIN IN USE

- A. Where affected by demolition or new construction, relocate, replace, extend, or repair piping and equipment to allow continued use of same. Use methods and materials as specified for new construction.

3.4 MATERIALS AND EQUIPMENT REMOVED

- A. All obsolete materials, piping, and equipment shall become the property of the Contractor and be removed from the site promptly.

END OF SECTION 23 0502

SECTION 23 0553 - 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 0501 apply to this Section.

1.2 SUMMARY

- A. Furnish and install identification of equipment and piping both new and existing 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.
- B. Use appropriate primer.

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:
 Supply Fan SF-1 - North Classrooms
 10,000 CFM @ 2.5"

- A. Make a list of and tag all valves installed in this work.
 - 1. Valve tags shall be of brass, not less than 1"x 2" round 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 –(new and existing).
 - 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 Supply & Return, Gas, & Valve Identification —(new and existing).
 - 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 painting of piping at identification locations –(new and existing).

Symbol	Name	Color
NG	Natural Gas	Yellow
HWS	Hot Water Supply	Lt. Green
HWR	Hot Water Return	Lt. Green

- 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

END OF SECTION 23 0553

SECTION 23 0593 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Division 23 - Basic Mechanical 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. Hydronic Piping Systems.
 - a. Primary - Secondary Systems
 - b. Pumps
 - c. Boilers

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
- 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. Actual metered running amperage for each phase of each motor on all pumps and air handling equipment.
- 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 PROCEDURES FOR HYDRONIC SYSTEMS

- A. Measure water flow at pumps. Use the following procedures, except for positive-displacement

pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
 3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
 4. Report flow rates that are not within plus or minus 5 percent of design.
- B. Set calibrated balancing valves, if installed, at calculated presettings.
- C. Measure flow at all stations and adjust, where necessary, to obtain first balance.
1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
- D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
- E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
1. Determine the balancing station with the highest percentage over indicated flow.
 2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
 3. Record settings and mark balancing devices.
- F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
- G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.2 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.

END OF SECTION 23 0593

SECTION 23 0800 – 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 0800

SECTION 23 2113 - HYDRONIC PIPING

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

1.3 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.

1.4 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.

1.5 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.

- F. Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies.

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.
 - 3. 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.
 - 4. Automatic Flow-Control Valves:
 - a. Flow Design, Inc.
 - b. Griswold Controls.

2.2 PIPING MATERIALS

- A. General: All pipe and fittings to be from domestic manufacturer.

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. Wrought-Copper Fittings: ASME B16.22.
- D. Wrought-Copper Unions: ASME B16.22.
- E. Solder Filler Metals: ASTM B 32, 95-5 tin antimony.
- F. Brazing Filler Metals: AWS A5.8, Classification BAg-1 (silver).

2.4 STEEL PIPE AND FITTINGS

- A. Steel Pipe, NPS 2 and Smaller: ASTM A 53, Type S (seamless) or Type F (furnace-butt welded), Grade B, Schedule 40, black steel, plain ends.
- B. Steel Pipe, NPS 2-1/2 through NPS 12: ASTM A 53, Type E (electric-resistance welded), Grade B, Schedule 40, black steel, plain ends.

- C. Steel Pipe, NPS 14 through NPS 18: ASTM A 53, Type E (electric-resistance welded) or Type S (seamless), Grade B, Schedule 30, black steel, plain ends.
- D. Steel Pipe, NPS 20: ASTM A 53, Type E (electric-resistance welded) or Type S (seamless), Grade B, Schedule 20, black steel, plain ends.
 - 1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53, Schedule 40, black steel; seamless for NPS 2 and smaller and electric-resistance welded for NPS 2-1/2 and larger.
- E. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250.
- F. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.
- G. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300.
- H. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- I. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - 1. Material Group: 1.1.
 - 2. End Connections: Butt welding.
 - 3. Facings: Raised face.
- J. Grooved Mechanical-Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47, Grade 32510 malleable iron; ASTM A 53, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders designed to accept grooved end couplings.
- K. Grooved Mechanical-Joint Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
- L. Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.
- M. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.
- N. Plastic pipe and Fittings (Cooling Tower Lines only)
 - 1. CPVC Plastic Pipe: ASTM F 441, Schedules 40 and 80, plain ends.
 - 2. PVC Plastic Pipe: ASTM 1785, Schedules 40 and 80, plain ends.
 - 3. CPVC Plastic Pipe Fittings: Socket-type fittings, ASTM F 438 for Schedule 40 pipe; ASTM F 439 for Schedule 80 pipe.
 - a. CPVC Solvent Cement: ASTM F 493
 - 4. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe; ASTM D 2467 for Schedule 80 pipe.
 - a. PVC Solvent Cement: ASTM D 2564.

2.5 VALVES

- A. Gate, globe, check, ball, and butterfly valves are specified in Division 22 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. Calibrated Balancing Valves, NPS 2-1/2 and Larger: Cast-iron or steel body, ball type, 125-psig working pressure, 250 deg F maximum operating temperature, and having flanged or grooved connections. 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.
- E. Pressure-Reducing Valves: Diaphragm-operated, bronze or brass body with low inlet pressure check valve, inlet strainer removable without system shutdown, and noncorrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory set at operating pressure and have capability for field adjustment.
- F. Safety Valves: Diaphragm-operated, bronze or brass body with brass and rubber, wetted, internal working parts; shall suit system pressure and heat capacity and shall comply with the ASME Boiler and Pressure Vessel Code, Section IV.
- G. 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.

2.6 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. Pipe discharge to drain line.
- 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. Pipe discharge to drain line.
- C. 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.
- D. 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.
- E. 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.
- F. 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.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Hot Water, NPS 2 and Smaller: Aboveground, use Type L drawn-temper copper tubing with soldered joints or Schedule 40 steel pipe with threaded joints.
- B. Hot Water, NPS 2-1/2 and Larger: Schedule 40 steel pipe with welded and flanged joints.

3.2 VALVE APPLICATIONS

- A. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:
 - 1. Shutoff Duty: Ball, and butterfly valves.
 - 2. Throttling Duty: 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 0501: "Common HVAC Requirements" 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 15 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 0501: "Common HVAC Requirements" for joint construction requirements for soldered and brazed joints in copper tubing; threaded, welded, and flanged joints in steel 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 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.
- D. 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.
- E. 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.
- F. Install expansion tanks. 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.

3.8 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.
- B. 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.

3.9 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, and cooling towers to design requirements.
 8. Lubricate motors and bearings.

3.10 CLEANING

- A. See Section 23-2125.

END OF SECTION 23 2113

SECTION 23 2125 - 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 0501 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.

END OF SECTION 23 2125

SECTION 23 5134 – FLUES

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. Includes But Not Limited To:
 - 1. Furnish and install heating equipment exhaust piping and combustion air intake piping as described in Contract Documents.

1.3 REFERENCES

- A. American Society For Testing And Materials:
 - 1. ASTM D 1785-03, 'Standard Specification for Poly(Vinyl Chloride)(PVC) Plastic Pipe, Schedules 40, 80, and 120.'
 - 2. ASTM D 2564-02, 'Standard Specification for Solvent Cements for Poly(Vinyl Chloride)(PVC) Plastic Piping Systems.'
 - 3. ASTM D 2661-02, 'Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Drain, Waste, and Vent Pipe and Fittings.'
 - 4. ASTM D 2665-02, 'Standard Specification for Poly(Vinyl Chloride)(PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.'

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Air Piping: Schedule 40 pipe and fittings meeting requirements of ASTM D 1785, ASTM D 2661, or ASTM D 2665.
- B. Piping Primer And Cement: Meet requirements of ASTM D 2564.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation For Condensing Boilers:
 - 1. Run individual vent and individual combustion intake piping from each boiler to concentric roof termination kit provided by Manufacturer. Slope lines downward toward boiler.
 - 2. Slope combustion chamber drain downward to funnel drain. Anchor to wall with wall clamps, allowing free movement through clamp for expansion.
 - 3. Use concentric roof termination kit provided by Boiler Manufacturer. Install vent and combustion air intake piping at clearance and distances required by Manufacturer.
 - 4. Attach factory-supplied neoprene coupling to combustion-air inlet connection and secure with clamp.
 - 5. Ensure that factory-supplied perforated metal disc is installed in flexible coupling, unless its removal is required.
 - 6. Paint exposed piping thru roof dark color to match roofing materials.
- B. Support:
 - 1. Support concentric roof termination kit at ceiling or roof line with 20 ga sheet metal straps as detailed on Drawings.

2. Support horizontal sections of pipe in accordance with requirements of Section 23 0501.
Anchor securely to structure, not allowing pipe to sway.
- C. Paint exposed piping thru roof dark color to match roof.

END OF SECTION 23 5134

SECTION 23 5230 – GAS BOILERS

PART 1 - GENERAL

1.1 SUMMARY

1. Contractor shall supply and install Qty.: 3 Lochinvar “Knight” Model WHB399N boilers rated at 399,000 BTU/hr input and 377,000 BTU/hr output.

PART 2 – PRODUCTS

1. 4.9 Standard for Gas-Fired Low Pressure Steam and Hot Water Boilers. The unit(s) shall be designed and constructed in accordance with the ASME Boiler & Pressure Vessel Code, Section IV requirements for 160 psi (1103 kPa) maximum working pressure, and shall bear the ASME “H” Stamp and be listed by the National Board.
2. The boiler shall be listed with AHRI (Air Conditioning, Heating and Refrigeration Institute). The boiler shall have a minimum thermal efficiency of 95%.
3. The unit(s) shall be constructed to comply with the efficiency requirements of the latest edition of ASHRAE Standard 90.1.
4. The boiler shall be certified for placement indoors and outdoors, where freezing conditions do not exist.
5. The boiler must have knockdown feature that allows the top section of the boiler to be removed, allowing for easy handling and installation.
6. The boiler shall be equipped with an ASME certified pressure relief valve set at 75psi 517 (kPa). Optional pressure relief valves with settings of 30psi (207kPa), 50psi (345 kPa), 60psi (413 kPa), 125psi (861 kPa) or 150psi (1034 kPa) shall be available.
7. The water tube heat exchanger shall be stainless steel, rated for 160 psi (1103 kPa) working pressure. The heat exchanger shall be a low water volume design with micro-fin tubing, welded construction, with no gaskets, o-rings or bolts in the header. Heat exchanger shall be accessible for visual inspection and cleaning of all internal surfaces. The boiler shall be fully condensing design with built-in condensate drain and trap. The heat exchanger shall have a limited ten-year warranty.
8. Each boiler shall be fully test fired, (with water, gas, and venting connected), and all safety components tested, at the factory.
9. The boiler shall be sealed combustion. The boiler jacket shall be a unitized shell finished with acrylic thermo-set paint baked at not less than 325°F (163°C). The frame shall be constructed of galvanized steel for strength and protection. Chamber shall include a sight glass for viewing flame. Boiler sides and back shall be certified for zero no more than 11 inches clearance to combustible surfaces.
10. The boiler shall be equipped with an engineered gas/air chamber that ensures proper mixing for stable combustion at all firing rates
- 11.. Boiler shall operate on 4-13" w.c. gas pressure, and shall need no component changes to operate at high altitude, up to 10,000 feet.
12. The boiler shall use a premix burner with a stainless steel woven metal fiber wrap, and a negative pressure gas valve to burn cleanly, with NOx emissions not exceeding 9ppm. The boiler shall meet the emissions requirements of SCAQMD 2012.
13. The boiler shall be designed for vertical or horizontal Category IV venting, up to 100 equivalent feet, with 6" (1600), 8" (2000 & 2500), 10" (3000 & 3500) or 12" (4000) diameter CPVC, polypropylene or stainless steel vent material.
14. Air may be taken from the room, or ducted directly to the boiler using up to 100 equivalent feet of 6" (1600), 8" (2000 & 2500), 10" (3000 & 3500) or 12" (4000) diameter of ABS, PVC, CPVC or galvanized pipe.
15. The boiler shall be a vertical, micro-finned tube exchanger design, with one control and one burner
16. The boiler control shall be an integrated electronic PID temperature and ignition control with large touchscreen and color display and shall control the boiler operation and firing rate. The boiler display shall be visible without the removal of any jacket panels or control panels.
17. The control shall have the ability to control the boiler pump, system pump and indirect domestic water pump, each with delay and exercise features.
18. The control shall have a variable speed boiler pump control option.

19. The control shall have the ability to integrate indirect domestic water heating with the boiler system. The control shall have domestic hot water priority, and shall have the ability to recognize a domestic water sensor or closure from tank stat on the same terminals.
20. The control shall have built-in outdoor reset feature with customizable reset curves, based on the outdoor temperature and desired system water temperature. The boiler shall be shipped with the outdoor reset sensor, as standard equipment.
21. The control shall easily allow the user to force the boiler into minimum or maximum firing rate, for setup and diagnostic purposes, and shall have a cleaning mode that allows the user to wipe the screen without activating any functions from the touchscreen.
21. The control shall have dry alarm contacts for ignition failure. The control shall monitor flue gas temperature and shall stop the boiler from firing if temperature is excessive.
22. Allowable control adjustments shall include: boiler temperature setpoint; domestic water temperature setpoint; automatic high limit; °F or °C display; setpoint for time of day input; DHW setpoint for time of day input; PID gain parameters; DHW PID gain parameters; manual firing rate control; pump delay time; pump exercise interval; outdoor reset selection; low boiler setpoint temperature (for outdoor reset operation); boiler temperature at high outdoor temperature (for outdoor reset operation); boiler setpoint at low outdoor temperature (for outdoor reset operation); warm weather shutdown; automatic remote signal detection; anti-shortcycle feature enable/disable.
23. The control shall have installer-level password, and verification feature to ensure that safety-related parameters are not altered by mistake.
24. The control shall be able to cascade and lead-lag with other MagnaTherm controllers, for a total of eight MagnaTherm boilers, without additional system controllers.
25. The burners shall be controlled to keep each one in the lowest firing rate possible, based on system demand, to maximize efficiency. For example, in multiple boiler systems, the master control shall choose to bring on all boilers at low firing rates, instead of one boiler at a high rate, to meet the system needs.
26. A control that is chosen as master in a system with multiple controllers shall display an icon of each of the controls that it is controlling. The color of the icon shall indicate if the control is in normal operation, in lockout, in standby mode, in a hold state, or if there is a communication error.
27. The control shall graphically depict the firing rate of each burner in the boiler, and/or each burner in system, if the controller is the master of other MGH boilers in a multiple boiler system. The control shall also show information about system, such as outdoor temperature and system temperature, where applicable.
28. The control shall have the ability to accept a 4-20mA or 0-10VDC input connection from an external control or building automation system, to modulate the flame.
29. The controller shall be able to send information through a Modbus connection, including (but not limited to) inlet and outlet water temperatures, stack temperature, DHW temperature and priority, central heating temperature, frost protection, warm weather shutdown, status of sensors, fan speed, setpoints, remote control input, burner status, lockout codes, alarm reasons, system pump status, boiler pump status and domestic water pump status.
30. Control diagnostics shall include, at a minimum, the following: ignition failure, grounded flame rod, safety chain interrupt, boiler high limit exceeded, domestic water high limit exceeded, temperature rise limit exceeded, stack limit exceeded, pressure sensor fault, combustion pressure fault, blocked air intake, sensor errors (open or shorted), 24VAC voltage low or high, modulation fault, pump fault, AC input phases reversed, and fan speed proving rate failure.
31. The control shall have a clock with a battery backup and will allow the user to access the burner run time, and cycle counts for the burner, DHW pump, system pump and boiler pump.
32. The control shall differentiate between a lockout, a hold, or an alert. If an issue occurs, the system will display a brief description of the issue on the control screen. The user shall be able to tap the display to be presented with a more detailed explanation of the issue.

2.7 BOILER

1. The Boiler shall have an independent laboratory rating for Oxides of Nitrogen (NOx) of 20 ppm or less corrected to 3% O₂. The manufacturer shall verify proper operation of the burner, all controls and the heat exchanger by connection to water and venting for a factory fire test prior

- to shipping.
- 2. The Boiler shall operate at altitudes up to 4,500 feet above sea level without additional parts or adjustments.
- 3. The Boiler shall be started up, adjusted and checked out by a manufacturer's authorized service agency. A start-up report shall be submitted to the owner and the contractor for inclusion in the O&M Manuals.

2.8 MANUFACTURERS

- 1. Lochinvar "Knight"
- 2. Or approved equal

END OF SECTION 23 5230

END OF DIVISION 23