ADDENDUM No. 1
for

INVITATION FOR BID (IFB)

BOILER REPLACEMENTS

TOWN OF LONGMEADOW
MASSACHUSETTS

September 5, 2017

This document serves as Addendum No.1 for the Invitation for Bid (IFB) for Boiler Replacements. This Addendum forms part of the IFB and modifies the original document. **Acknowledge the receipt of all addenda numbers issued on the BID SUBMISSION FORM.** Failure to do so may subject the bidder to disqualification.

The following changes and/or additions are to be made to the original Invitation for Bid dated August 23, 2017:

1) **Revised Specifications Section, 23 00 00- 'Heating, Ventilation and Air Conditioning':**

   Delete reference to the Specifications section 23 00 00 –'Heating, Ventilation and Air Condition' supplied with the original IFB document, and in its place insert the revised specifications section 23 00 00 - 'Heating, Ventilation, and Air Conditioning' supplied with Addendum No. 1.

2) **Mandatory Pre-Bid Conference, List of Companies that Registered During the Conference on Wednesday August 30, 2017 Includes:**

   Icon West Corporation, Springfield, MA
   Bergeron Electrical Services, Southampton, MA
   Elm Electrical, Inc., Westfield, MA
   Aero Crane Service, South Windsor, CT
   Zap Electrical, Ludlow, MA
   T.J. Conway Co., Springfield, MA
   Lynch Electrical Contractors, Inc., Hampden, MA
   Kleeberg, Ludlow, MA
   Universal Electric, West Springfield, MA
   Goodless Electric Co., West Springfield, MA
   Hickman & Sgroi Electric, Inc., Ludlow & Westfield, MA
   Staiti Electric, Palmer, MA

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HEATING, VENTILATING AND AIR CONDITIONING

PART 1 - GENERAL

1.0 GENERAL PROVISIONS

A. The GENERAL REQUIREMENTS, DIVISION 01, and BIDDING AND CONTRACT REQUIREMENTS, and DIVISION 00 are hereby made a part of this Specification Section.

B. Examine all Drawings and all Sections of the Specifications and requirements and provisions affecting the work of this Section.

1.1 SCOPE OF WORK

A. This project consists of the replacement of three cast iron boilers located at three separate buildings in Longmeadow, MA. The three buildings are as follows: The Longmeadow Police Department Headquarters, Blueberry Hill Elementary School, and Center Elementary Schools. Scope of work includes demolition of existing boilers and hydronic piping and flues as required for boiler removal, installation of new cast iron boiler and associated piping and flues, and integration of new boilers into existing BAS at Blueberry Hill Elementary School and Center Elementary Schools. Fuel oil piping and associated components for existing boilers at Blueberry Hill Elementary School and Center Elementary Schools is to be demolished as shown on the plans and capped liquid tight. Work at the Center Elementary School and Blueberry Hill Elementary School is to be performed only during unoccupied hours.

B. The work under this Section shall include the furnishing of all materials, labor, equipment and supplies and the performance of all operations to provide complete working systems, in general, to include the following items:

1. Piping and Fittings (all systems and types) including submitting sizing where called for on the drawings or in these specifications
2. Pipe Hangers and Supports
3. Identification
4. Valves and Accessories (all types)
5. Boiler/Burner Units
6. Equipment Nameplates
7. Factory Tests
8. Insulation
9. Chimneys, Stacks, and Flues
10. Relocation of existing HVAC components that interfere with new construction and removal and disposal of obsolete components.
11. Operating and maintenance instructions and manuals

12. Cleaning, Testing, and Adjusting Piped Systems and Equipment

13. HVAC Control Systems

14. Training of Owners Personnel on Equipment, Systems, and Controls

C. The work to be done under this section is generally shown on the Mechanical HVAC Drawings.

1.2 RELATED WORK

A. Principal classes of Work related to the Work of this Section are listed below, and are specified to be performed under the indicated Sections of these Specifications. Refer to the indicated Sections for description of the extent and nature of the indicated Work, and for coordination with related trades. This listing may not include all related Work items. It is the responsibility of the Contractor to coordinate the Work of this Section with that of all other trades.

B. The following work is not included in this section and will be provided under other sections, except as specified herein:

1. Electrical power wiring for all HVAC equipment and to junction box(es) in mechanical areas. Power wiring from these box(es) to all control equipment (control panels, etc.) and all controls/interlock wiring shall be provided by the controls Contractor. Control wiring shall be from standby power source (if available).

2. Starters and variable speed drives that are not integral to equipment, unless specified otherwise.

3. Structural supports necessary to distribute loading from equipment to roof or floor.

4. Temporary light, power, water, heat, gas and sanitary facilities for use during construction and testing. Refer to Division 01, General Conditions.

5. Concrete work including concrete housekeeping pads and blocks for vibrating and rotating equipment, and cast-in-place manholes.

1.3 DEFINITIONS

A. As used in this Section, the following terms shall be understood to have the following meaning:

1. "**Contractor**," or "**Subcontractor**," unless otherwise qualified, shall mean the installer of the work specified under this Section, and shall be responsible for coordination of this work with the work of the ATC Contractor.

2. "**Furnish**" shall mean purchase and deliver to the project site, complete with every necessary appurtenance and product support.

3. "**Install**" shall mean unload at the delivery point at the site and perform all work necessary to establish secure mounting and proper operation at the proper location in the project.

4. "**Provide**" shall mean furnish and install.

5. **"Work"** shall mean all labor, materials, equipment, apparatus, controls, accessories and all other items required for a proper and complete installation.

6. "**Concealed**" shall mean hidden from sight in chases, furred in spaces, shafts, embedded in construction, in a crawl space, and above hung ceilings.

7. "**Exposed**" shall mean not installed underground or concealed as defined above.

8. "**Furnished by others**" shall mean materials or equipment purchased under other sections of the general contract and installed by this section of the specifications by this trade Contractor.

9. "**Owner's Representative**" shall be the party responsible to make decisions regarding all contractual obligations in reference to the Scope of Work for the Owner.

10. "**Date of Substantial Completion**" shall indicate the date where the work has been formally accepted as evidenced by completed final punch list or where the work has reached the stage that the Owner obtains beneficial use and commences utilization of the installed systems for business or occupancy purposes. The GENERAL REQUIREMENTS, DIVISION 01, shall supersede this definition where specifically defined.

11. "**Piping**" shall mean, in addition to pipe or tubing, all fittings, flanges, unions, valves, strainers, drains, hangers and other accessories relative to such piping.

12. "**ATC**" shall mean Automatic Temperature Controls, and shall be interchangeable with "**BAS**" (Building Automation System).

1.4 CODES, REFERENCES AND PERMITS

A. Materials, installation of systems and equipment provided under this section shall be done in strict accordance with the latest governing edition of the following standards, codes, specifications, requirements, and regulations, and any other Codes and Regulations having jurisdiction including but not limited to:

1. All Applicable NFPA Standards
2. State and Local Building Mechanical, Electrical, and Energy Codes
3. American Society of Mechanical Engineers (ASME)
4. American Society of Testing and Materials (ASTM)
5. American National Standards Institute (ANSI)
6. Underwriters' Laboratories, Inc. (UL)
7. Occupational Safety and Health Administration (OSHA)
8. Any other local codes or authorities having jurisdiction.

B. Heating, pumping, process piping and refrigeration systems shall be installed by Contractors and personnel appropriately licensed in the State (Installing Contractor).

C. All pressure vessels shall conform to ASME and State codes and regulations.

D. All equipment shall meet the more efficient requirement:

1. As shown on bid documents,

2. Minimum efficiencies state in ASHRAE 90.1-2007, or

3. Minimum efficiencies stated in the governing Energy Code.

E. Unless otherwise specified or indicated, materials, workmanship and equipment performance shall conform with the latest governing edition of the following standards, codes, specifications, requirements, and regulations, except when more rigid requirements are specified or are required by applicable codes but not limited to:

1. Air Conditioning and Refrigeration Institute (ARI)

2. Air Diffusion Council (ADC)

3. Air Movement and Control Association (AMCA)

4. American Boiler Manufacturers Association (ABMA)

5. American National Standards Institute (ANSI)

6. American Petroleum Institute (API)

7. American Society of Heating, Refrigeration and Air Conditioning (ASHRAE)

8. American Society of Mechanical Engineers (ASME)

9. American Society of Testing and Materials (ASTM)

10. American Welding Society, Inc. (AWS)

11. Associated Air Balance Council (AABC)

12. Certified Ballast Manufacturers (CME)

13. Copper Development Association (CDA)

14. Factory Mutual System (FM)

15. Insulated Cable Engineers Association (ICEA)

16. Manufacturer's Standardization Society of the Valve & Fitting Industry (MSS)

17. National Electric Manufacturers Association (NEMA)

18. National Environmental Balancing Bureau (NEBB)

19. North American Insulation Manufacturer's Association (NAIMA)

20. Sheet Metal and Air Conditioning Contractor's National Association, Inc. (SMACNA)

21. The Hydronics Institute (HI)

22. Thermal Insulation Manufacturer’s Association (TIMA)

F. Codes, laws and standards provide a basis for the minimum installation criteria acceptable. The drawings and specifications illustrate the scope required for this project, which may exceed minimum codes, laws and standards.

G. The date of the code or standard is that in effect at the Bid date.

H. Give all notices, file all plans, obtain all permits and licenses, and obtain all necessary approvals from authorities having jurisdiction. Deliver all certificates of inspection to the authorities having jurisdiction. No work shall be covered before examination and approval by the Owner’s Representative, inspectors, and authorities having jurisdiction. Replace imperfect or condemned work to conform to requirements, satisfactory to Owner’s

Representative, and without extra cost to the Owner. If work is covered before inspection and approval, this Contractor shall pay costs of uncovering and reinstalling the covering, whether it meets contract requirements or not.

1.5 GENERAL REQUIREMENTS

A. Nameplates

1. Each item of equipment shall have a nameplate bearing the manufacturer's name, address, type or style, model number, catalog number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

B. Maintenance Information

1. Systems and equipment which require periodic maintenance to maintain efficient operation shall be furnished with complete necessary maintenance information. Required routine maintenance actions, as specified by the manufacturer, shall be stated clearly and incorporated on a readily accessible label on the equipment. Such label may be limited to identifying, by title or publication number, the operation and maintenance manual for that particular model and type of product.

C. Equipment Guards

1. Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts so located that any person may come in close proximity thereto shall be completely enclosed or guarded. High-temperature equipment and piping so located as to endanger personnel or create a fire hazard shall be guarded or covered with insulation of type specified for service.

1.6 MATERIAL AND EQUIPMENT STANDARDS

A. Where equipment or materials are specified with the name of a manufacturer, such specification shall be deemed to be used for the purpose of establishing a standard for that particular item. No equipment or material shall be used unless previously approved by the Owner’s Representative.

B. Substitutions (approved equals) may be offered for review provided the material, equipment or process offered for consideration is equal in every respect to that indicated or specified. In order for Requests for substitution to be considered, all must be submitted for pre-approval of manufacturer within 30 days of award of contract. All requests must be accompanied by a list of minimum 5-year-old successful installations of similar scope (with Owner contact and phone number), complete specifications together with drawings or samples to properly appraise the materials, equipment or process. Allow 30 days for Owner’s Representative’s review.

C. If a substitution of materials or equipment in whole or in part is made, this Contractor shall bear the cost of any changes necessitated by any other trade as a result of said substitution.

D. All materials, equipment and accessories provided under this section shall be new and unused products of recognized manufacturers as approved.

1.7 SUBMITTALS

A. Conform to the requirements of Division 01, General Conditions, for schedule and form of all submittals unless specifically noted otherwise in this section. Coordinate this submittal with submittals for all other finishes. Shop drawings and design layouts shall be prepared by licensed installing Contractors and shall note the name(s), license number(s) and license expiration date(s) of the Contractor(s) installing the heating.

B. Definitions:

1. Shop Drawings are information prepared by the Contractor to illustrate portions of the work in more detail than indicated in the Contract Documents.

2. Acceptable Manufacturers: The mechanical design for each product is based on the single manufacturer listed in the schedule or shown on the drawings. In Part 2 of the specifications certain Alternate Manufacturers are listed as being acceptable. In addition, the MATERIAL AND EQUIPMENT STANDARDS paragraph potentially allows for substitutions as being acceptable. These are acceptable only if, as a minimum, they:

a. Meet all performance criteria listed in the schedules and outlined in the specifications. For example, to be acceptable, an air handling unit must deliver equal CFM against equal external static pressure (with the allowed pressure drop of dirty filters) using equal or less horsepower as the air handler listed in the schedules.

b. Fit within the available space it was designed for, including space for maintenance and component removal, with no modification to either the space or the product. Clearances to walls, ceilings, and other equipment will be at least equal to those shown on the design drawings. The fact that a manufacturer's name appears as acceptable shall not be taken to mean the Engineer has determined that the manufacturer's products will fit within the available space – this determination is solely the responsibility of the Contractor.

c. Products must adhere to all architectural considerations including, but not limited to: being of the same color as the product scheduled or specified, fitting within the architectural enclosures and details.

C. Submittal Procedures, Format and Requirements

1. Review submittal packages for compliance with Contract Documents and then submit to Owner's Representative for review. Submit enough sets of shop drawings such that, after review, two sets will be kept by the reviewer, with only the remaining sets returned with reviewer's marks and comments.

2. Each Shop Drawing shall indicate in title block, and each Product Data package shall indicate on cover sheet, the following information:

a. Title.

b. Equipment number.

c. Name and location of project.

d. Names of Owner, Engineer and Seller.

e. Names of manufacturers, suppliers, vendors, etc.

f. Date of submittal.

g. Whether original submittal or resubmitted.

3. Shop drawings showing manufacturer's product data shall contain detailed dimensional drawings (minimum ¼" = 1' scale) including plans and sections (where physical clearance could be an issue). Provide larger scale details as necessary. Sheet metal drawings shall show elements of reflected ceiling plan, exposed ductwork, walls and partitions (highlighting fire walls and smoke partitions), diffusers, registers, grilles, all dampers (fire, smoke, balancing, backdraft, and control dampers), sleeves and other aspects of construction as necessary for coordination.

4. Submit accurate and complete description of materials of construction, manufacturer's published performance characteristics, sizes, weights, capacity ratings (performance data, alone, is not acceptable), electrical requirements, starting characteristics, wiring diagrams, and acoustical performance for complete assemblies. Drawings shall clearly indicate location (terminal block or wire number), voltage and function for all field terminations, and other information necessary to demonstrate compliance with all requirements of Contract Documents.

5. Provide shop drawings showing details of piping connections to all equipment. If connection details are not submitted and connections are found to be installed incorrectly, this Contractor shall reinstall them within the original contract price.

   a. Alternate pipe joining methods such as grooved and permanent push-to-connect systems shall be shown on drawings and product submittals, and be specifically identified with the applicable manufacturer's style or series number. Installation shall include any additional hangers required for the alternate system.

6. Provide complete data for all auxiliary services and utilities required by submitted equipment. This shall include power, cooling water and compressed air requirements and points of connection.

7. Provide a complete description of all controls and instrumentation required including electrical power connection drawing for all components and interconnection wiring to starters, detailed information on starters, control diagrams, termination diagrams, and all control interfaces with a central control system.

8. Provide installation and erection information including; lifting requirements, and any special rigging or installation requirements for all equipment.

9. The Owner's Representative shall approve all materials before commitment for materials is made.

D. Specifications, Schedule, and Control Sequence Compliance Statement

1. The manufacturer shall submit a point by point statement of compliance with each specification criteria listed in each paragraph for those submittals listed in Paragraph E: Product Data that are noted with an asterisk (*).

2. The statement of compliance shall consist of a list of all paragraphs (line by line) identified in Part 2 and applicable Part 3 of the specification and that the unit controls will provide all manufacturer's portions of the control sequences shown on the drawings for which the submitted product in the opinion of the manufacturer complies, deviates, or does not meet.

3. Where the proposed submittal complies fully, the word "comply" shall be placed opposite the paragraph number.

4. Where the proposed submittal does not comply, or accomplishes the stated function in a manner different from that described, a full description of the deviation shall be provided.

5. Verify each field of the associated schedule where associated technical data is presented and sequences are shown on the drawings. Where the submitted material does not ‘comply” provide the value the submitted equipment will achieve based upon the specified conditions.

6. Where a full description of a deviation is not provided, it shall be assumed that the proposed system does not comply with the paragraph in question and the product will be rejected.

7. Submissions which do not include a point by point statement of compliance as specified shall be disapproved.

E. Product Data: Submit complete manufacturer's product description and technical information including:

1. Piping and Fittings (all services, types, and joining methods)

2. Pipe Hangers and Supports

3. Identification

4. Valves and Accessories (all types)

5. Pressure Gauges, Thermometers, Accessories

6. Electric Motors and Starters

7. Boiler/Burner Units (*)

8. Factory Tests

9. Insulation

10. Chimneys, Stacks, and Flues

11. Operating and maintenance instructions and manuals

12. Testing, Adjusting, & Balancing Qualifications, Plan, and Reports

13. HVAC Control Systems (*)

14. Identification, labels and tags

15. O&M manual table of contents

16. O&M manual

F. Submit shop drawings and product data grouped to include complete submittals of related systems, products and accessories in an individual (combined) submittal.

1. Access panel shop drawings shall be submitted to the Construction Supervisor for approval.

2. Do not submit multiple product information in a single bound manual.

3. Three-ring binders shall not be accepted.

G. Deviations

1. Concerning deviations other than substitutions, proposed deviations from Contract Documents shall be requested individually in writing whether deviations

result from field conditions, standard shop practice, or other cause. Submit letter with transmittal of Shop Drawings which flags the deviation to the attention of the Owner's Representative.

2. Without letters flagging the deviation to the Owner's Representative, it is possible that the Engineer may not notice such deviation or may not realize its ramifications. Therefore, if such letters are not submitted to the Owner's Representative, the Seller shall hold the Engineers, his consultants and the Owner harmless for any and all adverse consequences resulting from the deviations being implemented. This shall apply regardless of whether the Engineer has reviewed or approved shop drawings containing the deviation, and will be strictly enforced.

3. Approval of proposed deviations, if any, will be made at discretion of Engineer.

H. Schedule: Incorporate shop drawing review period into construction schedule so that Work is not delayed. This Contractor shall assume full responsibility for delays caused by not incorporating the following shop drawing review time requirements into his project schedule: Allow at least 10 working days, exclusive of transmittal time, for review each time shop drawing is submitted or resubmitted with the exception that 20 working days, exclusive of transmittal time are required for the following:

1. O&M manuals

2. If more than five shop drawings of a single trade are received in one calendar week.

I. Responsibility

1. Intent of Submittal review is to check for capacity, rating, and certain construction features. HVAC Contractor shall ensure that work meets requirements of Contract Documents regarding information that pertains to fabrication processes or means, methods, techniques, sequences and procedures of construction; and for coordination of work of this and other Sections. Work shall comply with approved submittals to extent that they agree with Contract Documents. Submittal review shall not diminish responsibility under this Contract for dimensional coordination, quantities, installation, wiring, supports and access for service, nor the shop drawing errors or deviations from requirements of Contract Documents. The Engineer's noting of some errors while overlooking others will not excuse the HVAC Contractor from proceeding in error and will not absolve the Contractor from meeting the full design intent of the associated system(s). Contract Documents requirements are not limited, waived nor superseded in any way by review.

2. Inform Contractors, manufacturers, suppliers, etc. of scope and limited nature of review process and enforce compliance with contract documents.

J. In the event that the HVAC Subcontractor fails to provide Shop Drawings for any of the products specified herein:

1. The HVAC Subcontractor shall furnish and install all materials and equipment herein specified in complete accordance with these Specifications.

2. If the HVAC Subcontractor furnishes and installs material and/or equipment that is not in complete accordance with these Specifications, he shall be responsible for the removal of this material and/or equipment. He shall also be responsible for the replacement of this material and/or equipment with material and/or

equipment that is in complete accordance with these Specifications, at the direction of the Owner's Representative.

3. Removal and replacement of materials and/or equipment that is not in complete compliance with these Specifications shall be done at no extra cost to the Owner.

4. Removal and replacement of materials and/or equipment that is not in complete compliance with these Specifications shall not be allowed as a basis for a claim of delay of completion of the Work.

K. Mark dimensions and values in units to match those specified.

L. Submit Material Safety Data Sheets (MSD) on each applicable product with submittal.

1.8 OPERATION AND MAINTENANCE DATA

A. Commence preparation of the Operating and Maintenance (O&M) Manuals immediately upon receipt of "Approved" or "Approved as Noted" shop drawings and submit each section within one month. The final submission shall be no later than two months prior to the projected date of Substantial Completion of the Project.

B. Each O&M document shall include the manufacturer's web address for equipment - specific O&M information for Internet access by the Owner.

C. The manual shall consist of (3) sets of manuals and include (3) sets of CDs, which shall contain the scanned content of the entire manual. The manual shall highlight the actual equipment used and not be a master catalog of all similar products of the manufacturer. The manual shall be submitted for review prior to creation of the CDs.

D. The Manual shall contain the following:

1. Operations Manual

a. Systems description including all relevant information needed for day-to-day operations and management including:

1) Start-up requirements and procedures, including Water Treatment systems.

2) Shut-down requirements and procedures, including Water Treatment systems.

3) Trouble-shooting checklist (i.e., common alarms with possible cause & effect, etc.).

b. Wiring diagrams, schematics, logic diagrams and sequence of operations that accurately depict the controls system.

c. Depiction of each interface screen where programmable logic and visual displays are provided. Descriptors shall be provided to define displayed data, alarms, etc.

d. A single sheet (for ease of removal) of all access codes and passwords necessary to access all levels of control and programming.

2. Maintenance Manual

a. Define all maintenance activities required to ensure system operation within manufacturers specified parameters. Maintenance documentation shall include:

1) Data retrieval sheet

2) Special instructions (i.e., lockout/tag-out, etc.)

3) Special tools (i.e., key, allen wrench, etc.)

4) Tasks

5) Frequency

6) Required materials, lubricants, etc.

b. Provide table of all required activities plotted vs. interval with adequate fill-in-space for “activity completion date” and “comments”. Where multiple instrument readings are required, provide data sheet formatted to accommodate activity.

c. Provide as part of each package, a valve and system chart that corresponds to the valve tags. Provide directions for normal positions and positions for equipment failure modes.

d. The HVAC Subcontractor shall furnish spare-parts data for each different item of equipment furnished. The data shall include a complete list of: parts and supplies, with current unit prices, lead time, and source of supply; a list of parts and supplies that are either normally furnished at no extra cost with the purchase of the equipment, or specified hereinafter to be furnished as part of the contract; and a list of additional items recommended by the manufacturer to assure efficient operation for a period of 360 days at the particular installation. The foregoing shall not relieve the HVAC Subcontractor of any responsibilities under the guarantees specified herein.

e. Provide copy of all warranty information including extended warrantees where specified with associated date of substantial completion (commencement of warranty) and end date of coverage. Define all components/subsystems specifically included and excluded.

E. Provide O&M manuals for each of the following as a minimum:

1. Valves and Accessories (all types, including charts for all balancing valves)

2. Boiler/Burner Units

3. HVAC Control Systems

1.9 RECORD DRAWINGS

A. Refer to DIVISION 01, General Conditions, for record drawings and procedures to be provided under this section, unless specifically noted otherwise in this section.

B. Record Drawings (red-line drawings) will be updated by this Contractor daily for review with the monthly requisition. The record drawing shall be an accurate depiction of the systems as completed, including dimensions (vertical/horizontal) of concealed components off fixed building elements.

C. The HVAC Foreman shall maintain complete and separate set of prints of Contract Drawings at job site at all times and shall record work completed and all changes from original Contract Drawings clearly and accurately including work installed as a modification or addition to the original design.

D. At completion of work the HVAC Contractor shall prepare a complete set of record drawings on AutoCAD showing all systems as actually installed. The Architectural background AutoCAD files will be made available for the Contractor's copying, at his expense, to serve as backgrounds for the drawings. The HVAC Contractor shall transfer changes from field drawings onto AutoCAD drawings and submit copy of files and three sets of prints to Owner's Representative for comments as to compliance with this section. CADD layering as established by the design team shall be maintained with any and all changes done by the Contractor.

E. The Engineer is not granting to the Contractor any Ownership or property interest in the CADD Drawings by the delivery of the CADD Disks to the Contractor. The Contractor's rights to use the CADD disks and the CADD Drawings are limited to use for the sole purpose of assisting in the Contractor's performance of its contractual obligations under its contract with respect to the Project. The Engineer is granting no further rights. Any reuse or other use by the Contractor will be at the Contractor's sole risk and without liability to the Engineer. The Contractor hereby waives and releases any losses, claims, damages, liabilities of any nature whatsoever, and costs (including attorney fees) arising out of, resulting from, or otherwise related to the use of the CADD Disks and CADD Drawings by the Contractor. The Contractor, to the maximum extent permitted by law, hereby agrees to indemnify, defend and hold the Engineer harmless from all loses, claims, damages, liabilities, and costs (including attorney fees) arising out of, resulting from, or otherwise related to the use of the CADD Disks and CADD Drawings by the Contractor.

F. Record Drawings, shall show "as-built" condition of all plans, mechanical room part plans, details, sections, piping diagrams, control diagram and sequence changes and corrections to schedules. Schedules shall show actual manufacturer model numbers and capacities of final installed equipment.

G. The HVAC Contractor shall submit the record set for approval a minimum of three weeks prior to seeking the permanent certificate of occupancy.

1.10 WARRANTIES

A. Submit manufacturer's standard replacement warranties for material and equipment furnished under this Section. Such warranties shall be in addition to and not in lieu of all liabilities which the manufacturer and the HVAC Subcontractor may have by law or by provisions of the Contract Documents.

B. All materials, equipment and work furnished under this Section shall be guaranteed against all defects in materials and workmanship for a minimum period of one year commencing with the Date of Substantial Completion. Where individual equipment sections specify longer warrantees, provide the longer warrantee. Any failure due to defective material, equipment or workmanship which may develop, shall be corrected at no expense to the Owner including all damage to areas, materials and other systems resulting from such failures.

C. Guarantee that all elements of each system meet the specified performance requirements as set forth herein or as indicated on the Drawings.

D. Upon receipt of notice from the Owner of the failure of any part of the systems during the guarantee period, the affected parts shall be replaced. Any equipment requiring excessive service shall be considered defective and shall be replaced.

1.11 COORDINATION

A. Refer to DIVISION 01, General Conditions, for record drawings and procedures to be provided under this section, unless specifically noted otherwise in this section.

B. Materials and apparatus shall be installed as fast as conditions of the building will permit and must be installed promptly when and as required.

C. Confer with all other trades relative to location of all apparatus and equipment to be installed and select locations so as not to conflict with work of other Sections. Any conflicts shall be referred immediately to the Owner's Representative for decision to prevent delay in installation of work. All work and materials placed in violation of this clause shall be readjusted to the Owner's Representative's satisfaction at no expense to the Owner.

D. Where work of this section will be installed in close proximity to work of other sections or where there is evidence that the work of this section may interfere with work of other sections, assist in working out space conditions to make satisfactory adjustment. Prepare and submit for approval 3/8" scale or larger working drawings and sections, clearly showing how the work is to be installed in relation to the work of other sections. If the work of this section is installed before coordinating with other trades or so as to cause interference with work of other trades, make changes necessary to protect conditions without extra charge.

E. Keep fully informed as to the shape, size and position of all openings required for all apparatus, piping, ductwork, etc., and give information in advance to build openings into the work. Furnish all sleeves, pockets, supports and incidentals, and coordinate with the Owner's Representative for the proper setting of same.

F. All distribution systems which require pitch or slope such as condensate drains and water piping shall have the right of way over those which do not.

G. Make reasonable modifications in the work as required by structural interferences, interference with work of other trades, or for proper execution of the work without extra charge.

H. Keep fully informed as to the size, shape and location of all openings required for the work of this Section and give full information to all Subcontractors and the Owner's Representative.

1.12 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

A. It is the intention of the Specifications and Drawings to call for complete, finished work, tested and ready for continuous operation. Any apparatus, appliance, material or work not shown on the Drawings, but mentioned in the Specifications or vice versa, or any

incidental accessories necessary to make the work complete in all respects and ready for operation, even if not particularly specified, shall be provided by the HVAC Subcontractor or his/her Sub Subcontractors, without additional expense to the Owner.

B. The Drawings are generally diagrammatic. The locations of all items that are not definitely fixed by dimensions are approximate only. The exact locations must be determined at the site and shall have the approval of the Owner before being installed. The HVAC Subcontractor shall follow Drawings, including shop drawings, in laying out work and shall check the Drawings of other trades to verify spaces in which work will be installed. Maintain maximum headroom and space conditions. Where space conditions appear inadequate, notify the Engineer before proceeding with the installation. The HVAC Subcontractor shall, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper execution of the work.

C. Any requests for information (RFI) for resolving an apparent conflict or unclarity, or a request for additional detail, shall include a sketch or equivalent description of Contractors proposed solution.

D. Sizes of ducts and pipes and routing are shown, but it is not intended to show every offset and fitting, nor every structural difficulty that may be encountered. To carry out the intent and purpose of the Drawings, all necessary parts to make complete approved working systems ready for use, shall be furnished without extra charge.

1.13 INSPECTION OF SITE CONDITIONS

A. Prior to submission of bid, visit the site and review the related construction documents to determine the conditions under which the Work has to be performed. Send a report, in writing, to the Owner's Representative, noting any conditions which might adversely affect the Work of this Section of the Specifications.

1.14 SURVEY AND MEASUREMENTS

A. Base all required measurements, horizontal and vertical, from referenced points established with the Owner's Representative and be responsible for correctly laying out the Work required under this Section of the Specification.

B. In the event of discrepancy between actual measurements and those indicated, notify the Owner's Representative in writing and do not proceed with the related work until instructions have been issued.

1.15 DELIVERY, STORAGE AND HANDLING

A. No materials shall be delivered or stored on site until Shop Drawings have been approved.

B. All manufactured materials shall delivered to the site in original packages or containers bearing the manufacturer's labels and product identification.

C. Protect materials against dampness. Store off floors, under cover, and adequately protected from damage.

D. Inspect all equipment and materials, upon receipt at the job site, for damage and conformance to approved shop drawings.

1.16 PROTECTION OF WORK AND PROPERTY

A. This Contractor shall be responsible for the care and protection of all work included under this Section until the completion and final acceptance of this Contract.

B. Protect all equipment and materials from damage from all causes including, but not limited to, fire, vandalism and theft. All materials and equipment damaged or stolen shall be repaired or replaced with equal material or equipment at no additional cost to the Owner.

C. Protect all equipment, outlets and openings with temporary plugs, caps and covers. Protect work and materials of other trades from damage that might be caused by work or workmen under this Section and make good damage thus caused.

D. Damaged materials are to be removed from the site; no site storage of damaged materials will be allowed.

1.17 SUPERVISION

A. Provide a competent Supervisor with a minimum of 5 years of experience in HVAC Construction Supervision who shall be in charge of the HVAC work at the site.

1.18 SAFETY PRECAUTIONS

A. Life safety and accident prevention shall be a primary consideration. Comply with all of the safety requirements of the Owner and OSHA throughout the entire construction period of the project.

B. Furnish, place and maintain proper guards and any other necessary construction required to secure safety of life and property.

1.19 SCHEDULE

A. Construct work in sequence under provisions of Division 01 and as coordinated with the Owner's Representative.

1.20 HOISTING, SCAFFOLDING AND PLANKING

A. The work to be done under this Section of the Specifications shall include the furnishing, set-up and maintenance of all derricks, hoisting machinery, cranes, helicopters, scaffolds, staging and planking as required for the work.

1.21 CUTTING AND PATCHING

A. Include all coring, cutting, patching, and fireproofing necessary for the execution of the work of this Section. Structural elements shall not be cut without written approval of the Owner. This Contractor shall be responsible for taking all precautions required to identify hidden piping, conduits, etc. before any core drilling and/or cutting of slabs commences, including X-raying the affected slabs. Provide fire stopping to maintain the fire rating of the fire resistance-rated assembly. All penetrations and associated fire stopping shall be installed in accordance with the fire stopping manufacturer's listed installation details and be listed by UL or FM.

B. All work shall be fully coordinated with all phases of construction, in order to minimize the requirements for cutting and patching.

C. Form all chases or openings for the installation of the work of this Section of the specifications, or cut the same in existing work and see that all sleeves or forms are in the work and properly set in ample time to prevent delays. Be responsible that all such chases, openings, and sleeves are located accurately and are of the proper size and shape and consult with the Owner's Representative and all trades concerned in reference to this work. Confine the cutting to the smallest extent possible consistent with the work to be done. In no case shall piers or structural members be cut without the approval of the Owner's Representative.

D. Fit around, close up, repair, patch, and point around the work specified herein to match the existing adjacent surfaces and to the satisfaction of the Owner's Representative.

E. Fill and patch all openings or holes left in the existing structures by the removal of existing equipment that is part of this Section of the Specifications.

F. All of this work shall be carefully done by workmen qualified to do such work and with the proper and smallest tools applicable.

G. Any cost caused by defective or ill-timed work required by this Section of the specifications shall be borne by the Subcontractor.

H. When, in order to accommodate the work required under this Section of the specifications, finished materials of other trades must be cut or fitted, furnish the necessary drawings and information to the trades whose materials must be cut or fitted.

1.22 SUPPLEMENTARY STEEL, CHANNELS AND SUPPORTS

A. Provide all supplementary steel, factory fabricated channels and supports required for proper installation, mounting and support of all equipment and systems provided under this section of the specification.

B. Supplementary steel and factory fabricated channels shall be firmly connected to building construction in a manner approved by the Owner's Representative, as shown on the drawings, or hereinafter specified.

C. The type and size of the supporting channels and supplementary steel provided under this section of the specifications shall be determined by the Subcontractor and shall be of sufficient strength and size to allow only a minimum deflection in conformance with the manufacturer's requirements for loading.

D. All supplementary steel and factory fabricated channels shall be installed in a neat and workmanlike manner parallel to the walls, floors and ceiling construction. All turns shall be made with 90 degree and 45 degree fittings, as required to suit the construction and installation conditions.

E. All supplementary steel including factory fabricated channels, supports and fittings shall be galvanized steel, aluminum, or stainless steel where exposed or subject to rust producing atmosphere and shall be manufactured by Unistrut, H-strut, Powerstrut, ERICO or approved equal.

1.23 HAZARDOUS MATERIALS

A. Dispose of all hazardous materials in accordance with Federal and State laws. All handling shall conform to EPA requirements. A uniform hazardous waste manifest shall be prepared for all disposals and returned with all applicable signoffs prior to application for final payment. Provide breakout cost for this scope.

B. Removed equipment or fluids containing any hazardous materials such as ethylene glycol, oil, mercury or chromate shall be recycled by a licensed facility approved by the Owner's Representative.

C. Where it has been identified that asbestos-containing material exists within the scope limits, refer to the Asbestos Abatement specification section for requirements. Where insulation is removed, provide new insulation (types and thicknesses as specified in this section). Where scope is not defined, provide unit prices with bid for all pipe and duct sizes involved.

1.24 ACCESSIBILITY

A. All work provided under this Section of the Specification shall be installed so that parts requiring periodic inspection, maintenance and repair are readily accessible. Work of this trade shall not infringe upon clearances required by equipment of other trades, especially code required clearances to electrical gear. Minor deviations from the drawings may be made to accomplish this, but changes of substantial magnitude shall not be made prior to written approval from the Owner's Representative.

1.25 WELDING QUALIFICATIONS

A. Piping shall be welded in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.9 (or B31.1 for steam boiler piping over 15 psig and all steam and condensate piping over 150 psig). The Owner's Representative shall be notified 24 hours in advance of tests and the tests shall be performed at the work site if practicable. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record. Structural members shall be welded in accordance with Division 01.

B. A fire watchman with an approved fire extinguisher shall be posted at the site of the welding work, during that work, and for a minimum of 30 minutes after the work is completed, to see that sparks or drops of hot metal do not start fires.

1.26 ELECTRICAL WORK

A. All electrical apparatus and controls furnished, and the installation thereof, as a part of the HVAC work, equipment, and controls shall conform to applicable requirements under DIVISION 26 - ELECTRICAL.

1.27 PROJECT CLOSEOUT

A. Certificates Of Approval

1. Upon completion of all work, provide certificates of inspections from the following equipment manufacturers stating that the authorized factory representatives have inspected and tested the operation of their respective equipment and found the equipment to be in satisfactory operating condition and installed per the manufacturers installation instructions and requirements.

a. Automatic Temperature Controls

b. Boilers

B. Construction Observations By The Engineer

1. The engineer shall make progress site visits during construction and one substantial completion (punch list) site visit for determining substantial completion.

2. The Trade Contractors and the General Contractor are required to inspect their own work and make any corrections to the work to comply with the specifications and the contract documents. It is not the responsibility of the engineer to develop lists of incomplete work items.

3. Progress Site Visits

a. The purpose of the progress site visit by the engineer is to observe if the work is proceeding in accordance with the contract documents.

b. The engineer will prepare a field report which will note in general the work completed since the last observation visit, work found not to be in accordance with the contract documents and work not corrected since the previous observation visit.

C. Substantial Completion

1. When the Contractor considers the Work under this Section is substantially complete, the Contractor shall submit written notice, through the General Contractor, with a detailed list of items remaining to be completed or corrected and a schedule of when each remaining work item will be completed. Should the engineer determine the list of remaining work does not constitute substantial completion the engineer will notify the Owner and he will not make a substantial completion site visit.

2. The following items shall be completed prior to the written request for substantial completion site visit:

a. Certification of successful operation of all systems.

b. Training of the Owner’s personnel in the operation of the systems.

c. Record Drawings in accordance with the contract specifications.

d. Operation and Maintenance manuals.

e. Testing reports.

f. Manufacturers certificates of approvals.

g. Emergency contact list for reporting of malfunctioning equipment during the warrantee period.

h. Contractors Project Completion certificate in accordance with the building code requirements.

3. Should the Engineer, during the substantial completion visit, observe that the Work is substantially complete, s/he will provide a written listing of the observed deficiencies referred herein as the Punch List. The Punch List will provide for a place for the Contractor and general Contractor to sign off and date each item individually indicating that the observed deficiency item has been corrected.

4. Should the Engineer, during the substantial completion site visit, observe that the Work is not substantially complete, s/he will provide, a written list of the major deficiencies and a reason for the work not being considered substantially complete.

5. If the work is found not to be substantially complete then the engineer shall be reimbursed for his time to re-observe the work. A re-observation fee shall be charged to the Contractor through the contractual agreement for any further observations by the engineer.

6. The Contractor shall remedy all deficiencies listed in the punch list within the time frame required by the contract.

D. Engineers Construction Completion Certification

1. Where required by the applicable code, the Engineers Construction Completion Certification will be issued by RDK Engineers when all life safety and health related issues are complete, all required functional tests are complete and all reports are complete. The following is a minimum listing of the required systems to be tested with reports generated indicating they are complete and ready for use:

a. Boiler Plant Start Up

b. Pipe Pressure Tests

c. Commissioning of Systems

2. There shall be NO outstanding items identified on the punch list for scope within any of these categories.

E. Final Completion

1. The following items shall be submitted prior to the written request for Final completion:

a. Revised Substantial Completion items to be resubmitted in accordance with the review process comments.

b. Warranties commencing the date of Substantial completion

c. Individual Signed and dated Punch List acknowledging completion of all punch list items

2. When the Contractor considers all of the punch list work items complete, the Contractor shall submit written notice through the General Contractor that all Punch List items are complete and resolved and the work is ready for final observation site visit. The signature lines for completion of each punch list item shall be signed by the Contractor indicating the work is complete and signed by the General Contractor indicating s/he has inspected the work and found it to be complete. Should the Engineer find the work to be finally complete and all Punch List items are complete the Engineer will make a recommendation to the Owner. If the Engineer has found the punch list work to be incomplete during final inspection a written listing of the observed deficiencies will be prepared by the Engineer.

3. If the work is not fully complete then the engineer shall be reimbursed for his time to re-observe the work. A re-observation fee shall be charged to the Contractor through the contractual agreement for any re-observations by the engineer.

F. Re-observation Fees

1. The re-observation fee shall be $1200.00 per visit.

G. Contractor's Project Completion Certificate

1. Upon completion of work and prior to request for Certificate of Occupancy, each Trade Contractor and the General Contractor shall issue a certificate stating that work has been installed generally consistent with construction documents and all applicable codes. RDK Engineers can furnish a blank Contractor's certificate form upon request. The certificate shall certify:

   a. Execution of all work has been installed in accordance with the approved construction documents.

   b. Execution and control of all methods of construction was in a safe and satisfactory manner in accordance with all applicable local, state and federal statutes and regulations.

2. The certificate shall include the following information:

   a. Project.

   b. Permit Number.

   c. Location.

   d. Construction Documents.

   e. Date on Plans and Specifications submitted for approval and issuance of the Building Permit.

   f. Addendum(a) and Revision Dates.

3. The certificate shall be signed by the Contractor and include the following:

   a. Signature.

   b. Date.

   c. Company.

   d. License Number.

   e. License Expiration Date.

PART 2 - PRODUCTS

2.0 PIPING AND FITTINGS

A. General Requirements for Pipe

1. Pipe material shall be indicated in the Schedule of Pipe and Fittings for each type of service.

2. Steel pipe shall conform to ASTM A53 Grade B or ASTM A106 Grade B (A106 is required for systems with temperatures that could go over 750 degrees F) black steel. Pipe thickness (schedule) shall be as specified for the service.

3. Stainless steel pipe shall be grade 304, 304L, 316 or 316L and shall conform to ASTM A312, seamless. Pipe thickness (schedule) shall be as specified for the service.

4. Copper tubing shall conform to ASTM B75 or ASTM B88, seamless. Thickness (type) shall be as required for the service with a minimum safety factor of 4:1. Tubing for compressed air tubing shall conform to ASTM B251.

5. Polyethylene tubing shall be fire-resistant (FR), low-density virgin polyethylene conforming to ASTM D 1248, Type I, Category 5, Class B or C.

B. General Requirements for Fittings

1. Pipe fittings shall be indicated in the Schedule of Pipe and Fittings for each type of service. Fittings shall be rated to match the larger of the pipe pressure rating in the Schedule or the valve rating listed in the valve tables in the Part 2 Valve and Strainer section of this specification.

2. All fittings shall be installed per code requirements and the manufacturer's best recommendations.

3. Malleable iron pipe fittings shall conform to ASME B16.3, type required to match adjacent piping.

4. Cast iron (CI) pipe fittings shall conform to ASME B16.1 or ASME B16.4 type required to match adjacent piping.

5. Steel pipe fittings shall have the manufacturer's trademark affixed in accordance with MSS SP-25 so as to permanently identify the manufacturer. For 90° elbows, provide long radius fitting unless they will not physically fit, in which case short radius may be used. Flanges shall be flat faced weld neck up to Class 125 and raised face weld neck type for Class 150 and above.

6. The steel pipe joining methods below are only allowed when they are specifically listed in the Schedule of Pipe and Fittings:

a. Type S1: Welded fittings shall conform to ASTM A234 with WPA marking. Butt-welded fittings shall conform to ASME B16.9, and socket welded fittings shall conform to ASME B16.11. Make fusion welded joints as required by ANSI/ASME B31.1.

b. Type S2: Steel flanged fittings including flanges, bolts, nuts, bolt patterns, etc. shall be in accordance with ASME B16.5 for the class required (Class 150 minimum). Flange material shall conform to ASTM A53 Grade B. Blind flange material shall conform to ASTM A516 for cold service and ASTM A515 for hot service. Bolts shall be high strength or

intermediate (Class 150 only) strength with material conforming to ASTM A193.

c. Type S3: Cast Iron (CI) flanged fittings shall be of malleable cast iron conforming to ASTM A47, Grade 32510. Bolts shall be high strength or intermediate (Class 125 only) strength with material conforming to ASTM A193. Class 125 iron flanges shall be limited to 175 psig / 230°F (up to 12") and 125 psig / 230°F (14" – 24"). Class 250 iron flanges shall be limited to 400 psig / 250°F (up to 12") and 250 psig / 250°F (14" – 24").

d. Type S4: Ductile iron (DI) flanged fittings shall conform to ASTM A536, Grade 65-45-12. Bolts shall be high strength or intermediate (Class 150 only) strength with material conforming to ASTM A193. Class 150 ductile iron flanges shall be limited to 225 psig / 230°F. Class 300 ductile iron flanges shall be limited to 425 psig / 450°F.

e. Type S5: Threaded joints: For use up to 2" pipe size. Pipe threads shall conform to ASME B1.20.1. Nipples shall conform to ASTM A733 or ASTM B687. Class 125 iron threaded fittings shall be limited to 150 psig / 250°F or 125 psi at 350°F. Class 250 iron threaded fittings shall be limited to 340 psig / 250°F. Class 150 ductile iron threaded fittings shall be limited to 185 psig / 250°F or 150 psig / 300°F (maximum temperature). Class 300 ductile iron threaded fittings shall be limited to 1200 psig / 250°F or 600 psig / 450°F (maximum temperature).

f. Type S6: Malleable iron pipe press fittings equal to IMS Fastlock may be used (in exposed, accessible areas only) and shall be NSF-61-4 certified, approved by the state where it will be installed, and be IAPMO approved. Sealing elements for press fittings shall be EPDM gasket and 316L stainless steel ring. System shall be suitable for, and limited to, water systems up to 2" pipe size with operating temperatures up to 210°F and maximum pressure rating up to 200 psig. Press ends shall have a design feature to assure leakage of liquids and/or gases from inside the system past the sealing element of an un-pressed connection with a 10 psig air pressure test. The function of this feature is to provide the installer quick and easy identification of connections which have not been pressed prior to putting the system into operation.

   1) Do not use on steam systems or hot water systems that use steam heat exchangers. Exception: Press fitting joints may be used on hot water systems below 210° generated by low pressure steam providing the steam control valves fail closed, the hot water piping has minimum 3 foot thermal traps at the heat exchanger (both supply and return), and the first grooved joint is a minimum of 25 feet away from the heat exchanger's thermal pipes.

g. Type S7: For use over 2" pipe size. Standard grooved mechanical pipe joints shall conform to ANSI/AWWA C606. Use is limited to low temperature water systems below 210°F and 250 psig in easily accessible locations. Couplings shall be designed for not less than 250 psi service and shall provide a water-tight joint.

   1) Do not use on steam systems or hot water systems that use steam heat exchangers. Exception: Grooved joints may be used on hot water systems below 210° generated by low pressure steam providing the steam control valves fail closed, the hot water piping has minimum 3 foot thermal traps at the heat

exchanger (both supply and return), and the first grooved joint is a minimum of 25 feet away from the heat exchanger's thermal pipes.

2) Grooved mechanical joint fittings shall be full flow factory manufactured forged or fabricated steel fittings or cast ductile iron fittings. Mechanical pipe couplings shall be of the bolted type and shall consist of a housing fabricated in two parts, a synthetic rubber gasket, and nuts and bolts to secure unit together. Housings shall be of ductile iron conforming to ASTM A536, Grade 65-45-12. Coupling nuts and bolts shall be of heat treated carbon steel, zinc electroplated to ASTM B-633 and conform to ASTM A-183 and A-449, minimum 110,000 PSI tensile strength. Gaskets shall be of molded synthetic rubber, Type EPDM (for water service) with central cavity, pressure responsive configuration, rated for a temperature range of -30ºF to +230ºF, and shall conform to ASTM D-2000 (Gaskets shall be verified as suitable for the intended service prior to installation).

3) Rigid grooved joints shall incorporate an angle bolt pad design which maintains metal-to-metal contact of housings upon installation to insure positive rigid clamping of the pipe. Rigid grooved pipe couplings shall be used with grooved end pipes, fittings, valves and strainers. Rigid segmentally welded elbows shall not be used. Standard rigid coupling (2"-12") housings shall be Victaulic Style 107, 07, or Grinnell Style 772, (over 12" shall be 2 piece housings equal to Victaulic AGS) and shall provide system rigidity equal to welded steel with supports and hanging requirements corresponding to ANSI B-31.1 Power Piping and ANSI B-31.9 Building Services Codes (same spacing as steel pipe).

4) Flexible grooved joints will not be permitted, except as vibration isolators adjacent to mechanical equipment other than pumps.

5) Grooves shall be prepared in accordance with the coupling manufacturer's latest published standards. Grooving shall be performed by qualified grooving operators having demonstrated proper grooving procedures in accordance with the tool manufacturer's recommendations. The Owner's Representative shall be notified 24 hours in advance of test to demonstrate operator's capability, and the test shall be performed at the work site, if practical, or at a site agreed upon. The operator shall demonstrate the ability to properly adjust the grooving tool, groove the pipe, and verify the groove dimensions in accordance with the coupling manufacturer's specifications.

7. Fittings for copper tubing shall be wrought copper and bronze fittings conforming to ASME B16.22 and ASTM B75 or cast copper alloy fittings conforming to ASME B16.18. Copper may be used up to 2" tubing size. Adapters may be used for connecting tubing to flanges and threaded ends of valves and equipment. The copper tubing/pipe joining methods below are only allowed when they are specifically listed in the Schedule of Pipe and Fittings:

a. Type C1: Soldered copper fittings shall use either 95/5 (Tin/Antimony), silver solder (for systems up to 250 degrees F and 175 psi), or shall be brazed (for higher temperature/pressure systems – Contractor shall

submit brazing material and pressure/temperature rating of joint). Solder shall conform to ASTM B32. Solder and flux shall be lead free. Silver solder shall conform to FS QQ-B-654. Brazing alloys shall be B-Ag alloy (or equivalent strength alloy) having a melting point above 1000 degrees F.

b. Type C2: Copper and copper alloy press fittings equal to Viega ProPress may be used (in exposed, accessible areas only) and shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117. Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed or an alternative supplied by fitting manufacturer and shall be suitable for, and limited to, water systems with operating temperatures up to 210ºF and maximum pressure rating up to 200 psig. Press ends shall have a design feature to assure leakage of liquids and/or gases from inside the system past the sealing element of an un-pressed connection. The function of this feature is to provide the installer quick and easy identification of connections which have not been pressed prior to putting the system into operation.

c. Type C3: Grooved joints (copper tube sized) fittings (rated and limited for systems up to +210 degrees F and maximum pressure rating of 300 psi) equal to Victaulic Style 607 may be used for water systems (in exposed, accessible areas only).

8. Type SC1: Vic-Press 304™ fittings and couplings or ProPress® Stainless joints with Schedule 5 stainless steel pipe may be used for up to 2" water piping (in exposed, accessible areas only) in lieu of other copper or steel joining methods to a maximum operating temperature of +210 degrees F and maximum pressure rating of 200 psi. Pipe shall be ASTM A312 Schedule 5, stainless steel. Fittings shall be stainless steel with EPDM O-ring seals.

   a. Do not use on steam systems or hot water systems that use steam heat exchangers. Exception: Press fitting joints may be used on hot water systems below 210º generated by low pressure steam providing the steam control valves fail closed, the hot water piping has minimum 3 foot thermal traps at the heat exchanger (both supply and return), and the first grooved joint is a minimum of 25 feet away from the heat exchanger's thermal pipes.

9. Composition gaskets for flanges shall conform to ASME B16.21. Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1/16 inch thickness, full face or self-centering flat ring type. Gaskets shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). NBR binder shall be used for hydrocarbon service. Gaskets shall be suitable for pressure and temperatures of piping system.

10. Unions shall conform to FS WW-U-531 or FS WW-U-516, type to match adjacent piping.

11. Adapters for copper tubing shall be brass or bronze for soldered and brazed fittings.

12. Dielectric Waterway fittings equal to PPP Clearflow shall be used where dissimilar pipe materials (such as steel and copper) in any water or glycol system are joined. Fittings shall conform to the tensile strength and dimensional requirements specified in FS WW-U-531. Waterways shall have metal connections on both ends to match adjacent piping. Metal parts of dielectric

Waterways shall be fully separated by NSF/FDA listed thermoplastic lining so that the electrical current is well below 1 percent of the galvanic current that would exist upon metal-to-metal contact. Fittings shall be rated for 300 psig and 225°F. Galvanized pipe, dielectric unions, or insulated couplings shall not be used.

13. Flexible pipe connectors shall be as specified in Vibration Isolation paragraph.

C. Schedules of Pipe and Fittings

1. As used in the pipe and fitting schedule tables, closed loop systems have expansion tanks and are not open to the atmosphere, examples are chilled, hot, dual temperature and closed heat pump condenser water systems. Open loop systems are open to the atmosphere with open condenser water system being the most common.

2. Relief valve piping shall have the same pressure/temperature ratings as the fluid being relieved. Exposed outdoor piping shall be stainless steel.

WATER AND GLYCOL SERVICES:
UP TO 230 PSIG AT 250ºF, OR 275 PSIG AT 100ºF
(Some joint types or materials may have lower pressure and/or temperature limits and Contractor shall ensure they are only used where those limits will NOT be exceeded.)

Service	Pipe Material & Schedule or Type	Joint Types Allowed	Fitting Material	Min. Pressure Class (psig) & / or Schedule
Closed loop piping up to 2”	Copper / Type L	C1, C2, C3, or SC1	Copper, Bronze	150
Closed loop piping up to 2”	Steel / Schedule 40	S5, S6, or SC1	CI, DI	250 / Standard Weight
Closed loop piping 2.5”-24”	Steel / Standard Weight	S1, S2, S3, S4, or S7	Steel, CI, DI	150 / Standard Weight
Cold water make-up	Copper / Type L	C1 (silver soldered or brazed only), C2, C3, or SC1	Copper, Bronze	150

D. Diesel and Fuel Oil Piping and Fittings

1. Indoor Above Grade - Single Wall:

a. Piping: Seamless steel A53, A105, A120 or ERW A53E. Threaded joints shall be Schedule 80, welded joints shall be Schedule 40. Cast iron fittings must not be used on fuel systems.

b. Fittings: Steel, beveled butt-weld ends, ASTM A234, ANSI B169, same schedule as adjoining pipe, all elbows long radius, all interior surfaces smoothly contoured. Threaded fittings shall be malleable iron, 300 PSI Class, ASTM A47, or forged or rolled steel, ASTM A234.

c. Unions: Malleable iron, 300 PSI Class, brass seat, ANSI B16.39, or 2,000 pound forged steel, ASTM A105.

d. Joints: Welded for piping 2-1/2 inches and above, threaded or butt-welded for pipe 2 inches and below.

e. Flanges shall be forged steel welding neck type with flanges, bolts, nuts, bolt patterns, etc. being in accordance with ASME B16.5 for the class required (Class 150 minimum). Flange material shall conform to ASTM A53 Grade B. Bolts shall be high strength or intermediate (Class 150 only) strength with material conforming to ASTM A193.

2.1 PIPE HANGERS AND SUPPORTS

A. Hangers shall be as manufactured by Carpenter & Patterson, Inc., Grinnell Corporation, B-Line Systems, ERICO, or equal. Hangers shall transmit the load exclusively to the structure of the building. All hangers and supports to conform to MSS standards SP-58 and SP-69 and ANSI B 31.1.

B. Hangers for all piping 4 inches and above shall be adjustable roll type. Hangers for piping below 4 inches shall be clevis type. Hangers for piping in tunnels on strut support frames shall be roller type, similar to Fig. B379 by B-Line Systems. Additionally, the first five (5) pipe hangers on both sides of all pump piping (suction and discharge) to be precompressed spring and double-deflection neoprene style, with 30° hanging rod swing capability, similar and equal in all respects to Mason Industries Model PC 30N, selected by manufacturer for anticipated loading and deflection.

C. Provide all additional structural steel required for proper installation of hangers, anchors, guides and supports; hangers shall be arranged to maintain the required grading and pitch of piping, to prevent vibration and to provide for expansion and contraction.

D. Maximum spacing of hangers and supports for steel pipe:

Pipe Size (inches)	Horizontal	Vertical
Up to 1	6 feet	10 feet
1¼-2½	9 feet	15 feet
3-and up	12 feet	15 feet

E. Reduce Steel pipe spacing to a maximum of 10', regardless of pipe, as necessary for fittings, valves, and other concentrated loads.

F. Horizontal copper tubing shall have maximum hanger spacing of 5' for tubing up to 1-¼" and 8' for 1½" and larger. Vertical copper tubing shall have maximum hanger and support spacing of 10 feet. Maximum spacing for PVC pipe hangers and supports shall be 4' (horizontal), and 10' (vertical) with mid-story guides.

G. Steel or stainless steel tubing shall have maximum hanger and support spacing of 8 feet (horizontal) or 10 feet (vertical).

H. If any other piping material is used, the maximum hanger and support spacing shall be the lesser of manufacturers recommendation or the listed spacing in the mechanical code (currently IMC-2009 Table 305.4).

I. Branch piping and runouts of over 5 feet shall have at least one hanger or support.

J. At all copper piping, provide pipe supports with copper finish to eliminate the possibility of galvanic action.

K. Furnish additional hangers or supports at vertical or horizontal changes of direction and at locations of concentrated loads due to valves, fittings, strainers, and accessories.

L. Hangers and supports shall provide for 2" of vertical adjustments.

M. Hanger rods shall be steel, threaded and furnished with two removable nuts at each end of positioning rod and hanger and locking each in place.

N. Except as otherwise noted, hanger rods shall be of the following sizes:

SCHEDULE OF PIPE HANGER ROD SIZES		
Pipe sizes (inches)	**Single rod diameter (inches)**	**Double rod diameter (inches)**
½-2	3/8	3/8
2½-3	½	3/8
4 & 5	5/8	½
6	¾	5/8
8 – 12	N/A	7/8
14 – 18	N/A	1
20	N/A	1¼
24	N/A	1-½

O. Pipe covering protection saddles shall not be loaded to more than 80% of maximum loading as rated by the manufacturer.

P. Insulated piping insulation shields:

1. Up to 3" pipe size: 18 gauge galvanized steel, located outside the vapor barrier, minimum 180° arc, 12" long, or pipe covering protection saddles.

2. 4" pipe size and larger: pipe covering protection saddles.

Q. Vertical support shall be by means of riser clamps (anchors with split ring type allowable up to 2" size only) and adjustable pipe support with flange anchored to floor or supplementary steel.

R. Rods, clamps and hangers shall be electro-galvanized coated.

S. Valve and piping supports, from the floor, shall be equal to Carpenter & Paterson, Inc. Figure 101, adjustable pipe support and complete with pipe standard and flange, anchored to floor.

1. Supports shall be installed at each control valve, riser, tee or elbow and where any unsupported section exceeds 4'-0" in length measured along piping centerline.

T. Upper Attachments to Building Structure:

1. Existing Reinforced Concrete Construction: Upper attachment welded or clamped to steel clip angles that are expansion-bolted to the concrete. Expansion bolting shall be located so that piping loads place bolts in shear. Submit details for approval.

2. Structural Steel Framing: Upper attachments welded or clamped to structural steel members. Additional steel members may be necessary in some support locations where piping locations differ from that known on contract drawings. Submit details for approval.

3. Structural Wood Framing: Submit details for approval.

4. Expansion Fasteners and Power Set Fasteners: In existing concrete slab construction, expansion fasteners may be used for hanger loads up to one-third the manufacturer's rated strength of the expansion fastener. Power set fasteners may be used for loads up to one-fourth of rated load. When greater hanger loads are encountered, additional fasteners may be used and interconnected with steel members combining to support the hanger.

U. All hangers and shields exposed to the exterior shall be galvanized steel and PVC coated to manufacturer's standard thickness.

V. In grooved piping systems, rigid type grooved joint mechanical couplings may be used on IPS steel piping systems, which meet the support and hanging requirements of these specifications and ASME B31.1 and B31.9. Adequate numbers of flexible type couplings may also be used to compensate for thermal expansion and contraction, settling of the pipe, vibration, noise or other piping system movement. Maximum hanger spacing for flexible couplings shall be in accordance with either manufacturer's published guidelines or the requirements of Item D of this section; whichever is more stringent.

2.2 VALVES AND STRAINERS

A. General:

1. Valves and strainers shall be constructed of the materials shown in the tables for each system and be rated by the manufacturer for the appropriate pressure class required for the listed pressure and temperature limits and for the fluid used and per the valve tables.

2. The manufacturers and model numbers indicated below are to be used as a means of identifying the type, quality, materials and workmanship required. Note that some of the manufacturers listed for a type of valve do not make valves for all pressure/temperature limits and/or all sizes. All valves of each type (400 psig ball, 150 psig globe, etc.) for the project shall be by the same manufacturer.

3. All valves shall be located and oriented as to valve stem direction to permit proper and easy operation, and access to valve for maintenance of packing, seat and disc. Valve stems shall not be tilted down unless approved by the manufacturer. Where valves are more than seven feet above the floor, stems shall be horizontal and all valves 2-1/2" and above shall have chain wheel and "endless link" style chain for operation from floor; where impact wheel is required, it shall be provided. Packing and gaskets shall not contain asbestos. Provide unions adjacent to equipment end of all threaded and soldered or permanent push-to-connect end valves. Provide grooved joint couplings adjacent to equipment end of all grooved end valves.

B. Service:

1. Shutoff or Isolation Valves shall be provided in all branch connections to mains and where shown on piping diagrams.

   a. In general, for 2½" and larger piping use flanged valves or grooved-ended valves in grooved water systems; butterfly valves for water and glycol systems or gate valves for steam and condensate systems.

   b. In general, for piping smaller than 2½" use threaded, sweat, permanent push-to-connect or press/crimped water system connections; full port ball valves for water, fuel oil, and glycol systems or gate valves for steam and condensate systems.

2. Balancing Valves

   a. No balancing valves are required where Pressure Independent Automatic Control Valves (PIACV) are used for a single coil. Where multiple coils are served by a single PIACV, each coil shall have a combination balancing and shut-off valve to provide proportional balancing. When non-PIACVs are used, provide automatic flow limiting valves or combination balancing and shut-off valves as shown on drawings and details for water and glycol systems and globe valves for steam and condensate. Triple duty valves (balancing with flow measurement, shut-off, and check valve) or equivalent tri-service assemblies (in grooved piping systems) can be used where shown on the drawings and allowed in the tables on pump discharges.

3. Check Valves

   a. For pump discharge use silent check valves (where allowed in the tables and where triple duty valves are not used). All others shall be swing-check type.

4. Drain Valves and Manual Vent Valves

   a. Globe with plug-type disc or ball valves (as shown on drawings).

5. Vacuum Breakers

   a. Vacuum breakers shall be of stainless steel and brass construction rated for a minimum of 200 psig saturated steam and be equal to Spriax Sarco Model VB-14. Provide at least one vacuum breaker for each steam coil and heat exchanger.

C. Swing Check Valves: Bronze valves shall conform to MSS SP-80, of the type required for the pressure class and body connection type listed in the tables. Iron valves shall conform to MSS SP-71, of the type required for the pressure class and body connection type listed in the tables. Steel valves shall conform to ASME B16.34, of the type required for the pressure class and body connection type listed in the tables. Valves shall be as manufactured by Stockham, Milwaukee, Crane, Nibco, Victaulic (grooved), Grinnell (grooved), or Hammond.

D. Silent Check Valves: Silent check valves for use on pump discharge shall be of the materials and pressure/temperature ratings shown in the tables. Minimum open area through valve shall be at least 100% of the pipe area. Valves shall be as manufactured by Mueller, Nibco, Metraflex, APCO, Victaulic (grooved), Grinnell (grooved), or SF Equipment.

E. Globe Valves (including angle valves): Bronze valves shall conform to MSS SP-80, of the type required for the pressure class and body connection type listed in the tables. Iron valves shall conform to MSS SP-85, of the type required for the pressure class and body connection type listed in the tables. Steel valves shall conform to ASME B16.34, of the type required for the pressure class and body connection type listed in the tables. Maximum seat leakage for manual valves shall be no more than 10 cc/hr per inch of diameter. Control valves leakage shall be no more than that allowed by ANSI seat leakage Class IV (0.01% of full open valve capacity). Valves shall be as manufactured by Stockham, Milwaukee, Crane, Nibco, or Hammond. For areas where clearances are restricted, non-rising stems may be used – Contractor shall indicate locations on submittal.

F. Gate Valves: Bronze valves shall conform to MSS SP-80, of the type required for the pressure class and body connection type listed in the tables. Iron valves shall conform to MSS SP-70, of the type required for the pressure class and body connection type listed in the tables. Steel valves shall conform to ASME B16.34, of the type required for the pressure class and body connection type listed in the tables. Maximum seat leakage shall be no more than 10 cc/hr per inch of diameter. Valves shall be as manufactured by Stockham, Milwaukee, Crane, Nibco, or Hammond. For areas where clearances are restricted, non-rising stems may be used – Contractor shall indicate locations on submittal.

G. Ball Valves: Valves shall meet FS WW-V-35C, Type II, and have the appropriate trim to meet the required pressure/temperature ratings listed in the tables. Valves shall have locking handles to allow servicing and removal of piping or equipment. Valves on insulated piping shall have stem extension assemblies equal to the insulation thickness. Valves shall have 100% tight shut-off (no seat leakage). Valves used for isolation (all 2-position applications) shall be full port. Valves shall be as manufactured by Conbraco Industries (Apollo), Watts, Stockham, Nibco, Hammond, or Milwaukee. Ball valves for modulating control service may be reduced port andshall have characterized disc where available to provide equal percentage flow characteristics and extended rangeability. Modulating ball valves shall be Bray VCB series or Belimo B series.

H. Butterfly Valves: Provide butterfly valves of the type and materials listed in the tables. Valve necks shall allow a minimum of 2” insulation. Valves shall have the trim required to meet the listed pressures and temperatures listed in the tables. Valves shall have visual position indication. Valve seats shall have zero or near zero (bubble-tight) bi-directional seat leakage. Valves 6” and larger and all steam valves shall be gear operated. Non-steam valves under 6” shall be lever operated with balance stops.

1. General Service: Standard lug or grooved (in grooved systems) type with ductile or cast iron body, resilient EPDM seats, bronze, nickel, PPS (Polyphenylene Sulfide), Nylon 11 or EPDM coated ductile iron disc and 416 stainless steel stem. Valves shall comply with MSS SP-25, MSS SP-67, and API-609. Valves shall be as manufactured by Mueller, Centerline, DeZurik, Milwaukee, Nibco, Hammond, Keystone, Bray Model 31H, Victaulic Masterseal (grooved), Grinnell Model B302 (grooved), or SF Equipment.

2. High Performance: Valves shall have lug-style carbon steel body, 316 stainless steel eccentric disc, offset 17-4 PH stainless steel shaft, and filled PTFE soft seat. Valves shall comply with ANSI B16.5, ANSI B16.34, MSS SP-25, MSS SP-61 (zero leakage), MSS SP-58, and API-609. Valves shall be as manufactured by Flowseal (Crane), Neles-Jamesbury, DeZurik, Posi-Seal, Milwaukee, Hammond or Bray/McCannalok.

I. Automatic Flow Limiting Valves: Valves shall be pressure flow limiting independent type with spring loading to provide the required opening to maintain constant flow across the entire control pressure range. Valve flow selection shall be adjustable on the valve assembly with a minimum range of +50% above the design flow. Valves whose flow rate can't be field selected (fixed flow) shall be selected within in the range of -5% to +10% of the design flow and be provided with replacement flow cartridges as required by the balancing Contractor or engineer. The valves shall be provided with a permanent nameplate or tag carrying a record of the factory-determined flow rate, flow range and flow control pressure ranges. Valves shall be certified to control the flow within 5 percent of the flow set per the tag's listed flow and control pressure range. Unless shown otherwise, the minimum control pressure range shall be 2 to 32 psid. Valves shall be of materials suitable for the maximum operating pressure and temperature listed in the table for the intended service. Valves up to 2-inches shall be threaded or solder-end. Valves over 2-inches shall be flanged. Each valve shall have a pressure fitting with quick disconnect valve located on both sides of the valve. Provide deluxe meter kit in carrying case. Provide molded insulation kit. Valves shall be as manufactured by Griswold, Flow Design/Autoflow, Macon, Hays or Nexus.

J. Strainers

1. Strainer-body connections shall be the same size as the pipe lines in which the connections are installed. The bodies shall have arrows clearly cast on the sides to indicate the direction of flow. Each strainer shall be equipped with an easily removable cover and sediment basket. The body or bottom opening shall be equipped with a tapped blowdown opening. Provide full size nipple and appropriate type of valve for blowdown. The basket shall be of stainless steel with small perforations of sufficient number to provide a net free area through the basket of at least 5 times that of the entering pipe. The flow shall be into the basket and out through the perforations. Bronze strainers shall conform to MSS SP-80, of the type required for the pressure class and body connection type listed in the tables. Iron strainers shall conform to MSS SP-71, of the type required for the pressure class and body connection type listed in the tables. Steel strainers shall conform to ASME B16.34, of the type required for the pressure class and body connection type listed in the tables. Y-type strainers are listed in the tables, provide basket type strainers of same construction where shown on drawings. Strainers shall be as manufactured by Mueller, Sarco, Watts, Armstrong, Keckley, or Yarway.

2. Strainers for grooved end piping systems shall be of the same size as the pipe lines in which the connections are installed. The bodies shall have arrows clearly cast on the sides to indicate the direction of flow. Each strainer shall be equipped with an easily removable cover and sediment basket. The body or bottom opening shall be equipped with a tapped blowdown opening:

a. Y-pattern, 2" through 12" sizes, 300 psi maximum pressure rating. Suitable for services up to 210°F, ductile iron body, Type 304 stainless steel perforated metal removable baskets, blowdown port with pipe plug and grooved ends.

b. T-pattern, 2" through 12" sizes, 300 psi maximum pressure rating. Suitable for services up to 210°F, ductile iron body, Type 304 stainless steel frame and mesh removable basket, removable access coupling/cap for strainer maintenance, and grooved ends.

c. T-pattern, 14" through 24" sizes, 300 psi maximum pressure rating. Suitable for services up to 210°F, carbon steel body, Type 304 stainless

steel frame and mesh removable basket, carbon steel T-bolt hinged closure/cap for strainer maintenance, and grooved ends.

K. Pressure Relief Valves and Accessories

1. Pressure relief valves shall be provided where shown on the drawings in accordance with ASME BPV VIII Division 01. Relief valves shall be constructed for the maximum pressure the system can operate at. The aggregate relieving capacity of the relief valves shall be not less than that required by the above code. Provide at least one relief valve for each closed loop piping system. Discharge from water relief valves shall be to indirect drain. Pipe chiller refrigerant relief and steam relief valves to a safe location outdoors. Valves shall be as manufactured by Watts, Kunkle, Lonergan, or Lunkenheimer.

2. For steam relief valves that are piped outdoors, provide steam exhaust heads where shown on drawings. Exhaust heads shall be low pressure drop cyclone design with drains as manufactured by Bryan Steam HEH Series (rated at 7,000 fpn) or equal by, Crane (Cochrane), Penn Separator, Watson McDaniel, Anderson or Hayward (Wright-Austin). Pipe drains as required. Exhaust heads shall remove at least 99% of liquids and solids larger than 10 microns and be fabricated of cast iron or carbon steel (with high heat and rust resistant aluminum paint) with stainless steel separating elements. Contractor shall verify that the exhaust head's steam capacity is equal to or greater than the associated relief valves capacity and provide any required pipe increases

L. Air Vents: Provide air vents at all high points in the piping systems meeting the pressure and temperature limits shown on the table for each system.

1. Automatic: Normal Capacity – Float operated with bronze or steel body and stainless steel internals, ball-check valve type with materials as required for the pressure/temperature listed in the table for the system. Provide each vent with safe drainage piping for venting air/water to drain.

2. Manual: For low pressure/temperature water and glycol systems, provide 1/8-in. brass body, chrome plated with two-detachable keys. For higher pressure/ temperature systems, provide globe valves with plug-type disc or ball valves with materials, as required and allowed in the table for the system.

M. Drain Valves: Drain valves shall be one of the type listed for isolation in the table for each piping system. Provide drain connections at all equipment and all low points in the piping systems to allow for complete drainage. Drain connections shall have full size threaded hose end connections with cap/plug. For piping up to 4", provide minimum ¾" valves. For piping between 4" and 10", provide minimum 1½" valves. For piping larger than 10", provide minimum 2" valves. Provide 50' of premium grade hose for each size drain.

N. Valve Lubrication: Furnish a lubrication gun in the mechanical equipment room with extra lubricant sticks sufficient to repack each valve. Guns shall be extra heavy, lever type hydraulic hand type with automatic shutoff, 1500 psi gauge and 12" long connecting hose. Lubricant shall be as required by valve manufacturer for the service intended.

WATER AND FUEL OIL SERVICES: Maximum 150 psig at 120°F (CHW, CW, FO)						
Valve Type	**Size**	**Type**	**Application**	**Body/Trim Body/Seat**	**Type of Connection**	**Minimum Pressure Rating/Class**
Ball	To 2”	2 or 3 piece	Isolation or ATC Modulation (with characterized disc)	Brass or Bronze/RTFE	Sweat (3-piece only) or Threaded (2 or 3-piece)	400 psig CWP (Cold Working Pressure)

WATER SERVICES: Maximum 150 psig at 250°F (Heating & Dual Temperature Systems), or 275 psig at 120°F (CHW & CW)						
Valve Type	**Size**	**Type**	**Application**	**Body/Trim Body/Seat**	**Type of Connection**	**Minimum Pressure Rating/Class**
Ball	To 2”	2 or 3 piece	Isolation or ATC Modulation (with characterized disc)	Brass or Bronze/RTFE	Sweat (3-piece only) or Threaded (2 or 3-piece)	400 psig CWP (Cold Working Pressure) or ANSI Class 150
Butterfly	2½” - 12”	General Service	Isolation or ATC 2-Position	Iron/EPDM	Flanged	200 psig CWP, Bi-directional, dead end service.
Balancing /Shutoff	To 2”	Flow Indication	Isolation and balancing	Bronze or Brass/Brass	Threaded	ANSI Class 125 or 300 psig CWP
Balancing /Shutoff	2½” -12”	Flow Indication	Isolation and balancing	Iron or Steel/Brass	Flanged	ANSI Class 125 for 150 psig or 300 psig CWP for 275 psig
Check	To 2”	Swing	Piping	Bronze/Bronze	Threaded	ANSI Class 125 for 150 psig or Class 200 for 275 psig
Check	2½” - 12”	Swing	Piping	Iron or Steel /Bronze or 13 Cr steel	Flanged	ANSI Class 125 for 150 psig or Class 250 or 150 Steel for 275 psig
Strainer	To 2”	Y-type	ACVs, P&F HXs	Bronze/Stainless 1/16” screen	Threaded	ANSI Class 125 for 150 psig or Class 200 for 275 psig
Strainer	2½” – 4”	Y-type	ACVs, P&F HXs	Iron or Steel /Stainless 1/16” screen	Flanged	ANSI Class 125 for 150 psig or Class 250 or 150 Stl for 275 psig

WATER SERVICES: **Maximum 150 psig at 250°F (Heating & Dual Temperature Systems), or 275 psig at 120°F (CHW & CW)**						
Valve Type	**Size**	**Type**	**Application**	**Body/Trim Body/Seat**	**Type of Connection**	**Minimum Pressure Rating/Class**
Strainer	5" – 12"	Y-type	ACVs, P&F HXs	Iron or Steel/Stainless 1/8" screen	Flanged	ANSI Class 125 for 150 psig or Class 250 or 150 Steel for 275 psig
Strainer	To 16"	Suction Diffuser	Pump Inlet (non-reducing)	Cast or Ductile Iron /Stainless 5/32" screen	Threaded (to 2") or Flanged	300 psig CWP or ANSI Class 125

ALTERNATE PIPING METHOD (GROOVED JOINT) FOR WATER SERVICES: **Maximum Service Rating of 230F; with pressure as required for the systems (see standard valve tables)**						
Valve Type	**Size**	**Type**	**Application**	**Body/Trim Body/Seat**	**Type of Connection**	**Pressure Rating/Maximum System Rating**
Ball	1½"-6	2-piece	Isolation or ATC 2-Position	DI (ASTM A-536)/Cr.-plated stem, ball TFE seats	Grooved	800 PSI/600 PSI
Ball	2"	1-piece	Diverting (3-port) or ATC 2-Position	DI (ASTM A-395)/SS TFE	Grooved	600 PSI/450 PSI
Butterfly	2"-12"	General Service	Isolation or ATC 2-Position	DI (ASTM A-536 or 395) DI/EPDM	Grooved	300 PSI (dead-end to full rating of valve)/230 PSI
Butterfly, 3-way	2"-12"	General Service	Diverting	DI (ASTM A-536 or 395)/ DI/EPDM	Grooved	300 PSI (dead-end to full rating of valve)/230 PSI
Butterfly	14"-24"	General Service	Isolation	DI (ASTM A-395) SS/EPDM	Grooved	175 PSI (dead-end to full rating of valve)/150 PSI
Butterfly	14"-24"	General Service	Isolation	DI (ASTM A-395 or 536) DI/EPDM	Grooved	300 PSI (dead-end to full rating of valve)/230 PSI
Balancing /Shutoff	To 2"	Flow Indication	Isolation and balancing	Ametal® Brass-Copper Alloy/EPDM	Sweat or Threaded	300 PSI/230 PSI

ALTERNATE PIPING METHOD (GROOVED JOINT) FOR WATER SERVICES:
Maximum Service Rating of 230F; with pressure as required for the systems (see standard valve tables)

Valve Type	Size	Type	Application	Body/Trim Body/Seat	Type of Connection	Pressure Rating/Maximum System Rating
Balancing /Shutoff	2½"-12"	Flow Indication	Isolation and balancing	DI (ASTM A-536)/EPDM	Flanged or Grooved	300 PSI/230 PSI
Tri-Service	2½"-12"	Flow Indication	Pump discharge isolation, check and balancing	DI (ASTM A-536) DI/EPDM	Grooved	300 PSI/230 PSI
Check	2½"-12"	Silent	Pump Discharge	DI (ASTM A-395 or 536) DI/EPDM	Grooved	300 PSI/230 PSI
Check	4"-12"	Silent	Pump Discharge	DI (ASTM A-395 or 536) DI/EPDM	Grooved	300 PSI/230 PSI
Check	2"-4"	Swing	Piping (Horizontal)	DI (ASTM A-536) SS/EPDM	Grooved	300 PSI/230 PSI
Strainer	2"-12"	Y-Type	ACV's, P&F HXs	DI (ASTM A-395 or 536) /EPDM SS 1/16" or 1/8" screen	Grooved	300 PSI/230 PSI
Strainer	1½"-12"	T-Type	ACV's, P&F HXs	DI (ASTM A-395 or 536) /EPDM SS 1/8" screen	Grooved	400 PSI/350 PSI

2.3 PIPING, EQUIPMENT, PANEL AND VALVE IDENTIFICATION

A. All piping, equipment, panels and valves furnished and/or installed under this Section of the Specifications including automatic temperature controls shall be identified with pipe markers, valve tags, and equipment name plates. Refer to Part 3 – IDENTIFICATION for materials and methods of installation.

2.4 MOTORS, DRIVES AND STARTERS

A. All equipment shall be provided complete with motors and drives, unless otherwise indicated.

B. Motors shall be Premium Efficiency (as available by size/speed/horsepower) and shall conform to NEMA Standards and shall be suitable for load, duty service and location. Motors shall have nameplates giving manufacturer's name, serial number, horsepower, efficiency, speed and current characteristics. Motors shall be Century "E+3", General

Electric “Energy Saver Premium”, Reliance “Premium Energy Efficient” Series, Baldor “Super Premium Efficiency”, or approved equal.

C. Motors shall be tested in accordance with the standards of ANSI C50 and conform therewith for insulation resistance and electric strength. Minimum efficiency levels shall be as listed in latest edition of ANSI/ASHRAE Standard 90.1 or the state’s energy code, whichever is higher. All motors shall be tested in accordance with IEEE Standard 112, Test Method B. Provide on nameplate the type of bearing grease to use.

D. Motors 1/2 HP and larger shall have ball or roller bearings with pressure grease lubrication, specifically wound for the scheduled voltages. All bearings shall be suitable for radial and thrust loading.

E. Single-Phase Motors

1. Motors 1/20 HP and Smaller: Shaded-pole type.
2. Motors over 1/20 HP and less than 1/12 HP shall be one of the following, to suit starting torque and requirements of specific motor application:
    a. Permanent-split capacitor.
    b. Split phase.
    c. Capacitor start, inductor run.
    d. Capacitor start, capacitor run.
3. Motors not less than 1/12 HP and less than 1 HP shall have a minimum efficiency of 70% (rated in accordance with DOE 10 CFR 431), a means to adjust motor speed for balancing or modulation or remote speed control (based on the application requirements), and be one of the following, to suit starting torque and requirements of specific motor application:
    a. Electronically commutated (ECM).
    b. Permanent-split capacitor.
    c. Capacitor start, inductor run.
    d. Capacitor start, capacitor run.
4. Bearings: Prelubricated, antifriction ball bearings for motors 1/12 HP and larger or, for motors under 1/12 HP, ball or sleeve bearings. All bearings shall be suitable for radial and thrust loading.
5. Fractional horsepower motors, integral to equipment intended for installation in finished public spaces, shall be provided with an overload device responsive to motor current. The device shall be integral to the motor and include a wired, concealed, NEMA rated disconnect switch.

F. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

G. Motors shall be furnished complete with conduit terminal box of size adequate to accommodate conduits and wires as sized on the Electrical Drawings or specified under this Section.

H. Motor capacity shall be sufficient to operate associated driven devices under conditions of operation and load and with overload and at least the horsepower indicated or specified. All motors shall be of the premium efficiency, high power factor, low energy consuming type most suitable for the application and installed environment. Any motor replacement necessary for compliance to the application shall be at no additional cost to the Owner.

I. Motors shall be suitable for continuous duty at rated horsepower with temperature rise not to exceed 40°C for drip proof motors, 50°C for splash proof motors, 55°C for totally enclosed or explosion proof motors. All non-VFD motors shall be capable of 15% overload without overheating and suitable for operation for the ambient conditions of its specific location.

J. Direct connected motors shall be furnished with adjustable base. Motors connected to driven equipment by belt or shaft shall be furnished with adjustable sliding bases, except fractional HP motors, which shall have slotted mounting holes.

K. Drives for belted motors shall be as manufactured by Dodge Manufacturing Company, Browning Manufacturing Company, T.B. Woods Company or equal with adjustable motor sheaves and adjustable slide bases. The drive belts shall be as short as practicable. All fans and fan units shall be furnished with cogged-type triple V-belt drives, each sized for 150% of the design drive capacity. All multiple belt drives shall have matched sets of belts.

L. Where starters or variable speed drives are not integral with packaged equipment specified in this section, the Electrical Subcontractor shall furnish all starters and drives in accordance with Division 26 drawings and specifications.

M. For packaged equipment, motor controllers shall be equipped with all poles, auxiliary contacts and other devices necessary to permit the interlocking and control sequences required. Controller operating coils shall be generally designed for 120 volt operation, and 3 phase motors shall be provided with thermal overload protection in all phases.

N. All electrical apparatus furnished under this Section shall be approved by UL (or other agencies approved by the authority having jurisdiction) and shall be labeled or listed where such is applicable. Where custom-built equipment is specified and the UL label or listing is not applicable to the completed product, all components used in the construction of such equipment shall be labeled or listed by UL where such is applicable to the component.

2.5 BOILERS (CAST IRON, GAS-FIRED)

A. Provide cast iron gas-fired hot water boilers and burners as scheduled with all required operating and safety controls (including those shown on the control drawing as by the manufacturer). Units shall be as manufactured by Weil-Mclain, Smith, Peerless, or approved equal.

B. Units shall meet requirements of:

1. American National Standard Institute - ANSI Z21.13-1989 Standard for Gas-Fired Low Pressure Steam and Hot Water Boilers; ANSI Z223.1 (NFPA 54-1988) for Gas-Fired Boilers; and National Electrical Code (NFPA 70).
2. American Society of Mechanical Engineers (ASME) Section IV of the Boiler and Pressure Vessel Code, Rules for the Construction of Heating Boilers.

3. American Society of Mechanical Engineers (ASME) Section VI of the Boiler and Pressure Vessel Code, Recommended Rules for the Care and Operation of Heating Boilers.

4. Hydronics Institute (HI) - Testing and rating Standard for Cast Iron and Steel Heating Boilers and the (Minimum Efficiency Standards of) National Appliance Energy Conservation Act of 1992, effective 1 January, 1994.

5. 522 CMR 16.00

6. UL 795-1989 Gas Burners, as applicable.

C. Boilers:

1. Each Boiler shall be furnished as a knocked down unit for field erection in strict accordance with the manufacturer's instructions and recommendations. Multiple "U" steel channels shall be supplied to provide level support for the Boiler(s) when shimmed and grouted to the concrete pad. Steel "L" shaped angle irons shall not be acceptable for floor rails. Provide four hold down bolts of at least 5/8-inch diameter into the concrete and fastened through the steel base channels of the Boiler.

2. Boiler shall be equipped with a flange mounted flame retention type, forced draft Burner designed and tested for a minimum of 82% combustion efficiency based on I=B=R testing procedure to meet ASHRAE 90.1 and the National Energy Policy Act of 1992 requirements.

3. Furnished with insulated boiler mounting plate having necessary holes and tappings to mount burner. High temperature sealing rope is used to provide a permanent gas tight seal between front section and plate.Installing Contractor shall furnish and install pipe and pedestal for each Burner to provide additional floor support.

4. Boiler is to be furnished with two observation ports (one in front and one in back) to allow visual inspection of the flame. Port openings must be of captured seal design – a machined groove assures uniform compression of the sealing ring and protects the seal from contaminants. Elastomer sealing rings are to be used to provide permanent watertight seal between sections. Unlike cast iron or steel push nipples, the elasticity of the seals fills any gaps caused by misalignment or expansion or contraction. Boiler is to be provided with sufficient tappings to install required controls.

5. Boiler is to be designed with a low silhouette to provide maximum headroom.

6. Boiler shall be constructed of cast iron sections utilizing wet base design and not require a refractory combustion chamber.

7. Boiler shall be constructed for a minimum 50 PSI water working pressure or more as scheduled in accordance with the ASME Section IV Rules for Construction of Heating Boilers. Individual sections shall have been subjected to a hydrostatic pressure test of 200 PSIG at the factory before shipment and they shall be marked, stamped or cast with the National Board Standard.

8. Provide with cast-in air elimination to separate air from circulating water.

9. Constructedto provide balanced water flow through entire section assembly using single supply and return connections for water. No external headers are necessary for water.

10. Boiler sections shall be assembled with short, individual draw rods. Boiler sections shall be cast with sealing grooves to assure permanent gas-tight seal. Boiler sections shall be sealed watertight by elastomer sealing rings, not cast iron nipples. Each port opening is machined to completely capture sealing ring between sections.

11. Boiler shall have individual cleanout openings between sections covered with insulated steel covers designed to ensure a gas tight seal.

12. Flue connector(s) shall be Back Horizontal outlet, provided with cast iron flue collar with a built-in adjustable damper capable of being locked into place after adjustment.

13. The Boiler shall be provided with insulated heavy gauge steel jackets with durable powdered paint enamel finish. Jacket shall have removable side panels on the left side so that the jacket can be removed for cleaning without removing screws or disturbing system piping.

14. Limited 10-year warranty against workmanship and defects to be in writing by manufacturer.

15. Boiler trim shall include:

    a. Combination Pressure-temperature gauge.

    b. A19ADP-1 high limit aquastat (set at 210˚F) equipped with manual reset and SPDT switch for alarm and alarm terminal.

    c. Automatic reset high limit aquastat set at 20˚F below the manual reset set point.

    d. Operating aquastat and Low Fire control.

    e. ASME approved water relief valve sized to exceed the Gross Output of the Boiler that shall be factory set to relieve pressure at 50 PSI water working pressure.

    f. One (1) M&M #PS-851-M-120 Low Water cutoff device with manual reset. Probe LWCO shall incorporate a Burner circuit test switch that, when depressed, will test out the burner control circuit by dropping out the Burner if the circuit is properly wired. Boiler shall be fitted with either a float type or a probe type LWCO located above the lowest safe permissible water level established by the Boiler manufacturer. LWCO shall be UL listed and FM approved, suitable for commercial hydronic heating service at 50 PSI. If a float type LWCO is installed, it shall be vented at a high point and equipped with a pair of McDonnell & Miller Test-N-Check Model TC-4 valves. Simple time delay shall not be considered acceptable to this installation.

D. Boiler foundations

1. Installer to construct needed support and level concrete foundations where boiler room floor is uneven or will not support the weight of the boiler. Contractor to modify existing boiler housekeeping pads as required to proper installation per manufacturers installation instructions.

E. Electrical Coordination: Coordinate with electrical Contractor to provide the following:

1. All Boiler room wiring from the main disconnect switch panel to the Burner Control panels, Flame Safeguard Controls, Multiple Boiler Control System,

Circulators, Limits, Operating controls, Gas Valves, switches and additional control devices shall be furnished and installed under this section of the work.

2. Motors shall meet the requirements of separate specification “Motors, Drives and Starters” paragraph, be a maximum of 1 HP. furnished for operation on voltages indicated on plans. Control circuit shall be taken from a two-wire branch circuit, one side grounded, not exceeding 150 Volts, line to line. All safety control switching shall be accomplished in the hot ungrounded conductor and through the 24V low voltage wiring provided by the Boiler manufacturer and in accordance with the manufacturer’s instructions and recommendations.

3. An electrical thermal switch fused to break the ungrounded conductor in the main circuit at 165^{o} F. shall be installed in the main power line within six feet over the top of the burner. If the ceiling above the Burner exceeds 12 feet in height, an additional thermal switch shall be installed on the ceiling and series connected with the lower switch. Fuse protection for the control circuit shall be provided. A manually operated remote heating plant shutdown switch shall be furnished and installed just outside the Boiler room door and shall be marked for easy identification. If there is more than one (1) Boiler room door, there shall be a switch located at each door. Shutdown switches must be wired to disconnect all power to the Boiler controls.

4. Furnish and install a flow switch, Honeywell or equivalent, installed in the common supply water piping up-stream of the Multiple boiler Water Temperature Sensor. Flow switch shall be wired so as to prevent Burner operation during no-flow conditions across the supply water temperature sensors.

5. All wiring for the Boiler and Burner shall be rated for the Maximum operating temperature to which it may be exposed. All wiring between components shall have copper conductors not less than 18 AWG and constructed in accordance with the NEC/NFPA 70. All field installed romex, conduit, junction boxes and the like shall be installed so as not to interfere with the Boiler manufacturers recommended cleaning and maintenance procedures.

F. Boiler shall be furnished with a Natural Gas burner system listed by the Boiler Manufacturer, tested to I=B=R standards and capacities and which shall be listed by the Gas Regulatory Board. Burner shall incorporate all the necessary devices and controls to make a complete fuel burning system and shall bear Underwriters Laboratories seal of approval.

G. Burner Configuration:

1. Flame retention type, nozzlemix multi-port, forced draft burner.

2. Provide burners with operating mode as indicated on mechanical schedule on sheet M0.00 with Combustion air flow switch and Proven Low Fire Start Interlock.

3. Codes – CSD-1

4. Burner mounted control panel complete with the following controls and devices:

   a. RM7895A/UV Primary Control equipped with LED sequence status lights and S7800A keyboard display module. Provide Pre-Purge; 15 second Trial for Pilot; 15 second Trial for Main Flame with 4 second Flame Failure response time with non-recycling safety shutdown upon loss of Main Flame at point of supervision.

   b. Low Fire “Hold” switch and SPST Burner Service Switch. Provide the following factory installed isolating relays:

1) Alarm Relay to initiate a remote "Boiler Off" alarm signal to DDC/ATC on Control Lockout. One (1) relay per Burner.

2) 4” Inch Dia. alarm bell with silencing switch and relays, wired to alarm each of the three (3) specified conditions that will generate a Lockout condition.

c. The burner shall be provided with fresh air contacts and alarm for control of combustion air damper.

d. Pilot Lights to indicate:

1) “Main Fuel Valve Open”

2) “High Limit”

3) “Control Lockout”

4) “Low Gas Pressure”

5) “High Gas Pressure”

5. Burner shall be furnished with a gas pilot of the pre-mix type with interrupted Pilot ignition and the Primary Control shall monitor the Main Flame so that the Main Fuel Valve cannot open until the Pilot Flame has been established and proven.

6. Gas valve train shall be furnished in accordance with UL-795 requirements for Automatic Gas Fired Boilers, and shall comply fully with the Massachusetts Fuel Gas Code for Gas Utilization Equipment in Large Boilers including not less than the following:

a. Separate Pilot and separate Main Gas pressure regulators. Each regulator shall be designed for operation with up to a Maximum of 14” inches W.G. inlet gas pressure. Vent to outdoors.

b. Pilot and Main manual shutoff gas cocks. Manual shutoff gas cock larger than 2” inches shall be of the lubricated plug or ball type with stops.

c. Dual Safety Shutoff Gas Valves piped in series. An approved motor driven Safety Shutoff Gas Valve complete with actuator shall be provided in the Main gas line to the Burner. An approved auxiliary solenoid Safety Shutoff Gas Valve shall be provided upstream from the main SSOV. Combination Gas Valve/Pressure Regulator similar to V4943B shall not be considered acceptable.

d. Leakage test cock and Pilot gas solenoid valve.

e. One quarter inch (1/4”) plugged tappings shall be provided, one of which shall be located upstream of the Main gas pressure regulator and another to be located near the Burner head to permit gas pressure readings with a Manometer.

f. Gas pressure supervision shall be provided by listed pressure switches interlocked to accomplish a non-recycling safety shutdown in the event of High or Low gas pressure. Vent to outdoors.

7. Gas valve train components shall be furnished as specified above with the Pilot Gas train, and combustion air dampers and linkage installed and wired at the factory. All other components shall be furnished loose for field assembly. Gas valve train assembly shall be sized for minimum acceptable pressure drop firing Natural Gas with a minimum gas pressure of 4.00” inches W.G. at the inlet to the Main Gas pressure regulator.

8. All Main gas and Pilot gas pressure regulators and High and Low gas pressure switches are to be independently vented to a safe outdoor location. Vent lines shall be of steel or wrought iron pipe, 3/4" inch IPS minimum, which shall discharge to outside atmosphere. Pilot gas pressure regulators shall also be vented to outdoors unless constructed or equipped to limit the escape of gas from the vent opening in the event of diaphragm failure to not more than 2.5 cubic feet per hour. Vent lines from regulators shall not be connected into a common line with the bleed line from gas operated diaphragm valves or from pressure relief valves.

H. Provide the services of a Company Field Advisor of the Boiler manufacturer for the following:

1. To assist and review the installing Contractor with the assembly and erection of the Boiler. Upon completion of the Boiler assembly, the Boiler manufacturer's Company Field Advisor shall certify the proper assembly and connection of the Boiler prior to startup.

2. The Boiler manufacturers Company Field Advisor shall be Present at time of Start-up to supervise the initial firing of the Boiler.

3. The Boiler manufacturer's Company Field Advisor shall instruct Boiler Room Operating Personnel.

I. After final assembly and connection, each Boiler shall be thoroughly cleaned internally following the manner described within the Boiler manufacturers installation instructions, or by ASME Section VI, either method acceptable by the boiler manufacturer.

J. The process of cleaning the Boiler(s) shall include the use of a boil-out compound of Caustic Soda or Tri-Sodium Phosphate at the rate of one (1) pound of either chemical per 50 Gallons of total water in the system being cleaned. This cleaning shall include Boiler Cleanout, Surface Blowoff, Blowdown and a wash as directed and detailed in referenced instructions. The process of cleaning the Boiler(s) shall be repeated as often as necessary and as directed by the boiler manufacturer to ensure that all mill scale, core sand, rust, dirt and debris, cutting oils and thread sealers or any other contaminants have sufficiently been eliminated from the Boiler and to produce a condition of the Boiler water that is clean and considered acceptable to the boiler manufacturer.

K. All field tests after the Boilers have been installed and connected to the system shall be limited to not more than 50 PSI. Installing Contractor shall furnish all equipment, piping, labor, staging, fittings, valves, hoses and other materials and shall pay all required permits for Inspection as may be required to perform such tests as may be directed by these Contract Documents and as required by the Consulting Engineer and the State Boiler Inspector.

1. An initial hydrostatic pressure test of 50 PSI shall be conducted on each Boiler for a period of not less than 5 hours. Tests shall be of such duration as necessary and as directed by the Consulting Engineer to ensure that each Boiler has been installed and piped correctly with no leaks or other improper operating conditions.

2. Installing Contractor shall contact and notify the State Boiler Inspector when the installation of the Boilers, Burners and controls is substantially complete. Installing Contractor shall request an inspection of the Boilers to be conducted by the State Boiler Inspector and to have a Certificate of Inspection issued upon satisfactory inspection.

3. After receipt of certificate of Inspection, Installing Contractor shall furnish a suitable glass front frame in which to place said certificate. Frame, with Inspection certificate inserted therein, shall then be placed on or posted in a suitable location within the Boiler room in which the new Boilers have been installed.

4. Installing Contractor shall maintain all apparatus in satisfactory operating condition. Perform periodic Burner tune-up and cleaning of the Boiler fireside surfaces when dirty, provide preventative maintenance, perform turndown tests, conduct tests for Flame Safeguard, Combustion Efficiency, Draft tests, Limit Control tests and Safety Valve tests, check the ignition system and adjust, repair or replace any as necessary while the heating system is under his Ownership and control a and until such time as the Owner accepts the equipment, issues the Final certificate of Payment and assumes the full obligation of Ownership.

5. Installing Contractor shall note that any follow-up Burner Service (Hereinafter specified) as may be absorbed by the authorized Service representative shall in no way absolve the Installing Contractor from any and all responsibility for the Care, Service and Preventative Maintenance for Materials furnished to this Contract, while the Heating System is under his Control, and until final acceptance by the Owner.

L. Acceptance Testing:

1. An authorized representative of the Boiler or Burner manufacturer shall perform the initial start-up, final adjusting and testing of the Burners and Controls in the presence of the Gas Inspector and the gas Company representative and the Owners Operating Personnel.

2. The process of Start-Up and Acceptance Testing shall include Purging of the Boilers; Burner Operation Tests, including CO sampling, Stack Temperature; CO_2 sampling; Tests for Venting; Ignition Tests; Pilot Turndown Tests; Manifold Pressure Tests, Instruction to the Owner and all other such procedures as may be directed by the Consulting Engineer.

3. The final results of a Combustion Efficiency Test with all pertinent Combustion Data shall be logged onto a check sheet which shall be submitted to the Consulting Engineer to prove compliance with this section of the Specifications and for Record purposes.

4. Combustion efficiency testing shall include no less than the following:

   a. Clock and adjust Burner input at the Meter to establish correct rate of fire and set each Burner to rated input at High Fire. Set Main Gas regulator and provide all adjustments to both Primary and Secondary Air as necessary to ensure proper flame shape at 100% input with no direct impingement upon heating surfaces and with good quality through the High to Low rates of input with not more than 0.04% CO in the flue gas analysis.

   b. CO_2 in the flue gas at Low and High rates of fire with recorded Gross and Net Stack Temperatures to establish stack loss value. Burner shall be set to operate at the overall best performance and combustion efficiency for which the equipment is designed and capable of.

   c. Adjustment and checkout of all aquastat controls, limits, switches, operating controls, low water cutoff devices, gas valves, pressure regulators, combustion controls, high and low gas pressure switches and all Lockout conditions.

d. He shall supervise purging of the Boiler and shall conduct Pilot turndown tests. All required tests for proper venting which shall include setting and adjusting the Boiler outlet damper to the Boiler manufacturer's specifications.

e. Provide instruction to the Owners Operating Personnel in the procedures to resolve a "Lockout" condition. Operating personnel shall also be instructed in the Operation and routine daily maintenance of the Burner and controls during the lightoff process. The Owner shall arrange to have the personnel who require training to be present at the Lightoff.

M. Factory Authorized Service representative shall provide the initial Burner lightoff and One (1) Year of Follow-Up Burner service. This requirement shall not be waived, nor shall the responsibility for the Service Contract be assumed by any other party unless previously approved by the Consulting Engineer in writing.

N. Authorized manufacturers service representative shall furnish One (1) Year of Follow-Up Burner Service on the Burner and Controls which shall commence from the Date of Original Lightoff and shall continue to provide Follow-Up Burner Service coverage up to and including the First Anniversary of Burner Lightoff.

O. Follow-Up Burner service shall include labor and materials to replace any parts or controls which might fail in service as the result of a defect in materials or manufacture. Normal wear and tear on parts as the result of daily operation will not be included as "no charge" items (nozzles, igniters, etc.) and other such devices, which may require replacement as the result of operation during the Service Contract shall not be included as "defective".

P. Preventative maintenance, in the form of yearly tune-up and bi-yearly cleanings and adjustments shall be the responsibility of the Installing Contractor throughout the duration of his Guarantee Contract while the equipment is under the Acceptance criteria of these Contract Documents and by the Owners obligated Service Company after Final Acceptance.

2.6 INSULATION

A. Scope: Provide all labor, equipment, materials and accessories, and perform all operations required, for the correct installation of insulation on the following systems and all other necessary items connected into the systems subject to condensation, loss of heat, or personnel protection (above 120 degrees F):

1. Piping insulation (other than pre-insulated underground piping), jackets and accessories (including all valves and fittings with easily removable sections for maintenance of strainers, balance valves, and unions).

2. Equipment and flue gas breeching insulation, and covering (including easily removable sections for maintenance).

3. Ductwork insulation, jackets, and lining (including all fittings).

B. Environmental Requirements: Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

C. Quality Assurance: Insulation materials must be asbestos free, UL listed, and manufactured at facilities certified and registered to conform to ISO 9000 Quality Standard. All insulating products and jackets shall carry a 25/50-flame spread/smoke developed rating as tested in accordance with ASTM E 84.

D. Workmanship: All insulation shall be installed by a licensed applicator and applied in accordance with the manufacturer's recommendations. All work shall comply with all applicable federal, state, and local codes including, but not limited to, OSHA. All work shall conform to industry and trade accepted standards for commercial and industrial insulations. Verify that piping, heat trace, and ductwork has been tested (including applicable pressure/leakage tests) before applying insulation materials. Surfaces to be insulated shall be cleaned free of dirt, scale, moisture, oil and grease. No vapor barrier leaks or insulation voids will be accepted. Continue insulation vapor barrier through penetrations except where prohibited by code. All fire rated walls and penetrations shall be sealed with fire stopping. Locate insulation and cover seams in least visible locations. Neatly finish insulation at supports, protrusions, and interruptions. For all systems requiring a vapor barrier seal all terminations including fittings, wall penetrations, and supports with vapor barrier mastic such as Foster 30-65, Childers CP-35 or approved equal. In addition, in brine or chilled water pipe systems vapor seal pipe terminations every four pipe sections, using Foster 30-65, Childers CP-35 or approved equal. Bevel and seal ends of insulation at equipment, flanges, and unions. Where insulation is used over stainless surfaces, the material shall be chlorine free.

E. Delivery and Storage of Materials

1. Deliver all materials to the job site and protect the insulation against dirt, water, chemical and mechanical damage before, during and after installation. Do not install damaged insulation and remove it from the job site.

2. Deliver insulation, coverings, cements, adhesives coatings etc. to the site in factory-fabricated containers with the manufacturer's stamp or label affixed showing fire hazard ratings of the products, name of manufacturer and brand.

3. Installed insulation that has not been weatherproofed shall be protected from inclement weather by an approved waterproof sheeting installed by the Contractor. Any water-damaged insulation shall be removed and replaced by the Contractor at no additional cost.

F. Manufacturers: Johns Manville (JM), CertainTeed, Owens-Corning, 3M, Armstrong, Knauf, Armacell, or approved equal. Note that the listed manufacturers may not be able to supply all the insulation products required for the project. Unless otherwise noted, JM insulation products are listed to provide the minimum standards required for each type of insulation.

G. Pipe Insulation: Provide the following products depending on temperature of each system. Insulation shall be marked to show the locations of all unions, break flanges, strainers, check and balancing valves.

1. For piping with a service temperature between 40°F and 600°F such as chilled water, hot water, dual temperature water, make-up and feed water, blow-down, all outdoor condenser water piping, all indoor condenser water supply piping from the towers to the free cooling heat exchanger, condensate drain, glycol heat recovery (with down to 0°F minimum winter temperature), boiler feed water, heated oil, water defrost piping in refrigerated rooms, steam, and steam condensate, provide glass fiber insulation equal to JM Micro-Lok. Insulation shall be rigid molded and noncombustible, meeting ASTM C 547, Type I. K-factor

shall be 0.23 at 75°F mean temperature. All-purpose vapor retardant jacket shall be JM AP-T PLUS. Jacket shall be white kraft paper reinforced with glass fiber yarn and bonded to aluminum foil, secure with self-sealing longitudinal laps and butt strips or AP Jacket with outward clinch expanding staples (coated with vapor barrier mastic for all chilled water, dual temperature water and glycol heat recovery systems). A breather mastic for applications above ambient pipe service temperatures (fittings, tees, valves, etc.) shall be water based Foster 46-50 or Childers CP-10 / CP-11. A rigid, non-compressible insulation, equal to Pittsburg-Corning FoamGlas or KingspanTarec Kooltherm shall be used at all pipe hangers and supports for all steel chilled water piping where the pipe is supported by hangers, anchors, and guide with a minimum length of 18 inches.

H. Minimum pipe insulation thicknesses shall be as shown on the drawings.

I. Field Applied Piping and Fitting Jackets

1. Provide covers for insulation of all pipe fittings (i.e. elbows, tees, end caps, reducers, unions, flanges, mechanical joints), strainers and valves with surface temperatures between –20°F and 150°F (all water, low pressure steam and condensate systems with glass fiber insulation and over 1" foam insulation on refrigerant piping). Provide easily removable sections for cleaning and maintenance of unions, balancing valves, and strainers. Fitting covers shall be 30-mil thick white PVC equal to JM Zeston 2000 molded high impact, UV resistant covers. Attach with water-resistant pressure sensitive color matching vinyl tape to maintain vapor barrier. Insulate all fittings per manufacturer's recommendations to prevent surface temperature from exceeding the 150°F limit.

2. Other than where foam type insulation is used on up to 1" outdoor pipe, with 2 coats of UV protection, protect all piping insulation that passes through walls and floors, all outdoor pipe insulation, mechanical room pipe insulation (all within 7 feet of floor) and elsewhere where called for on drawings with 0.016 inch thick smooth or embossed aluminum sheet jacket or 0.01 inch thick smooth or corrugated type 304 stainless steel or 30 mil thick Zeston 2000 perma-weld high impact UV resistant PVC jacket with perma-weld fitting covers. Seams shall be on the bottom half of the pipe arranged to shed water. Provide minimum 2-inch overlap for all longitudinal and transverse joints. All seams of outdoor jacket shall be filled with waterproof adhesive. Provide 1" wide draw bands (same material as jacket) on 12" centers.

J. Equipment and Flue Gas Breeching Insulation - General:

1. Apply insulation as close as possible to equipment by grooving, scoring, and beveling insulation, if necessary. As required, secure insulation to equipment with studs, pins, clips, adhesive, wires, or bands.

2. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retardant cement.

3. Provide insulated dual temperature equipment or cold equipment containing fluids below ambient temperature with vapor retardant jackets.

4. Cover fiber glass and calcium silicate insulation on warm or room temperature equipment with 0.016 inch thick (smooth or embossed) aluminum jacket, or with metal mesh and finish with heavy coat of insulating cement or mastic (such as Foster 35-00/46-50 or Childers CP-10/11).

5. For equipment located outdoors, in mechanical equipment rooms (all within 7 feet of floor), or in finished spaces insulated with fiber glass, finish with perma-weld Zeston 2000 jacketing (up to a surface temperature of 150°F) and fitting covers or 0.016 inch thick (smooth or embossed) aluminum jacketing. Outdoor aluminum jacketing seams shall be on the bottom half of the pipe arranged to shed water. Provide minimum 2-inch overlap for all longitudinal and transverse joints. All seams of outdoor jacket shall be filled with waterproof sealant equal to Foster Elastolar 95-44.

6. Do not insulate over nameplate or ASME stamps. Bevel and seal insulation around such.

7. Provide easily removable/replaceable sections (without damage) of insulation for areas that will require maintenance, repair, or cleaning, such as pumps (bearings, seals, and impellers), heat exchangers (tube pull), strainers (basket pull), expansion tanks (bladder access), etc.

K. Equipment and Flue Gas Breeching Insulation: Provide the following insulation types for the listed equipment.

1. Insulate higher temperature equipment and flue gas breeching between 600°F and up to 1200°F with 5” thick rigid molded hydrous calcium silicate block insulation. Insulation shall be equal to JM Thermo-12/Gold meeting ASTM C 533, non-combustible, asbestos free (color coded throughout material thickness) with K-factor of 0.41 at 300°F mean temperature when tested in accordance with ASTM C 177 and C 518. Insulation shall be securely banded in place, tightly butted, joints staggered and secured with 16 gauge galvanized or stainless steel wire or 1/2" x .015" galvanized steel bands on 12" maximum centers for large areas.

2.7 METAL CHIMNEYS AND FLUES

A. Per 248 CMR 5.00 and 7.00, provide the services of a licensed plumber or gasfitter to be responsible for, supervise, and/or install flue venting system(s) for all gas-fired equipment based on the equipment capacity. The licensed plumber or gasfitter shall obtain a gas fitting permit in compliance with 248 CMR 3.00 as required by the Massachusetts Fuel Gas and Plumbing Code.

B. Gas-Fired only Boilers and Water Heaters (with draft hoods, up to 84% efficiency):

1. Furnish and install, as shown on the drawings, type-B gas vent systems for the gas-fired only equipment with draft hoods.

2. The factory-built chimney shall be laboratory tested and listed by Underwriters' Laboratories, Inc., as "Building Heating Appliance Chimney" (ref. UL std. 103) for use with building heating equipment, burning gas or fuel oil as described in NFPA 211, Chapter 2.

3. The double-wall metal vent piping shall have an outer jacket of galvanized steel (indoors only, for outdoors stainless steel or aluminum alloy shall be used) and an

inner liner of aluminum alloy or type 430 stainless steel. The outer jacket and inner liner shall be separated by a 1/2" air space, except as required for construction of the pipe, which shall be in accordance with the terms of the products UL listing.

4. All runs of vent piping shall be supported, guided and compensated for expansion at intervals as specified in the product installation instructions and as by the manufacturer.

5. Vent piping size, system configuration and parts must be selected to operate only under a neutral or negative pressure induced or gravity draft during all operating modes of the attached appliances.

6. Furnish and install all barometric flue dampers where required for proper operation or where shown on the drawings. Dampers shall be compatible for use in system specified as fired by natural gas and shall be furnished with thermal spill switches, wired to shut down all burners in the event of a flue blockage or downdraft condition.

7. Vent piping system shall be complete with all required elbows, tees, laterals, tapered increasers/reducers, adapters, adjustable lengths, expansion sections, appliance connectors, thimbles and all necessary hangers and supports. Final system design/layout shall be by vent piping system manufacturer. Submit shop drawings for approval.

8. System shall be as manufactured by Schebler, Selkirk Metalbestos, Ampco, Metal-Fab, or approved equal providing they meet the specified requirements.

2.8 BOILER CONTROL PANEL

A. Boiler control panel shall be capable of operating one hot water boiler in addition to the requirements listed on Drawings H0.00, H2.0A, H2.0B, and H2.0C. The controller shall be provided with all necessary sensors and accessories for a fully operational system.

B. Panel shall be capable of communicating with existing building automation system (where applicable, refer to drawings H2.0A, H2.0B, and H2.0C) and provided with Bacnet interface.

C. Panel shall be as manufacturered by Weil Mclain, Heat Timer, Tekmar, or approved equal.

2.9 AUTOMATIC TEMPERATURE CONTROLS

A. Manufacturers:

1. Automatic Temperature Controls shall be provided by Automated Logic Corporation of Keenesaw, GA. for the standardization of the Town of Longmeadow facilities.

B. In accordance with Massachusetts General Laws, Chapter 30, Section 39M Paragraph (b), the Owner, in the public interest, has stated in writing in the public records that the Automatic Temperature Controls will be solely allowed under this contract, as manufactured by Automated Logic Corporation of Keenesaw, GA. Bidders may contact the Owner to obtain a copy of the written decision.

C. Furnish an install all control components for stand-alone operation and to interface with existing automatic temperature controls (where applicable, refer to drawings H2.0A, H2.0B, and H2.0C). This system of automatic temperature control shall be complete in all respects including all labor, materials, equipment, and services necessary and shall be installed by personel employed by the ATC Contractor.

1. Automated temperature control system using field programmable micro-processor based units (Stand Alone Digital Controllers or SDC's, Application Specific Controllers or ASC's).

2. All control equipment to be full proportioning, and the latest state of the art in manufacture and design.

3. The controls systems to be installed by competent controls mechanics and electricians under the supervision of the manufacturer of the control equipment. All control equipment to be the product of one (1) manufacturer and all ATC components to be capable of interfacing with the HVAC equipment. The factory trained control contractor must maintain adequate staff and offer standard services to fully support the Owner in the timely maintenance, repair, and operation of the control system. Contractors who do not maintain such staff and offer services or who must develop same for this project are not acceptable. Bids from franchised dealers as well as wholesale, distributor, or representative type ATC contractors, or others whose principal business is not the manufacture, installation and service of temperature control systems will not be acceptable.

4. Contractor shall have a large support, technical, and engineering staff on call 24 hours a day, located within 50 miles of the Town of Longmeadow. The ATC contractor must support all hardware and software regardless of age. The ATC Contractor shall be "forward-backward" supportive. The software shall be extremely user friendly. Changes in programming must be made without having to rewrite the programming. Local branch/company/division must offer onsite and offsite computer operation straining.

D. Scope of work:

1. The control system provided to consist of all microprocessors, software, transformers, transducers, relays, and all other necessary control components, along with a complete system, interlocking, and communication wiring/cabling to fill the intent of the specification and provide for a complete and operable system.

2. ATC contractor to meet with the boiler controls manufacturer to coordinate the required controls signals, status signals (for the graphics), and alarms for the boiler system.

3. Alarms, where applicable, and all interlocking wiring required to be provided by the ATC contractor.

4. The ATC contractor to review and study all HVAC and Electrical drawings and entire specification to familiarize themselves with the equipment and system operation and to verify the quantities and types of components they have to provide.

5. All interlocking wiring and installation of all required control devices associated with boilers to be provided by the ATC contractor. Close Coordination to be exercised between the ATC contractor and the HVAC contractor and equipment manufacturers so that installation will be provided in a manner to result in fully operable systems as intended in these specification and shown on drawings H2.0A, H2.0B, and H2.0C.

6. The ATC Contractor shall hire licensed electricians and shall provide all required interlock wiring and wiring of all control devices including sensors, control valves and damper actuators, control panels, etc.) Scope of wiring includes the provision of additional required power wiring beyond what is shown on the electrical drawings. Any additional wiring required from electric panels shall be coordinated with the Division 16 electrical Contractor and paid for by the BAS Contractor. All wiring shall comply with the requirements of the electrical section of these specifications.

E. Incidental Work By Others:

1. The following incidental work to be furnished by the designated contractor under the supervision of the ATC contractor.

a. The HVAC contractor to coordinate required work with ATC contractor and without limiting the generality thereof, the work they are to perform for the ATC contractor to include the following:

1) Install sensor wells and other similar equipment that are specified to be supplied by the ATC contractor
2) Furnish and install all necessary valved pressure taps, water, drain, and overflow connection and piping.
3) Provide, on all magnetic starters furnished, all necessary auxiliary contacts, with buttons and switched in required configurations.
4) Provide access doors or other approved means of access through ceilings and walls for service to control equipment.

F. Electric Wiring:

1. All electric wiring, wiring connections and all interlocking required for the installation of the temperature control system, as herein specified and as shown on drawings H2.0A, H2.0B, and H2.0C, to be provided by the ATC contractor, unless specifically shown on the Electrical drawings or called for in the Electrical Specifications, Division 16. Power to valves and actuators to be by the ATC contractor, except as specifically noted in the Electrical drawings and specifications.

2. All wiring and wiring methods to comply with the requirements of the Electrical Section of the specifications.

3. Provide, on magnetic starters, all necessary auxiliary contacts, with buttons and switches in required configurations.

G. Submittal Brochure:

1. In addition to the requirements of Division 1, the following to be submitted for Approval:
    a. Control drawings with detailed piping and wiring diagrams, including bill of material and written sequence of operation for each system controlled by the ATC contractor. Diagrams to include individual wiring and tubing marking designation, interlock details and wiring details of interfaces to other manufacturers systems.
    b. Data sheets for all control system components.

H. Guarantee:

1. In addition to the guarantee requirements of the Contract and General Conditions, the Contractor shall obtain in the name of the Owner the standard manufacturer's guarantee of all materials furnished under this Section where such guarantees are in addition to, and not in lieu of, other liabilities which the Contractor many have by law or other provisions of the Contract Documents.

I. Instruction and Adjustment;

1. Upon completion of the project, the ATC contractor is to:
    a. Fine-tune and "de-bug" all software control loops, routines, programs and sequences of control associated with the control system supplied.
    b. Completely adjust and make ready for use, all transmitters, relays, etc., provided under this Section.
    c. The ATC contractor shall provide an on-site training program for the Owner's staff in the operation and use of the control system. Training to include the following:
        1) Include 4 hours of hands-on training (combined, all 3 facilities included in this Project) to instruct Owner's personnel in the system configuration, component characteristics, control strategy on each controlled system and all requirements for daily operation and use of the system. This will give the Owner's representative a working proficiency in day-to-day operational requirements (i.e., system monitoring, alarm acknowledgement, HVAC system troubleshooting techniques, setpoint and time schedule adjustments, manual override, etc.).
        2) All training to take place at the site and at times mutually agreed to between the ATC Contractor and the Owner.

J. DDC Sensors and Point Hardware

1. Temperature Sensors

    a. All temperature devices shall use precision thermistors or RTDs accurate to +/- 1 degree F over a range of –30 to 230 degrees F. Space temperature sensors shall be accurate to +/- 0.5 degrees F over a range of 40 to 100 degrees F. Outdoor air temperature sensors shall be accurate to +/- 0.7 degrees F over a range of -20 to 120 degrees F.
    b. Standard space sensors shall be available in an off white enclosure for mounting on a standard electrical box. Temperature sensor may be combined with humidity or carbon dioxide sensor in one housing providing it meets the specifications listed above.
    c. Where manual overrides are required in the sequences for off-hours occupancy, space temperature sensor housings shall feature both an optional means for adjusting the space temperature set point, as well as a push button for selecting after hours operation.

d. Space sensors shall incorporate either an LED or LCD display for viewing the space temperature, set point and other operator selectable parameters. The sensors shall include built in buttons that allow local temperature set point adjustment. Displays shall be capable of being blanked out for no local readings where specifically requested by the Owner.

e. Duct temperature sensors shall incorporate a thermistor bead or RTD embedded at the tip of a stainless steel tube. Probe style duct sensors are useable in air handling applications where the AHU or duct area is less than 12 square feet. Tube shall be long enough so that the sensor is at least 1/3 of the way into the air stream.

f. Averaging sensors shall be employed in AHU's or ducts that are 12 square feet and larger. The averaging sensor tube must contain at least one thermistor or RTD for every 3 square feet of AHU or duct area. Sensors shall be accurate to +/- 0.5 F over their normal operating temperature range +/- a 20- degree margin. Example, for a heating/cooling air-handling unit that normally varies between 55 and 100 degrees F, the sensor shall have the stated accuracy over a range of 35 to 120 degrees F.

g. Immersion sensors employed for measurement of temperature in all chilled, condenser, glycol and hot water applications as well as steam and refrigerant applications shall incorporate a precision thermistor or RTD type sensor. "Smart" sensors (where called for) shall be RTD type and include either an LED or LCD display. Chilled water sensors shall be accurate to +/- 0.5 degrees F over their normal operating temperature range +/- a 20-degree margin. Condenser and hot water sensors shall be accurate to +/- 0.5 degrees F over their normal operating temperature range +/- a 20-degree margin. Example, for a hot water system that normally varies between 90 and 200 degrees F, the sensor shall have the stated accuracy over a range of 70 to 220 degrees F. Thermal wells shall be brass or stainless steel for non-corrosive fluids below 250 degrees F and 300 series stainless steel for all other applications.

h. Where BTU measurement is called for, the associated temperature sensors shall be matched and calibrated so they differ by no more than 0.2°F.

i. Outside Air Temperature Sensors: Utilize precision thermistor or RTD-type units. Sensors shall be designed to withstand the environmental conditions to which they will be exposed. Sensor enclosure shall allow for adequate air flow over the sensing element. Housing shall be NEMA-3R construction as a minimum.

2. Pressure Sensors

a. Air pressure measurements in ranges up to 0 to 10" water column will be accurate to +/- 1% of range using a solid-state sensing element. Select the smallest range applicable to the use of the sensor. Sensors shall be bi-directional for room pressure monitoring. Acceptable manufacturers include Ashcroft Inc., Modus Instruments, Setra and Mamac.

b. Differential pressure measurements of liquids or steam shall be accurate to +/- 0.5% of range. Housings shall be NEMA 4 rated.

c. Provide wind baffles for outdoor pressure sensor locations and indoor locations where there can be turbulence.

3. Current Devices: Current devices shall be used to monitor fans, pumps, motors and electrical loads. Current devices shall be available in solid and split core models, and offer either a digital (switch for on-off status of constant speed

equipment) or an analog (sensor for status of VFD driven equipment) signal to the automation system. Current switches shall be capable of differentiating between free-wheeling (belt breakage) and normal motor load. Acceptable manufacturers are Veris, Siemens, or approved equal.

4. Water System Flow Sensors

   a. Provide where indicated insertion dual turbine flowmeters for measurement of liquid flows in pipe sizes above 2 inches. Below 2 ½" pipe, provide in-line type flow meters with isolation valves and manual bypass.
   b. Install the insertion flow meters on isolation valves to permit removal without process shutdown.
   c. Sensors shall be capable of reading velocities between 0.17 and 20 fps with +/- 2% accuracy above 0.4 fps, have local readout, and 4 to 20 mA or 0-10 volt output to the control system. Sensors shall be as manufactured by ONICON or approved equal.
   d. Contractor shall ensure proper straight lengths of upstream (minimum 10 pipe diameters) and downstream (minimum 5 pipe diameters) pipe per manufacturer's recommendations for the location chosen.

K. Contractor Responsibilities

1. General: Installation of the building automation system shall be performed by this Contractor or his Subcontractor(s). However, all installation shall be under the personal supervision of the Contractor. The Contractor shall certify all work as proper and complete. Under no circumstances shall the design, scheduling, coordination, programming, training, and warranty requirements for the project be delegated to a Subcontractor.
2. Access to Site: Unless notified otherwise, entrance to building is restricted. No one will be permitted to enter the building unless their names have been cleared with the Owner or the Owner's Representative.
3. Code Compliance: All wiring shall be installed in accordance with the more stringent of all applicable electrical codes, equipment manufacturer's recommendations, and wiring specifications in Division 26.
4. Cleanup: At the completion of the work, all equipment pertinent to this contract shall be checked and thoroughly cleaned, and all other areas shall be cleaned around equipment provided under this contract. Clean the exposed surfaces of tubing, hangers, and other exposed metal of grease, plaster, or other foreign materials.

L. Wiring, Conduit and Cable

1. All wire will be copper and meet the minimum wire size and insulation class listed below:

Wire Class	Wire Size	Isolation Class
Power	12 Gauge	600 Volt
Class One	14 Gauge Std.	600 Volt
Class Two	18 Gauge Std.	300 Volt
Class Three	18 Gauge Std.	300 volt
Communications	Per Mfr.	Per Mfr.

2. Class Two and Three wiring and communications wiring may be run in the same conduit.

3. Where different wiring classes terminate within the same enclosure, maintain clearances and install barriers per the National Electric Code.
4. Where wiring is required to be installed in conduit, galvanized EMT shall be used indoors unless indicated otherwise on the Drawings or as required by Division 26 specifications. Conduit shall be minimum 1/2 inch. Set screw fittings are acceptable for dry interior locations. EMT with compression fittings shall be used for interior damp locations. All exterior conduit shall be GRSC with threaded fittings. Provide conduit seal-off fitting where exterior conduits enter the building or between areas of high temperature/moisture differential.
5. Flexible metallic conduit (max. 3 feet) shall be used for connections to motors, actuators, controllers, and sensors mounted on vibration producing equipment. Liquid-tight flexible conduit shall be use in exterior locations and interior locations subject to moisture.
6. Junction boxes shall be provided at all cable splices, equipment termination, and transitions from EMT to flexible conduit. Interior dry location J-boxes shall be galvanized pressed steel, nominal four-inch square with blank cover. Exterior and damp location JH-boxes shall be cast alloy FS boxes with threaded hubs and gasketed covers.
7. Where the space above the ceiling is a supply or return air plenum, the wiring shall be plenum rated. Teflon wiring can be run without conduit above suspended ceilings. EXCEPTION: Any wire run in suspended ceilings that is used to control outside air dampers or to connect the system to the fire management or smoke control systems shall be in conduit.
8. Coaxial cable shall conform to RG62 or RG59 rating. Provide plenum rated coaxial cable when running in return air plenums.
9. Ethernet 10/100 Base –T network wiring shall be equivalent to Owner's premise wiring or, as a minimum, Category 5e or 6 cabling up to 300' maximum run.
10. Fiber optic cable shall be used for runs over 300' and shall be the following size: 50/125.
11. Only glass fiber is acceptable, no plastic.
12. Fiber optic cable shall only be installed and terminated by an experienced Contractor. The BAS Contractor shall submit to the Engineer the name of the intended Contractor of the fiber optic cable with his submittal documents. Provide all fiber optic transceivers for all fiber cabling runs. Provide all power required at each fiber optic transceiver.
13. Provide all networking electronics required for separate IP based BAS system network.

M. Hardware Installation

1. Installation Practices for Wiring

    a. All controllers are to be mounted vertically and per the manufacturer's installation documentation.
    b. The 120VAC power wiring to each Ethernet or Webserver controller shall be a dedicated run, with a separate breaker. Each run shall include a separate hot, neutral and ground wire. The ground wire shall terminate at the breaker panel ground. This circuit shall not feed any other circuit or device.
    c. A true earth ground must be available in the building. Do not use a corroded or galvanized pipe, or structural steel.
    d. Wires shall be attached to the building proper at regular intervals such that wiring does not droop. Wires shall not to be affixed to or supported by pipes, conduit, ducts, etc.

e. Conduit in finished areas, shall be concealed in ceiling cavity spaces, plenums, furred spaces and wall construction. Exception; metallic surface raceway may be used in finished areas on masonry walls. All surface raceway in finished areas must be color matched to the existing finish within the limitations of standard manufactured colors.
f. Conduit, in non-finished areas where possible, shall be concealed in ceiling cavity spaces, plenums, furred spaces, and wall construction. Exposed conduit will run parallel to or at right angles to the building structure.
g. Wires shall be kept a minimum of three (3) inches from all piping.
h. Where sensor wires leave the conduit system, they are to be protected by a plastic insert.
i. Wire shall not be allowed to run across telephone equipment areas.

2. Installation Practices for Field Devices

a. Well-mounted sensors shall include thermal conducting compound within the well to insure good heat transfer to the sensor.
b. Actuators shall be firmly mounted to give positive movement and linkage shall be adjusted to give smooth continuous movement throughout 100 percent of the stroke.
c. Relay outputs shall include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.
d. Water line mounted sensors shall be removable without shutting down the system in which they are installed.
e. For duct static pressure sensors, the high pressure port shall be connected to a metal static pressure probe inserted into the duct pointing upstream. The low pressure port shall be left open to the plenum area at the point that the high pressure port is tapped into the ductwork.
f. For building static pressure sensors, the high pressure port shall be inserted into the space via a metal tube. Pipe the low pressure port to the outside of the building with a shield to prevent distortion of reading due to wind.

3. Enclosures

a. For all I/O requiring field interface devices, these devices where practical shall be mounted in field interface panels (FIP). The Contractor shall provide an enclosure, which protects the device(s) from dust, moisture, conceals integral wiring and moving parts.
b. FIPs shall contain power supplies for sensors, interface relays and contactors, and safety circuits.
c. FIP enclosures shall be of steel construction with baked enamel finish, NEMA 1 rated with hinged doors and keyed locks. The enclosures shall be sized for twenty percent spare mounting space. All locks will be keyed identically.
d. All wiring to and from the FIP shall be to labeled screw type terminals. Analog or communications wiring may use the FIP as a raceway without terminating. The use of wire nuts within the FIP is prohibited.
e. All outside mounted enclosures shall meet the NEMA-4 rating.
f. The wiring within all enclosures shall be run in plastic track. Wiring within controllers shall be wrapped and secured.

4. Identification

a. Identify all control wires with labeling tape or sleeves using words, letters, and/or numbers that can be exactly cross-referenced with as-built drawings.
b. All I/O field devices inside field interface panels (FIP) shall be clearly labeled.
c. Junction box covers shall be marked to indicate that they are a part of the BAS system.
d. All enclosures (including controllers), all I/O field devices (except space sensors), all control valves and actuators, all routers and other field devices that are not mounted within FIP's shall be identified as follows:

1) Identification shall be with bakelite nameplates. The lettering shall be in white against a black or blue background, be keyed to the as built drawings, and indicate that the device is a control device.

5. Location

a. The location of sensors shall be per mechanical and architectural drawings. Coordinate with installing Contractor to provide appropriate straight upstream and/or downstream runs for accurate readings of mixed temperatures or flows.
b. Space humidity, carbon dioxide or temperature sensors shall be mounted away from machinery generating heat, direct light and diffuser air streams.
c. Outdoor air temperature sensors shall be mounted on the north building face directly in the outside air. Install outdoor temperature and humidity sensors with solar radiation/precipitation shields to minimize the effects of heat radiated from the building or sunlight and from rain.
d. Field enclosures shall be located immediately adjacent to the controller panel(s) to which it is being interfaced.
e. Control panels used for smoke control shall be located in building life safety electric rooms, coordinate exact locations with the electrical Contractor.

N. System Startup and Acceptance Testing

1. Cooperate and coordinate with all trade Contractors in the start-up of all BAS controlled and monitored equipment installed under this project.
2. Point to Point Checkout: Each I/O device (both field mounted and located in field interface panels and firefighters override panels (FOP)) shall be inspected and verified for proper installation and functionality (such as fan status and valve positioning). A pre-functional performance test checkout sheet itemizing each device shall be filled out, dated and approved by the Project Manager and submitted (with copy to the Owner’s Representative).
3. Controller and Webserver Checkout: A field checkout of all controllers and the Webserver, modem, etc. shall be conducted to verify proper operation of both hardware and software. A pre-functional performance test checkout sheet itemizing each device and a description of the associated tests shall be prepared and submitted (with copy to the Owner’s Representative) before the completion of the project.
4. System Acceptance Testing

a. All application software shall be verified and compared against the specified sequences of operation in both normal and failure modes. Control loops shall be exercised by inducing a set point shift of at least 10% and observing whether the system successfully returns the process

variable to set point. Record all test results and attach to the Functional Performance Test Results Sheets and submit (with copy to Owner's Representative).

b. Test each alarm in the system and validate that the system generates the appropriate alarm message, that the message appears at all prescribed destinations [existing operator's workstation,] Webserver, Webserver users, or printers, and that any other related actions occur as defined (i.e. graphic panels are invoked, reports are generated, etc.). Submit Functional Performance Test Results Sheets (with copy to the Owner's Representative).

c. Perform an operational test of each unique graphic display and report to verify that the item exists, that the appearance and content are correct, that the control systems readings (flows, temperatures, etc,) match field readings, and that any special features work as intended. Submit Functional Performance Test Results Sheets (with copy to the Owner's Representative).

d. Perform an operational test of each third party interface that has been included as part of the automation system. Verify that all points are properly polled, that alarms have been configured, and that any associated graphics and reports have been completed. If the interface involves a file transfer over Ethernet, test any logic that controls the transmission of the file, and verify the content of the specified information. Submit Functional Performance Test Results Sheets (with copy to the Owner's Representative).

e. Perform an operational test of the Webserver by testing all graphics and systems (including alarm acknowledgement) from remote locations. Submit Functional Performance Test Results Sheets (with copy to the Owner's Representative).

f. After the above tests have been completed and the system has demonstrated to function as specified, a 30-day performance test period shall begin. If all systems perform as specified throughout the test period, requiring only routine maintenance, submit Functional Performance Test Results Sheets for each system (with copy to the Owner's Representative) and the BAS system shall be accepted. If any system fails during the test, and cannot be fully corrected within 8-hours, the Owner may request that the performance test be repeated and delay acceptance until all systems pass.

O. Sequences of Operation: Sequences of operation shall be as noted on Drawings H2.0A, H2.0B, and H2.0C. If any items are not shown, include BAS manufacturer's best standard sequences.

P. Final Documentation: Upon completion of work and prior to request for Certificate of Occupancy, Contractor shall issue a certificate stating that work has been installed generally consistent with construction documents and tested per the specifications. All submittals, test reports, as-builts and O&M manuals are to be provided for engineer's review, prior to request for engineer's completion certificates. In addition, and also prior to request for completion certificates, all punch list items must be completed to the satisfaction of the engineer. The Contractor must verify that all sequences of operations and controls have been incorporated and all systems and equipment are working per the sequences of operations. A blank Contractor's certificate form can be furnished by RDK Engineers upon request.

2.10 WATER TREATMENT SYSTEMS AND EQUIPMENT

A. General

1. Supervise the cleaning and flushing out of all systems.

a. After completing the installation or modification of each system, it shall be properly flushed out prior to start up. Flush out chemicals and procedures shall be furnished by the Water Treatment Subcontractor. Passivation shall be done as recommended by water treatment Subcontractor for the piping and equipment or as required by Boiler Manufacturers.

b. Systems shall then be refilled as specified and treated chemically in accordance with recommendation of the Water Treatment Subcontractor. HVAC contractor shall notify the Water Treatment Subcontractor at least 48 hours in advance of initial system fill.

c. Tests shall be made following the flush out and refilling procedure and a written report submitted to the Engineer and Owner stating that the flushing out has been completed satisfactorily.

B. Qualifications of the Water Treatment Subcontractor:

1. The Water Treatment Subcontractor shall have a minimum of five years' experience in the water treatment business, have laboratory facilities and staff capable of performing all necessary analyses relating to this job. All treatment programs shall be performed under the direction of a graduate chemist or licensed professional engineer.

C. Prior to the initial filling of the piping system, the pipes shall be thoroughly flushed and cleaned with non-toxic, environmentally friendly cleaners and charged with the required quantity of the most appropriate non-toxic, environmentally friendly corrosion inhibitors that will best protect the piping and system components. Chemicals shall be by Dearborn, Dow, Barclay, Nalco, or equal.

D. Chemicals: Water to be used in each system shall be treated to maintain the conditions recommended by this specification as well as the recommendations from the manufacturers of the heating, cooling, condenser, and evaporator coils. Chemicals shall meet all required federal, state, and local environmental regulations for the treatment of evaporator coils and direct discharge to the sanitary sewer.

1. Cleaning of piping system: Immediately after hydrostatic testing of piping is completed, systems shall be cleaned, drained, and flushed with clean water. Any chemical additives used in this process shall be thoroughly flushed from the piping system. If the system is not immediately (within 4 days) put into operation after cleaning and flushing, the system shall be drained of any stagnant water left over from testing or flushing.

PART 3 - EXECUTION

3.0 DEMOLITION

A. The existing facility will continue to operate during all phases of the demolition work and subsequent construction. No interruption of the systems will be permitted without prior approval of the Owner's Representative. Work at both Center School and Blueberry Hill Schools is to be performed only during unoccupied hours. Provisions for both Center School and Blueberry Hill School are to be made to ensure remaining boiler at each facility are to remain in operation throughout construction during occupied hours.

B. Submit proposed methods and sequence of operations for the selective demolition work to the Owner's Representative for review prior to the start of the work.

C. Perform all demolition while ensuring minimum interference with adjacent occupied areas.

D. Where sections of a system are to be removed and the system serves other areas of the building that are outside the scope of the work, perform the following:

1. Coordinate the temporary shutdown of the system with the Owner's representative.
2. Install supports in the remaining active sections of the system as required by the removal of nearby supports associated with the demolition.
3. Isolate the system.
4. Cap the remaining system section, leaving the remainder of the system active.

E. Provide temporary shoring or bracing during the demolition work to prevent movement, settlement, or collapse of the system or adjacent systems due to the work.

F. Promptly repair any damage caused to adjacent facilities or areas that are designated to remain at no additional cost to the Owner.

G. Equipment:

1. Coordinate with the Contractor and Subcontractors to provide disconnection prior to equipment removal.
2. Remove equipment by unfastening at the supports or attachments. Then remove the attachments from the building, leaving no component of the original installation.
3. The Owner has requested the contractor to provide the boilers removed from Blueberry Hill Elementary School and Center Elementary School to be salvaged for parts. If the Owner chooses not to take possession of the equipment, the Subcontractor shall remove the equipment and dispose of the equipment in accordance with Paragraph H specified below.
4. Exercise care with equipment that is to be relocated or turned over to the Owner, examine the equipment before removal in the presence of the Owner's representative to determine its condition. Make a record of any marks, etc. by a photograph or videotape acknowledged by the Owner's representative.
5. Equipment to be turned over to the Owner: Deliver to an on-site location designated by the Owner, and obtain acknowledgment of receipt in good condition.

H. All equipment, etc., not turned over to the Owner shall be put into the General Contractor's dumpsters; become the property of the General Contractor, and shall be removed from the site by the General Contractor. For equipment containing any

refrigerant, it shall be reclaimed for recycling. Any hazardous materials such as mercury from thermometers or thermostats; ethylene glycol; or lead shall be properly disposed of, following EPA guidelines.

3.1 GENERAL

A. Install all items specified under PART 2 - PRODUCTS, according to the manufacturer's requirements and best quality recommendations, shop drawings, the details as shown on the Drawings and as specified in this specification section.

B. Install all work so that parts requiring inspection, replacements, maintenance and repair shall be readily accessible. Minor deviations from the Drawings may be made to accomplish this, but any substantial change shall not be made without prior written approval from the Owner.

C. Equipment bases mounted on concrete slabs and pads, or mounted on stands, gratings, platforms, or other, shall not be set in any manner, except on the finished and permanent support.

D. Support of equipment on studs or other means, and the placing or building of the supporting slab, pad, pier, stand, grating, or other "to the equipment", is prohibited.

E. Concrete supporting structures shall have been constructed and cured a minimum of 14 days before equipment is mounted.

F. All welding done under this section shall be performed by experienced welders in a neat and workmanlike manner. All welding done on piping, pressure vessels and structural steel under this Section shall be performed only by persons who are currently qualified in accordance with ANSI Code B31.9 and B31.1 for Pressure Piping and certified by the AWS, ASME or an approved independent testing laboratory, and each such welder shall present certificate attesting his/her qualifications to the Owner's representative whenever requested to do so on the job.

G. All pipe welding shall be oxyacetylene or electric arc. High test welding rods suitable for the material to be welded shall be used throughout. All special fittings shall be carefully laid out and joints shall accurately match intersections. Care shall be exercised to prevent the occurrence of protruded weld metal into the pipe. All welds shall be of sound metal free from laps, cold shots, gas pockets, oxide inclusions and similar defects.

H. All necessary precautions shall be taken to prevent fire or damage occurring as the result of welding operations.

I. Care shall be taken when working on the roof. Protect the roof from damage.

3.2 IDENTIFICATION

A. General

1. All piping, ductwork, equipment, panels, and valves furnished and/or installed under this Section of the Specifications shall be marked for ease of identification.

2. Marking shall be done using self-adhering (screw or rivets for equipment) labels applied to clean, smooth surfaces. All lettering shall have sharply contrasting

background for ease of identification. Colors shall be in accordance with ANSI A13.1 Standards. Samples of stickers together with color schedules shall be submitted for approval.

B. Equipment Identification (by Unit Manufacturer)

1. Equipment marking shall be prominently located and securely attached with screws or rivets (no adhesives or cements are permitted) on the normally visible side of the equipment.

2. Equipment identification designations shall be taken from equipment callouts as shown on drawings and coordinated with the Owner's facility group to assure designations match up with Owner's maintenance management system identification database.

3. Provide on the label (or on a prominently located second label) all required routine maintenance action (per manufacturer). Label may be limited to identifying, by title or publication number, the operation and maintenance manual for that particular model and type of product.

3.3 PIPING

A. General

1. Piping shall be cut accurately to measurements established at the jobsite, shall be installed without cold springing, and shall properly clear windows, doors and other openings and electrical gear. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted. Piping shall be free of burrs, oil, grease, and other foreign matter. Piping shall be installed to permit free expansion and contraction without damaging building structure, pipe, joints, or hangers. Changes in direction shall be made with fittings. Vent pipes shall be carried through the roof and shall be properly flashed.

2. If the pipe turns from vertical to horizontal, the sealant strip shall be run to a point just beyond the first elbow. When penetrating waterproofing membrane for floors, the metal jacket shall extend from a point below the backup material to a minimum distance of 2 inches above the flashing. For other areas, the metal jacket shall extend from a point below the backup material to a point 12 inches above floor; or when passing through walls above grade, jacket shall extend at least 4 inches beyond each side of the wall.

B. Water Piping:

1. Unless otherwise indicated, horizontal water piping shall pitch down in the direction of flow with a grade of not less than 1 inch in 40 feet and condensate drain piping shall pitch down in direction of flow with a grade of not less than 1 inch in 10 feet. Unless otherwise detailed, horizontal reducers shall be the eccentric type, flat on bottom (FOB), to allow for complete drainage. Open ends of pipelines and equipment shall be properly capped or plugged during installation to keep dirt or other foreign materials out of the systems. Pipe not otherwise specified shall be uncoated.

2. Unless otherwise allowed in Part 2 Piping and Fittings, or shown on the drawings, connections to equipment shall be made with malleable-iron unions or flanges for steel pipe 2 inches or less in diameter and with flanges or grooved joint couplings

for pipe 2-1/2 inches or more in diameter. Unions for copper pipe or tubing shall be brass or bronze. Connections between ferrous piping and copper piping shall be electrically isolated from each other with dielectric waterway as specified in the Part 2 Piping and Fittings section of this specification. Where the temperature or pressure of the system is beyond the waterway limits, dielectric couplings or other approved methods shall be used. Reducing fittings shall be used for changes in pipe sizes.

3. Pipe joints between sections of pipe shall be as listed in the Part 2 Piping and Fittings section in the Schedules for Piping and Fittings tables. Exceptions are pipe and fittings installed in inaccessible conduits or trenches beneath concrete floor slabs or in difficult to access locations such as shafts which shall be welded, soldered or brazed. Some joint types or materials listed may have lower pressure and/or temperature limits and Contractor shall ensure they are only used where those limits will NOT be exceeded.

4. Welded joints shall be fusion welded in accordance with ASME B31.1 for all water piping over 160 psig and any other piping where B31.1 is required. All other piping shall be welded in accordance with ASME B31.9 unless otherwise stated. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be acceptable. Branch connections may be made with either welding tees or forged branch outlet fittings, either being acceptable without size limitation. Branch outlet fittings, where used, shall be forged, flared for improvement flow where attached to the run, reinforced against external strains, and designed to withstand full pipe bursting strength.

    a. Beveling: Field and shop bevels shall be in accordance with the recognized standards and shall be done by mechanical means or flame cutting. Where beveling is done by flame cutting, surfaces shall be cleaned of scale and oxidation before welding.

    b. Alignment: Before welding, the component parts to be welded shall be aligned so that no strain is placed on the weld when finally positioned. Height shall be so aligned that no part of the pipe wall is offset by more than 20 percent of the wall thickness. Flanges and branches shall be set true. This alignment shall be preserved during the welding operation. If tack welds are used, welds shall be of the same quality and made by the same procedure as the completed weld; otherwise, tack welds shall be removed during the final welding operation.

    c. Erection: Where the temperature of the component parts being welded reaches 32 degrees F or lower, the material shall be heated to within 100 degrees F of the system's maximum design temperature for a distance of 3 feet on each side of the weld before welding, and the weld shall be finished before the materials cool to within 200 degrees F of the maximum design temperature.

    d. Defective Welding: Defective welds shall be removed and replaced. Repairing of defective welds shall be in accordance with the applicable standard: ASME B31.9 or B31.1.

    e. Electrodes: After filler metal has been removed from its original package it shall be protected or stored so that its characteristics or welding properties are not affected. Electrode material shall be as required for the pipe material. Electrodes that have been wetted or that have lost any of their coating shall not be used.

5. Flanges and unions shall be faced true, and made square and tight. Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1/16 inch thickness, full-face or self-centering flat ring type. The Gaskets shall contain aramid fibers bonded with styrene butadiene rubber (SBR) or nitrile butadiene rubber (NBR). NBR binder shall be used for hydrocarbon service. Union or flange joints shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items.

6. Threaded joints shall be made with tapered threads properly cut and shall be made perfectly tight with Teflon (polytetrafluoroethylene) tape or equal. Teflon tape shall be non-toxic and rated for piping systems with temperatures to at least 450 degree F and pressures to at least 1,000 psig. Tape shall be applied the male threads only, and in no case to the fittings.

7. Malleable iron pipe press fittings equal to IMS Fastlock may be used (where allowed in the Part 2 Piping and Fittings section of these specifications) and shall be installed in accordance with the manufacturer's guidelines and recommendations. Pipe shall be certified for use with the IMS Fastlock system. Pipe shall be square cut, properly deburred, and cleaned. Pipe ends shall be marked at the required location to ensure full insertion into the coupling or fitting during assembly. Use an IMS Fastlock approved tool with the proper sized jaw for pressing. Prior to putting the system into operation, Contractor shall perform an air pressure test to provide quick and easy identification of connections which have not been pressed.

8. Grooved joint piping systems may be used (where allowed in the Part 2 Piping and Fittings section of these specifications) and shall be installed in accordance with the manufacturer's guidelines and recommendations. All grooved couplings, fittings, valves and specialties shall be supplied by a single manufacturer. The gasket style and elastomeric material (grade) verified as suitable for the intended service as specified. Gaskets shall be supplied by the grooved coupling manufacturer. Grooved ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove. Provide all additional hangers required by the system (at least one hanger per flex coupling) where expansion joints are used. A factory trained field representative (a direct employee) shall provide on-site training to Contractor's field personnel in the installation of grooved piping products. Factory trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

9. Soldered and Brazed Joints: Pipe and tubing shall be cut square and burrs shall be removed. Both inside of fittings and outside of tubing shall be cleaned with an abrasive before sweating. Care shall be taken to prevent annealing of fittings and hard drawn tubing when making connection. Changes in direction of piping shall be made with soldered or brazed fittings only. Solder and flux shall be lead free. Joints for soldered fittings shall be made with silver solder or 95:5 tin-antimony solder, or as specified in the Part 2 Piping specification for the system. Cored solder shall not be used. Joints for brazed fittings shall use brazing alloys with strength equal to B-Ag alloy and have a melting point above 1000 degrees F. Swing joints or offsets shall be provided on all branch connections, mains, and risers to provide for expansion and contraction forces without undue stress to the fittings or to short lengths of pipe or tubing. Care shall be taken to ensure solder is uniformly (360 degrees) drawn into the joint.

10. Viega ProPress press fittings may be used where allowed in the Part 2 Piping and Fittings section of these specifications. Prepare copper tube and install in strict

accordance with manufacturer's installation instructions. Pipe ends shall be cleaned, free from indentations, projections, burrs and foreign matter. Use a tube preparation tool as supplied by manufacturer to clean and make installation mark. Push copper tube into fittings to installation depth mark, per manufacturer's installation instructions. Keep fittings free of dirt and oil. Prior to putting the system into operation, Contractor shall verify all connections have been properly pressed.

11. Vic Press 304™ or ProPress stainless steel crimped joints may be used where allowed in the Part 2 Piping and Fittings section of these specifications. Install in strict accordance with manufacturer's installation instructions. Pipe shall be certified for use with the system manufacturer. Pipe shall be square cut, properly deburred, and cleaned. Pipe ends shall be marked at the required location, using a manufacturer-supplied gauge, to ensure full insertion into the coupling or fitting during assembly. Use a system manufacturer's recommended tool with the proper sized jaw for pressing. Prior to putting the system into operation, Contractor shall verify all connections have been properly pressed.

C. Diesel and Fuel Oil Piping

1. Unless otherwise allowed in Part 2 Piping and Fittings, or shown on the drawings, connections to equipment shall be made with malleable-iron unions or flanges for steel pipe 2 inches or less in diameter and with flanges for pipe 2-1/2 inches or more in diameter. Reducing fittings shall be used for changes in pipe sizes. Exceptions are pipe and fittings installed in inaccessible conduits or trenches beneath concrete floor slabs or in difficult to access locations such as shafts which shall be welded. Cast Iron fittings shall NOT be used. Grooved fittings shall NOT be used.

2. All piping for double wall piping systems shall be installed and tested per manufacturer's recommendations.

3. Welded joints shall be welded and tested in accordance with ASME B31.9 unless otherwise stated. Changes in direction of piping shall be made with welding fittings only; mitering or notching pipe to form elbows and tees or other similar type construction will not be acceptable. Branch connections may be made with either welding tees or forged branch outlet fittings, either being acceptable without size limitation. Branch outlet fittings, where used, shall be forged, flared for improvement flow where attached to the run, reinforced against external strains, and designed to withstand full pipe bursting strength.

   a. Beveling: Field and shop bevels shall be in accordance with the recognized standards and shall be done by mechanical means or flame cutting. Where beveling is done by flame cutting, surfaces shall be cleaned of scale and oxidation before welding.

   b. Alignment: Before welding, the component parts to be welded shall be aligned so that no strain is placed on the weld when finally positioned. Height shall be so aligned that no part of the pipe wall is offset by more than 20 percent of the wall thickness. Flanges and branches shall be set true. This alignment shall be preserved during the welding operation. If tack welds are used, welds shall be of the same quality and made by the same procedure as the completed weld; otherwise, tack welds shall be removed during the final welding operation.

   c. Erection: Where the temperature of the component parts being welded reaches 32 degrees F or lower, the material shall be heated to approximately 100 degrees F for a distance of 3 feet on each side of the

weld before welding, and the weld shall be finished before the materials cool to below 50 degrees F.

d. Defective Welding: Defective welds shall be removed and replaced. Repairing of defective welds shall be in accordance with ASME B31.9.

e. Electrodes: After filler metal has been removed from its original package it shall be protected or stored so that its characteristics or welding properties are not affected. Electrode material shall be as required for the pipe material. Electrodes that have been wetted or that have lost any of their coating shall not be used.

4. Flanges and unions shall be faced true, and made square and tight. Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1/16 inch thickness, full-face or self-centering flat ring type. The Gaskets shall be compatible with diesel and fuel oil and shall normally contain aramid fibers bonded with nitrile butadiene rubber (NBR). Union or flange joints shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as pumps, control valves, and other similar items.

5. Threaded joints shall be made with tapered threads properly cut and shall be made perfectly tight with MEGALOC Multi-Purpose Thread Sealant or equal. Sealant shall be non-toxic, non-hazardous, and non-flammable. It shall not contain any lead, heavy metals, or volatile solvents. Sealant shall be applied the male threads only, and in no case to the fittings.

6. All piping shall be inspected for leaks with non-visible piping pressure tested in accordance with NFPA 31.

3.4 CONNECTIONS TO EQUIPMENT

A. Supply and return connections shall be provided by the Contractor unless otherwise indicated. Valves and traps shall be installed in accordance with the manufacturer's recommendations. Unless otherwise indicated, the size of the supply and return pipes to each piece of equipment shall be not smaller than the connections on the equipment. No bushed connections shall be permitted. Change in sizes shall be made with reducers or increasers only.

3.5 SUPPORTS

A. Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while supporting the load. Pipe guides and anchors shall be installed to keep pipes in accurate alignment, to direct the expansion movement, and to prevent buckling, swaying, and undue strain. All piping subjected to vertical movement when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers.

B. Piping and attached valves shall be supported and braced to resist seismic loads as specified under the SEISMIC PROTECTION FOR MECHANICAL, ELECTRICAL EQUIPMENT section. Structural steel required for reinforcement to properly support piping, headers, and equipment, but not shown, shall be provided under this section. Material used for supports shall be as specified under the STRUCTURAL STEEL section.

1. Structural steel brackets required to support piping, headers, and equipment, but not shown, shall be provided under this section. Material and installation shall be as specified under the STRUCTURAL STEEL section. Pipe hanger loads suspended from steel joist panel points shall not exceed 50 pounds. Loads exceeding 50 pounds shall be suspended from panel points.

2. Multiple pipe runs on a common base member shall be supported by clamps where each pipe crosses the base support member. Spacing of the base support members shall not exceed the hanger and support spacing required for any individual pipe in the multiple pipe run.

C. Pipe hangers, inserts and supports shall conform to MSS SP-58 and MSS SP-69, except as specified as follows:

1. Types 5, 12, and 26 shall not be used.

2. Type 3 shall not be used on insulated pipe which has a vapor barrier. Type 3 may be used on insulated pipe that does not have a vapor barrier if clamped directly to the pipe and if the clamp bottom does not extend through the insulation and the top clamp attachment does not contact the insulation during pipe movement.

3. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustment may be used if they otherwise meet the requirements for Type 18 inserts.

4. Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

5. Type 20 attachments used on angles and channels shall be furnished with an added malleable iron heel plate or adapter.

6. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

7. Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle shall be used on all pipe 4 inches and larger.

8. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves.

9. Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 15 feet, except that pipe shall be supported not more than 8 feet from end of risers, and at vent terminations.

10. Type 35 guides using steel, reinforced PTFE or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions and bearing loads encountered. Where steel slides do not require provision for restraint or lateral movement, an alternate guide method may be used. On piping 4 inches and larger, a Type 39 saddle may be welded to the pipe and freely rest on a steel plate. On piping under 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate. Where there are high system temperatures and welding to piping is not desirable, then the Type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe

shall be separated from the slide material by at least 4 inches, or by an amount adequate for the insulation, whichever is greater.

11. Except for Type 3, pipe hangers on horizontal insulated pipe shall be the size of the outside diameter of the insulation.

D. Piping in trenches shall be supported as indicated on drawings and as required by the manufacturer.

E. Escutcheons shall be provided at all finished surfaces where exposed piping, bare or covered, passes through floors, walls, or ceilings, except in boiler, utility, or equipment rooms. Escutcheons shall be fastened securely to pipe sleeves or to extensions of sleeves without any part of sleeves being visible. Where sleeves project slightly from floors, special deep-type escutcheons shall be used. Escutcheons shall be chromium-plated iron or chromium-plated brass, either one-piece or split pattern, held in place by internal spring tension or setscrew.

3.6 VALVES AND EQUIPMENT ACCESSORIES

A. Valves shall be of the type and construction specified for the service and installed at the locations shown or specified, and where required for the proper functioning of the system as directed. Valves shall be installed with their stems horizontal to or above the main body of the valve. Valves used with ferrous piping shall have threaded or flanged ends and threaded or sweat-type connections for copper tubing. Non-flanged valves shall have unions for ease of maintenance.

B. Gravity flow-control (check) valves to control the flow of water shall be installed where specified or indicated on the drawings. The valve shall operate to prevent reverse flow and so that when the circulating pump starts, the increased pressure within the main will open the valve; when the pump stops, the valve will close. The valve shall be constructed with a cast iron body and shall be provided with a device whereby the valve can be opened manually to allow gravity circulation. The flow-control valve shall be designed for the intended purpose, and shall be installed as recommended by the manufacturer.

C. Relief valves shall be installed where specified or indicated on drawings. Every closed loop piping system shall have system relief valve(s). For glycol systems, discharge shall be piped for gravity flow into a funnel to the glycol fill tank.

D. A thermometer well (or Pete's plug) shall be provided in each return line for each circuit in multicircuit systems.

E. All branches from main piping (including mains that serve different wings or buildings) shall be provided with isolation valves.

F. Air vents shall be installed where indicated, and on all high points and piping offsets where air can collect or pocket.

1. Water air vents shall be high capacity type, automatic or manual, as specified and shown on drawings. For glycol systems, discharge shall be piped for gravity flow into a funnel to glycol fill tank.

2. Steam air vents shall be a quick-acting thermostatic valve that continuously removes air. Valve shall be constructed of corrosion-resisting metal, and be designed to withstand the maximum piping system pressure, and shall

automatically close tight to prevent escape of steam and condensate. Vent shall be provided with a manual isolation valve. A vent shall be provided at all locations shown on drawings.

3.7 GAS OR OIL FIRED HEATING SYSTEMS INSTALLATION

A. Equipment shall be installed as indicated and in accordance with the recommendations of the equipment manufacturer and the listing agency, except as otherwise specified. Combustion air supply, ventilation, piping and pressure testing shall be in accordance with NFPA 31 (Oil) and/or NFPA 54 (Gas) depending upon fuel(s) used.

B. Heaters shall be installed with clearance to combustibles complying with minimum distances as determined by AGAL-01, UL-06 and as indicated on each heater approval and listing plate.

C. Vent dampers, piping and structural penetrations shall be located as indicated. Vent damper installation shall conform to ANSI Z21.66. Vent pipes, where not connected to a masonry chimney conforming to NFPA 211, shall extend through the roof or an outside wall and shall terminate, in compliance with NFPA 54. Vents passing through waterproof membranes shall be provided with the necessary flashings to obtain waterproof installations.

D. Gas piping shall be connected as indicated and shall comply with the applicable requirements at Section 22 00 00 PLUMBING.

E. Warm air heating installations shall conform to the requirements contained in NFPA 90A or NFPA 90B, as applicable.

F. Foundations, settings, or suspensions for mounting equipment and accessories including supports, vibration isolators, stands, guides, anchors, clamps, and brackets shall be provided. Foundations and suspension for equipment shall conform to the recommendations of the manufacturer, unless otherwise indicated on drawings. Suspended equipment shall be independently supported from the building structure and not from suspended ceiling systems. Anchor bolts and sleeves shall be set accurately using properly constructed templates. Anchor bolts, when embedded in concrete, shall be provided with welded-on plates on the head end and guarded against damage until equipment is installed. Equipment bases shall be leveled, using jacks or steel wedges, and when resting on concrete shall be neatly grouted in with a nonshrinking type of grout. Equipment shall be located as indicated and in such a manner that working space is available for all necessary servicing, such as shaft removal, replacing, or adjusting drives, motors, or shaft seals, air filters, access to automatic controls, and lubrication. Electrical isolation shall be provided between dissimilar metals for the purpose of minimizing galvanic corrosion. The interior of cabinets or casings shall be cleaned before completion of installation.

G. Nonmetallic tubing shall be run within securely covered rigid metallic raceway or electric metallic tubing except as indicated. Single nonmetallic tubing in a protective sheath may be used above accessible ceilings and in other concealed accessible locations. Tubing concealed in walls containing insulation, fill or other packing materials shall be hard-drawn copper tubing or nonmetallic tubing run in conduit. Terminal single lines shall be hard-drawn copper tubing, except if the run is less than 12 inches, flexible polyethylene may be used. Nonmetallic tubing shall not be used for applications where the tubing could be subjected to a temperature exceeding 130 degrees F. Multitube instrument bundle may

be used instead of individual tubes where a number of tubes run to the same points. Tubing shall be periodically tested for leaks during installation and all tubing shall be free of installation impurities and moisture before connecting to the control instrument. Tubing shall be number coded or color coded and keyed to the submittal drawings for future identification and servicing the control system.

3.8 HYDROSTATIC TESTS

A. Prior to flushing and cleaning and before the application of any insulation, hydrostatic tests shall be made in accordance with applicable ASME requirements. Coordinate with Owner's Representative for witnessing of tests. Test reports shall be submitted to the Engineer and Owner's Representative The systems shall be proved tight for four (4) hour tests (with no loss in pressure) under gauge pressures of 1-1/2 times the working pressure specified, but not less than the following:

1. Water piping (including pumped steam condensate) 150 psi

B. Retesting: If any deficiencies are revealed during test, such deficiencies shall be corrected and the tests reconducted at no additional costs to the Owner.

3.9 PIPING SYSTEM, CLEANING AND FLUSHING

A. Supply all materials, labor and power required for cleaning and flushing. Cleaning shall be started only after all piping has been successfully hydrostatically tested and all systems have been completely connected up.

B. Piping Cleaning and Flushing

1. Exercise every precaution to avoid introducing foreign matter such as welding beads and slag or dirt into the piping system. All completed welds shall be hammered to loosen debris. All piping, valves and fittings shall be internally cleaned of oil, grease or dirt, prior to assembly into system by use of wire brush and swab.
2. All cleaning and flushing work shall be coordinated with and supervised by the Water Treatment Sub Subcontractor for chemicals and procedures to be followed. See the Water Treatment Section of these Specifications.
3. Following the successful testing of the piping systems, they shall be cleaned under the supervision of the Water Treatment Sub Subcontractor.
4. Before submitting piping systems for acceptance, all strainers shall be inspected and thoroughly cleaned.
5. Cleaning shall be started only after all piping has been hydrostatically tested and all systems have been completely connected up.
6. Operate pumps or provide other means of circulating water throughout system for period of 8 hours. At the end of circulation, remove and clean all strainer baskets and blow off all low points.

3.10 BOILER/BURNER EFFICIENCY AND OPERATING TESTS

A. Upon completion, and before acceptance of the work, each boiler shall be subjected to such operating tests as may be required to demonstrate satisfactory functional operation. Each operating test shall be conducted at such times as the Owner's Representative may direct. Instruments, test equipment, and test personnel required to properly conduct all tests shall be provided by the Contractor and the necessary fuel, water, and electricity will be furnished by the Owner. The boiler operating tests for each modulating or staged boiler shall, as a minimum, be conducted continuously at the following capacities for the following times:

Time	Capacity
First hour	25% (or minimum)
Next hour	50%
Next hour	75%
Next 2 hours	100%

B. The general performance tests on the heating plant shall be conducted by an experienced test engineer and will be observed by the Owner's Representative. A test report including logs, tabulated results, and conclusions shall be submitted to the engineer and the Owner's Representative.

C. Retesting if any deficiencies are revealed during test, such deficiencies shall be corrected and the tests reconducted at no additional costs to the Owner.

3.11 BASES AND SUPPORTS

A. In addition to supports and hangers as mentioned in the MISCELLANEOUS METALS section, provide all bases and supports not part of the building structure, of required size, type, and strength, as approved by the Engineer, for all equipment and materials furnished by him. All equipment, bases and supports shall be adequately anchored to the building structure to prevent shifting of position under operating conditions.

B. All concrete foundations and all concrete supports will be provided by the General Contractor. The HVAC Subcontractor shall furnish shop drawings and templates for all concrete foundations and supports for setting all required hanger and foundation bolts and other appurtenances necessary for the proper installation of his equipment. All concrete work shall be shown in detail on the shop drawings prepared by the HVAC Subcontractor, and be submitted to the Engineer, showing the complete details of all foundations, including the necessary concrete and steel work and vibration isolation devices.

C. All floor-mounted equipment shall be erected on concrete pads over the complete floor area of the equipment, unless specified to the contrary herein.

3.12 MISCELLANEOUS IRON AND STEEL

A. All work shall be cut, assembled, welded and finished by skilled mechanics. Welds shall be ground smooth. Stands, brackets, and framework shall be properly sized and firmly constructed.

B. Measurements shall be taken on the job and worked out to suit adjoining and connecting work. All work shall be by experienced metal working mechanics. Members shall be straight and true and accurately fitted. Scale, rust, and burrs shall be removed. Welded joints shall be ground smooth where exposed. Drilling, cutting and fitting shall be done as required to properly install the work and accommodate the work of other trades as directed by them.

C. Members shall be generally welded, except that bolting may be used for field assembly where welding would be impractical.

D. All shop fabricated iron and steel work shall be cleaned and dried and given a shop coat of paint on all surfaces and in all openings and crevices.

3.13 PLACING IN SERVICE

A. At the completion of performance tests and following approval of test result, recheck all equipment to see that each item is adequately lubricated and functioning correctly.

B. Furnish upon completion of all work, certificates of inspections from the manufacturers stating that authorized factory engineers have inspected and tested the operation of their respective equipment and found same to be in satisfactory operating conditions.

3.14 CLEANING AND ADJUSTING

A. During the progress of the work, clean up and remove all oil, grease, and other debris caused by the work performed under this Section.

B. At the conclusion of the project, clean and repair all areas and finishes as installed or affected by this installation of work under this Section.

C. Pipes shall be cleaned free of scale and thoroughly flushed of all foreign matter. A temporary bypass shall be provided for all water coils to prevent flushing water from passing through coils. Strainers and valves shall be thoroughly cleaned. Prior to testing and balancing, air shall be removed from all water systems by operating the air vents. Temporary measures, such as piping the overflow from vents to a collecting vessel shall be taken to avoid water damage during the venting process. Air vents shall be plugged or capped after the system has been vented.

D. Equipment shall be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided for all fans that are operated during construction, and new filters shall be installed after all construction dirt has been removed from the building. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

3.15 OPERATING AND MAINTENANCE INSTRUCTIONS

A. All operating equipment installed under this section shall be placed in operation and shall function continuously in an operating test for a period of one week without shutdown due

to mechanical failure or necessity of adjustment. Prior to scheduling the Project Final Inspection and after completion of all installation and running adjustments, the HVAC Subcontractor shall perform all work required to place the equipment in complete operating condition to meet all requirements under this Specification.

B. During this running test period, the HVAC Subcontractor shall deliver to the designated representative of the Owner six complete sets of operating, service and replacement data for all equipment which will require operating maintenance or replacement and one copy of this literature shall be available during the instruction of the operating personnel while the other is checked for completeness by the Engineer.

3.16 TRAINING

A. Conduct a training course for the maintenance and operating staff. The training shall start after the system is functionally complete but before the final acceptance tests. The training shall include all of the items contained in the operating and maintenance instructions as well as demonstrations of routine maintenance operations. The Owner’s Representative shall be given at least two weeks advance notice of such training.

B. During all working hours of the one week operating test, the HVAC Subcontractor's instruction personnel shall be available for and provide thorough and detailed training to the Owner's operating and maintenance personnel in operation, maintenance and adjustment of all equipment installed. The instructions shall be videotaped by the Subcontractor. The master tape and one (1) copy shall be turned over to the Owner not more than 10 days following the completion of the training.

C. Give sufficient notice to the designated operating personnel of the Owner in advance of this period. Upon completion of instruction, obtain from such representatives written verification on that which the above mentioned instruction has been performed, such verification to be forwarded to the owner.

D. Provide instruction time of 40 hours for systems and an additional 40 hours for ATC.

END OF SECTION

(End- Addendum No. 1)