

SECTION 15010 – GENERAL MECHANICAL

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. The scope of Work includes a complete renovation of the heating plant for the Mosquito Lake School. Work includes removal of the existing heating plant, chimney, circulating pumps, electric control system, oil delivery system, duct booster coils, and the installation of two oil-fired boilers, circulating pumps, heating piping, oil delivery system with day tank, chimney, and direct digital controls.
- B. The Mechanical Work is governed by the entire Specifications and not just Division 15 and Division 17. The entire Specifications must be examined for requirements relating to the Work hereunder. The Work covered by this and all other Mechanical sections consists of furnishing labor, equipment, and materials in accordance with the Specifications or Drawings, or both, together with any incidental items not shown or specified which can be reasonably inferred or taken as belonging to the Work and necessary in good practice to provide a complete system described or shown as intended.
- C. Coordinate shutdown of systems with Maintenance Personnel. Contact name and phone number will be available through ARCHITECT.
- D. Continuity of Mechanical Systems for School Building: The work is anticipated to occur when during the summer months and not during the school season. Therefore temporary heating and continuity of the Mechanical systems is not required until start of the school season.
- E. Demolition of and Connection to Existing Material, Equipment, and Systems:
 - 1. Where piping and ductwork systems are shown to be partially removed for connection, prepare and protect the connection points appropriately to ensure later continuity of Work. CONTRACTOR shall provide all temporary supports as required and completely replace material and equipment that are not suitably protected during construction and becomes damaged.
 - 2. CONTRACTOR shall provide all temporary caps for ductwork and piping as required. CONTRACTOR shall provide all temporary partitions such as air-tight return air plenum separations as required to maintain continuity of systems and to not contaminate existing systems or finishes. CONTRACTOR shall remove all temporary provisions when the phase of Work is completed or earlier if required.
 - 3. Where items are shown to be removed such as piping or ductwork it is to be assumed that this includes the removal of the respective system including but not limited to pipe and duct hangers, supports, conduit, wiring, valves, and other related trim and appurtenances. Piping to be removed through a floor assumes that the piping is to be capped below floor and the floor finished smooth.
 - 4. Mechanical Contractor shall locate, isolate, and drain piping systems to be removed.

1.2 WORDING OF THE SPECIFICATIONS

- A. These Specifications are of the abbreviated or streamlined type and frequently include incomplete sentences. However, periods are used for clarity. Words such as "shall", "shall be", "the CONTRACTOR shall", and similar mandatory phrases shall be supplied by inference in the same manner, as they are required for the notes on the drawings.

1.3 CODES AND REGULATIONS

- A. All Work hereunder shall be strictly in conformance with applicable codes and regulations. All Work shall be in accordance with the 2006 Uniform Plumbing Code, 2006 International Mechanical Code, 2006 International Building Code, 2006 International Fire Code, the most recent edition of NFPA, and State of Alaska code modifications insofar as minimum requirements are concerned, but the Drawings and Specifications shall govern in case the minimum requirements are exceeded. All electrical equipment shall bear the UL label.

1.4 SUBMITTALS

- A. General: Provide submittals according to Conditions of Contract, Division 1 Specifications Sections, and as required hereunder. Drawings and general provisions of the Contract, including General, Supplementary Conditions, and all Division 1 Specification Sections, apply to this Section. Approval of the data shall not eliminate responsibility for compliance with the Drawings or Specifications unless specific attention has been called in writing to proposed deviations at the time of transmittal of the data and such deviations have been approved, nor shall it eliminate the responsibility for freedom of errors of any sort in the data. All Mechanical submittal data for Project construction is to be turned in for approval at the same time in order for an efficient review process. Partial submittals may be rejected until the full submittal is received.
- B. Specified Products: Trade names and catalog numbers of manufactured products included herein are intended to indicate the type, size, and grade of quality of equipment and materials required and such equipment and materials are approved for installation, subject to full compliance with the Specifications. Except where single manufacture is specified for standardization, requests for approval of other manufacturers than those specified must be accompanied by complete descriptions including overall dimensions, performance data, and, if catalog material, identification of specific products or items proposed.
- C. Submittal Format: All data shall be submitted at one time in neatly bound loose-leaf three ring binders with pockets and tabulated in the same order of Specification Division 15000 (or 17000) section. All data shall be typed, minimum 10 point font, no exceptions. Data submitted that is not conforming to these specification requirements will be returned without reviewing and will need to be resubmitted at Contractors sole complete cost.
 - 1. Each binder shall have a set of separators with index tabs A to Z. Tabs are to be printed type. Slip-in tabs not acceptable.
 - 2. The first page shall be a cover sheet with project name, address, date, submittal product name, all applicable contractors and contact information, and all applicable consultants and contact information.
 - 3. Second page shall be a submittal manual index of all project Specification sections with respective tab numbers, and respective book number, if applicable.

4. The first page of each manual section shall be an index of that respective project Specification section and number with each product name, manufacturer name and model number.
 5. Each manual section shall be labeled and certified by mechanical Subcontractor that the data presented is in accordance with project Specifications. Index sheet in front of completed binder listing each piece of equipment or material submitted.
 6. Product Data to be utilized shall be flagged and noted and all other data shall be crossed out or otherwise flagged that it is not in the project.
 7. Data shall be inserted in binders in order of Specification number. Specification number shall be clearly labeled on each submittal page.
- D. As-built Drawings: As-built drawings shall be required from all Mechanical Subcontractors and shall accurately show all changes from Contract Documents for existing (work area only) and new piping, ductwork, and equipment.
- E. Operating and Maintenance Data: See Division 1 for the number of sets of data to be provided for submittal and additional requirements. Provide a minimum of four (4) copies. The following data shall be provided to the ARCHITECT for approval 30 days prior to the request for Substantial Completion inspection. Except for the valve directory and nameplate directory, the data shall be provided complete at one time. Partial or separate data will be returned for completion. The valve directory and nameplate directory may be provided for approval previous to the other data. The first section of the O&M manual shall be as listed in the following subparagraphs in order presented hereunder. All of the following subparagraphs sections shall be furnished with permanent plastic see through covers. See requirements under 1.4.C for additional submittal and formatting requirements.
1. Cover and Index sheets as in 1.4.C. above.
 2. Description of systems and operating instructions: The Contractor shall prepare a brief type written description of all new and modified systems, explaining how the systems operate and indicating the proper settings of controls and switches. The instructions are to include all information required for the proper settings of controls and switches. The instructions are to include all information required for the proper operation of the systems. Technical knowledge on controls or adjustments requiring specialized technicians should not be included in the instructions.
 3. Nameplate directory: List of all new boilers, air handlers, fans, water heaters, expansion tanks, thermostatic mixing valves, pumps, unit heaters, cabinet unit heaters, air conditioning units, and other equipment nameplates, giving manufacturer's nameplate data, nameplate designation, location of equipment, area served, switch location, and normal position of the switch. Motor data must include the horsepower, voltage, full load amperage, phase, etc. See Section 15075 – Mechanical Identification.
 4. Manufacturers' literature: Manufacturers' instructions for operation and maintenance of all mechanical equipment and specialties, including replacement parts lists, capacity curves or charts, equipment data sheets, manufacturers' literature on the equipment, and as-built wiring diagrams and control drawings, all suitable for side binding to 8-1/2 x 11 inch size. All data not applicable to the job is to be crossed out or deleted. Manuals turned in for review with non-applicable data not crossed out shall be returned to the Contractor.
 5. Maintenance instructions: Typewritten instructions for the maintenance of the systems, listing each service required on all of the mechanical equipment, including inspections, lubrication, cleaning, checking, and all other operations required. The list is to include all types of bearings installed on the equipment and the type of lubricant required.

6. Maintenance schedule: List of each item of mechanical equipment requiring inspection, lubrication, cleaning, or service including the type of bearings and type of lubricating means for each piece of equipment. Each item of equipment is to be listed separately with the service required. List to include the times during the year when such inspection and maintenance shall be performed. The specific maintenance required shall be referenced back to the maintenance instructions.
 7. Valve directory: Indicating valve number, size, location, function, and normal position for each numbered valve. The directory shall be provided and approved before installation of the valve tags. A sample arrangement will be furnished upon request. Two copies required for the preliminary list. See Section 15075 – Mechanical Identification.
- F. Guide Documents: Sample operating and maintenance instructions and maintenance schedule may be obtained from the ARCHITECT upon request, to assist in properly setting up the data.
 - G. Instructions To Personnel and Training: The mechanical Subcontractor shall instruct operating personnel in the operation and maintenance of the systems before accepting the responsibility of operation and maintenance of the systems. Each training session shall be signed off by Project Manager.
 - H. Submit prior to Substantial Completion Inspection and Final Inspection a detailed list of equipment and systems that will not be completed for the completion date. Include status and information of deficiencies from all previous inspection reports.
 - I. Submit prior to Re-inspections of Substantial Completion Inspections, if applicable, and the Final Inspection a marked copy of the previous Engineers Inspection Reports detailing all items that have been completed and all items that have not been completed with reasons thereof. Re-inspection or Final Inspection will not occur until receipt of this list.

1.5 COOPERATIVE WORK

- A. The Work hereunder shall be coordinated between various mechanical Sections and with the Work specified under other divisions or contracts toward rapid completion of the entire Project. If any cooperative Work must be altered due to lack of proper supervision hereunder, or failure to make proper provisions in time, then the Work hereunder shall include all expense of such changes as are necessary to be made in the Work under other divisions and contracts, and such changes shall be directly supervised by the ARCHITECT and shall be made to the satisfaction of the ARCHITECT.
- B. In general pitched piping and ductwork shall take preference in location within the Project area. Coordination of all drain valves, duct access doors, and other equipment requiring access and maintenance procedures is required with all building components during construction for maximum accessibility and proper location as intended. In many portions of the building, piping mains, piping branches, and sprinkler piping, as well as some duct branches will need to be installed in the joist space to allow for installation of duct mains. Coordinate closely with all other Contractors.

1.6 QUALITY ASSURANCE

- A. Perform Work in conformance with all applicable codes, regulations, local ordinances, contract documents, and generally accepted good practice. If discrepancies exist between Specifications and Contract Drawings then the solution that provides the Owner with the highest quality of product or installation shall be deemed as intended by the Contract Documents.

1.7 FIELD MEASUREMENTS

- A. See Division 1 for specific requirements regarding: Field Measurements and Site Conditions.
- B. Verifications: All measurements shall be verified at the site and prior to fabrications of equipment and systems. The existing conditions shall be fully observed before beginning the Work hereunder, and the Work hereunder executed in full coordination with the existing conditions observed. All hazardous material including asbestos materials that are discovered during the course of construction shall be immediately brought to the attention of the ARCHITECT for action. All Work performed with hazardous materials not approved by the Owner shall be at the full responsibility of the contractor and not the Owner.
- C. Changes: Variations apparently necessary due to existing conditions shall be made only on approval in writing by the ARCHITECT.

1.8 WARRANTY

- A. See Division 1 for specific requirements regarding: Product warranties and product Bonds.
- B. The contractor shall provide continuous and generally trouble-free operation of the mechanical systems for the time period listed in Division 1 or for one year after Substantial Completion whichever time period is longer. The operation and maintenance of systems other than incidental operations such as room thermostat settings or changing of air filters, shall be the sole responsibility of the contractor and shall be addressed by the contractor immediately if deficiencies are present. Leaking of valves, flanges, or air vents shall be addressed immediately by the contractor during the warranty period. Control settings, noise problems, and other deficiencies resulting in unsatisfactory environmental conditions shall be addressed immediately.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 15010

SECTION 15060 - HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes pipe, duct and equipment supports, hangers, sleeves, anchors, bases, seismic restraint, and the sealing of Work to adjacent construction.

1.2 REFERENCES

- A. MSS SP58 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Pipe Hangers and Supports - Materials, Design and Manufacturer.
- B. MSS SP69 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Pipe Hangers and Supports - Selection and Application.
- C. MSS SP89 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.3 SUBMITTALS

- A. General: Provide submittal procedures according to Conditions of Contract and Division 1 Specifications Sections.
- B. Product Data: Submit manufacturers catalog data including load capacity. Provide specific UL listed manufacturer's data and shop drawing for piping and sleeves where required through fire rated assemblies. Submit seismic support details and data as specified hereunder.

1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.5 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Manufacturers:

1. Grinnel ITT.
2. Fee & Mason
3. Michigan Hanger Co.
4. PHD Manufacturing
5. Superstrut

B. General:

1. Hangers for Uninsulated Pipe Sizes 1/2 to 2 inch: Malleable iron or Carbon steel, adjustable swivel, split ring or ring type.
2. Hangers for Uninsulated Pipe Sizes 2-1/2 inches and Over: Carbon steel, adjustable, standard clevis. Lightweight clevis type not acceptable
3. Hangers for Insulated Pipes with overall diameter (including insulation thickness) less than 4 inches: Malleable iron or Carbon steel, adjustable swivel, split ring or ring type. Hanger size includes pipe diameter and insulation thickness.
4. Hangers for Insulated Pipes with overall diameter equal to or larger than 4 inches (including insulation thickness): Carbon steel, adjustable swivel, standard clevis type. Lightweight clevis not acceptable. Hanger size includes pipe diameter and insulation thickness.
5. Copper Pipe Hanger: Plastic coated, carbon-steel adjustable, ring. For use where hanger materials in contact with dissimilar metal piping.
6. Beam and Joist Supports: Malleable iron C-clamp with locknut and galvanized steel retainer strap.
7. Wall Support for Pipe Sizes to 3 inches: Cast iron hooks.
8. Wall Support for Pipe Sizes 4 inches and Over: Welded steel bracket and wrought steel clamp.
9. Vertical Support: Steel riser clamp.
10. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
11. All Plumbing and Heating Piping Hangers shall conform to MSS SP58, MSS SP69.

2.2 ACCESSORIES

- #### **A. Hanger Rods:** Mild steel threaded both ends, cadmium or zinc plated, threaded on one end, or continuous threaded.

2.3 DUCT HANGERS AND SUPPORTS

- #### **A. Conformance:** As detailed and shown hereunder with minimum requirements as shown in Section IV of SMACNA HVAC Duct construction Standards.

- B. Round ducts up to and including 24 inches: Hanger band or straps completely encircling duct with fastener located immediately above duct to connect strap to hanger or to single vertical strap.
- C. Rectangular Ducts: Ducts 30 inch wide and smaller supported from 1 inch wide 20 gage galvanized steel straps. Minimum 2-inch strap overlap across bottom of duct.

2.4 SLEEVES

- A. Sleeves for Pipes Through Non-fire Rated Beams, Floors, Concrete Walls, and Footings: Schedule 40 galvanized steel pipe or 18 gage thick galvanized steel.
- B. Sleeves for Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Schedule 40 galvanized steel pipe. Seal space between sleeve and wall or floor with fire rated caulk. Install fire stopping insulation between sleeve and pipe. Seal opening with fire rated caulk. Seal per UL listing of fire rated caulk for specific wall type.
- C. Sleeves for Round Ductwork: Galvanized steel.
- D. Sleeves for Rectangular Ductwork: Galvanized steel.
- E. Stuffing Fire-stopping Insulation: Glass fiber type, non-combustible.
- F. Sealant: Intumescent Fire Rated Caulk. UL listed.

PART 3 - EXECUTION

3.1 PIPE HANGERS AND SUPPORTS

- A. Support horizontal piping as scheduled.
- B. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent Work.
- C. Place hangers within 12 inches of each horizontal elbow.
- D. Use hangers with 1-1/2 inch minimum vertical adjustment.
- E. Support horizontal cast iron pipe adjacent to each hub or joint, with 5 feet maximum spacing between hangers.
- F. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
- G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- H. Support riser piping independently of connected horizontal piping.
- I. Provide plastic coated hangers and supports for copper piping.

- J. Design hangers for pipe movement without disengagement of supported pipe.
- K. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- L. Provide hangers suitable for pipe size and insulation. Coordinate with Section 15080 for insulation thickness.
- M. Provide insulation shields between pipe insulation and hanger.
- N. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 15080.
- O. Provide neat and close fitting escutcheon at all exposed penetrations.

3.2 DUCT HANGERS AND SUPPORTS

- A. Support ducts as scheduled and required.
- B. Coordinate support connections with structural components and locations.
- C. Ducts secured against vibration and displacement.

3.3 EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment.
- B. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.
- C. Construct supports of steel members or Steel pipe and fittings. Brace and fasten with flanges bolted to structure.
- D. Provide rigid anchors for pipes after vibration isolation components are installed.

3.4 SCHEDULES:

<u>PIPE SIZE</u> Inches	<u>MAX. HANGER SPACING</u> Feet	<u>HANGAR ROD DIAMETER</u> Inches
1/2 to 1-1/4	6.5	3/8
1-1/2 to 2	10	3/8
2-1/2 to 3	10	1/2
4 to 6	10	5/8
C.I. Bell and Spigot, No-Hub, and at joints	5	1/2

<u>DUCTS</u>	<u>MAX. HANGER SPACING</u>	<u>HANGAR ROD DIAMETER</u>
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Inches	Feet	Inches
Rectangular and round	10'	3/8" or strap
Exposed round	10'	3/8"

END OF SECTION 15060

SECTION 15075 - MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes nameplates, tags, and pipe markers. Symbols, numbers, and all mechanical identification shall be in accordance with Contract Documents. All existing and new mechanical equipment in the Project area is to be identified.

1.2 SUBMITTALS

- A. General: Provide submittal procedures according to Conditions of Contract and Division 1 Specifications Sections.
- B. Product Data: Provide manufacturers catalog literature for each product required.
- C. Shop Drawings: Provide list of wording, symbols, letter size, and color coding for mechanical identification and a valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number. Symbols, numbers, and all mechanical identification shall be in accordance with Contract Documents.
- D. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

1.3 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.
- B. Provide valve tag list for new valves. Revise original valve tag list for removed valves. See 2.2 paragraph B: Valve Tag Lists below.

1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing WORK of this section with minimum three years documented experience.

PART 2 - PRODUCTS

2.1 NAMEPLATES

A. Manufacturers:

1. MSI Marking Services, Inc.
2. Safety Sign Co.
3. Seton Identification Products.

B. Product Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.2 TAGS

A. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inches diameter with smooth edges.

B. Valve Tag Lists: Typewritten letter size list of applied tags and location in anodized aluminum frame under safety glass. Locate valve tag list in boiler room along with revised existing valve tag list. Cross out valves on existing valve tag list which have been removed in this project. Submit list of new valve tag list and revised valve tag list for approval prior to mounting. Copy of approved valve tag lists shall be located in O&M manual.

2.3 PIPE MARKERS

A. Color and Lettering: Conform to ASME A13.1.

B. Plastic Pipe Markers:

1. Manufacturers:

- a. MSI Marking Services, Inc.
- b. Safety Sign Co.
- c. Seton Identification Products.

2. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

3. To be used for un-insulated piping only.

C. Plastic Tape Pipe Markers:

1. Manufacturers:

- a. MSI Marking Services, Inc.
- b. Safety Sign Co.
- c. Seton Identification Products.

2. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

2.4 LABELS

A. Manufacturers:

1. MSI Marking Services, Inc.
2. Safety Sign Co.
3. Seton Identification Products.

B. Description: Laminated Mylar, approximate size 1.9 x 0.75 inches, adhesive backed with printed identification.

PART 3 - EXECUTION

3.1 PREPARATION

- #### A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

- #### A. Install identifying devices after completion of coverings and painting. Symbols, numbers, and all mechanical identification shall be in accordance with Contract Documents.
- #### B. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.
- #### C. Install labels and nameplates with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.
- #### D. Install tags using corrosion resistant chain. Number tags consecutively by location.
- #### E. Install approved valve tag lists in Boiler Room and in Operating and Maintenance Manuals with a separate copy submitted to ENGINEER.
- #### F. Identify air handlers, fans, pumps, water heaters, expansion tanks, thermostatic mixing valves, boilers, burners, etc. with plastic nameplates.
- #### G. Identify control panels and major control components outside panels with plastic nameplates.
- #### H. Identify valves in main and branch piping with sequentially numbered tags.
- #### I. Identify heating unit valves including automatic valves with sequentially numbered tags.
- #### J. Label automatic controls, instruments, and relays. Key to control schematic.

- K. Identify new exposed piping and concealed piping that is accessible with plastic pipe markers or plastic tape pipe markers. Plastic pipe markers are to be used on uninsulated piping. Identify service and flow direction. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction. Inaccessible piping need not be identified if piping is identified at nearest accessible or exposed locations.

END OF SECTION 15075

SECTION 15080 – MECHANICAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes ductwork insulation, equipment insulation, thermal insulation for piping systems including vapor retarders, jackets, and accessories. All new piping, equipment, and ductwork are to be insulated as specified. All existing piping, equipment, and ductwork are to be re-insulated where new work or connections are being performed. Re-insulate or repair insulation where previous insulation has been damaged due to new work or relocation of ductwork, piping, or equipment.
- B. Related Sections:
 - 1. Section 15075 – Mechanical Identification: Product requirements for mechanical identification for placement by this Section.

1.2 REFERENCES

- A. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
- B. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
- C. ASTM C518 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- D. ASTM C547 - Standard Specification for Mineral Fiber Preformed Pipe Insulation.
- E. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- F. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).
- G. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
- H. ASTM C1071 - Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material).
- I. ASTM C1136 – Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
- J. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
- K. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

- L. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
- M. ASTM E162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.
- N. NAIMA (North American Insulation Manufacturers Association) - National Insulation Standards.
- O. SMACNA (Sheet Metal and Air Conditioning Contractors' National Association) - HVAC Duct Construction Standards - Metal and Flexible.

1.3 SUBMITTALS

- A. General: Provide submittal procedures according to Conditions of Contract and Division 1 Specifications Sections.
- B. Product Data: Provide product description, thermal characteristics and list of materials and thickness for each service, and locations.

1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Applicator: Company specializing in performing WORK of this section with minimum three years documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Do not install insulation outside ambient conditions required by manufacturer of each product.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

1.7 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.1 MAN MADE MINERAL FIBER

A. Manufacturers:

1. Knauf.
2. Owens Corning.
3. CertainTeed.

B. Insulation: ASTM C547 Mineral Fiber Pipe Insulation, Type I 850 3 lb. density.

C. Vapor Retarder Jacket:

1. White Kraft paper with glass fiber yarn, bonded to aluminized film.
2. Moisture vapor transmission: ASTM E96; 0.02 perm-inches.

D. Tie Wire: 0.048-inch stainless steel with twisted ends on maximum 12-inch centers.

E. Vapor Retarder Lap Adhesive:

1. Manufacturers:
 - a. DuroDyne
 - b. Knauf
 - c. Vimasco
2. Compatible with insulation.

F. Insulating Cement/Mastic:

1. Manufacturers:
 - a. Vimasco
 - b. Fibrex
 - c. Insulco
 - d. DuroDyne
 - e. Childers
 - f. Fosters
2. Water based insulation adhesive, UL classified.

2.2 MINERAL FIBER, FLEXIBLE BLANKET OR BATTS

A. Manufacturers:

1. Owens Corning
2. Knauf
3. CertainTeed

- B. Insulation: ASTM C553; Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications. Type I, 850 1 lb. density.
 - C. Vapor Retarder Jacket: ASTM 1136, Type II Flexible and Low Permeance Vapor Retarders for Thermal Insulation.
 - 1. For systems operating at temperatures below ambient, close and secure seams and joints. If outward clinching staples are used, then the staple penetrations must also be sealed.
 - D. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
 - E. Vapor Retarder Lap Adhesive:
 - 1. Manufacturers:
 - a. DuroDyne.
 - b. Knauf.
 - c. Vimasco.
 - 2. Compatible with insulation.
 - F. Insulating Cement/Mastic:
 - 1. Manufacturers:
 - a. Vimasco.
 - b. Fibrex.
 - c. Insulco.
 - d. DuroDyne.
 - e. Childers
 - f. Fosters
 - 2. Water based insulation adhesive, UL classified.
- 2.3 PVC Plastic.
- A. Manufacturers:
 - 1. Proto/Knauf.
 - 2. Owens Corning.
 - 3. Speedline.
 - B. Pipe Jacket: One piece molded type fitting covers and sheet material, off-white color.
 - 1. Thickness: Minimum 15 mil
 - 2. Connections: Tacks or Pressure sensitive color matching vinyl tape.
 - C. Covering Adhesive Mastic:
 - 1. Manufacturers:
 - a. Proto/Knauf.
 - b. Owens Corning.

2. Compatible with insulation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that piping, equipment and ductwork has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

- A. Install in accordance with NAIMA National Insulation Standards.
- B. Exposed Piping: Locate insulation and cover seams in least visible locations.
- C. Insulate entire piping system including, but not limited to, fittings, valves, unions, flanges, strainers, and coil headers, unless otherwise noted.
- D. Insulated pipes conveying fluids below ambient temperature:
 1. Provide factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal all staple penetrations with vapor retarder mastic.
 2. Insulate fittings, flanges, unions, strainers, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with removable glass cloth and vapor retarder adhesive or PVC fitting covers. Removable section to be three inches either side of equipment.
- E. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.
- F. Insulated pipes conveying fluids above ambient temperature:
 1. Provide factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or the pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
 2. Insulate all fittings.
 3. Do not insulate flanges, unions, strainers, and valves serving piping 2-inches and under unless otherwise noted.
 4. Insulate valves, flanges, unions, and strainers serving piping 2-1/2 inches and larger with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers. Removable section to be three inches either side of equipment.
- G. Buried Piping: Insulate with flexible foam plastic suitable for underground installation. Seal seams with insulation cement. Use type of cement as recommended by manufacturer.

- H. Shields:
 - 1. Application: Piping or Equipment 1-1/2" insulated diameter or larger.
 - 2. Shields: Galvanized steel between pipe hangers and insulation.
- I. Continue insulation through penetrations of building assemblies or portions of assemblies having a fire resistance rating of one hour or less.
- J. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
- K. Fill joints, cracks, seams, and depressions with cement to form smooth surface.
- L. Finish insulation at supports, protrusions, and interruptions.
- M. Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.
- N. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation so it can be easily removed and replaced without damage.
- O. Removable Equipment Covering: Booster coils. Removable Fiberglass Blanket with canvass type jacket and wire fasteners and hooks.
- P. Factory Insulated Equipment: Do not insulate.
- Q. Exposed Equipment: Locate insulation and cover seams in least visible locations.
- R. Insulated ductwork conveying air below ambient temperature:
 - 1. Provide insulation with vapor retarder jackets.
 - 2. Finish with tape and vapor retarder jacket.
 - 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - 4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- S. Insulated ductwork conveying air above ambient temperature:
 - 1. Provide with standard vapor retarder jacket.
 - 2. Insulate entire duct system including all appurtenances

3.3 SCHEDULES

- A. Piping Systems:
 - 1. Domestic Hot and Cold Water Supply and Hot Water recirculation: Mineral fiber pipe insulation, 1 inch thick.
 - 2. Plumbing Vents Within 10 feet of the Vent Through Roof: Mineral fiber pipe insulation, 1 inch thick.
 - 3. Heating Water Supply and Return: Mineral fiber pipe insulation:
 - a. Pipe Size Range: Up to and including 2" pipe diameter; thickness of 1-1/2 inch.

4. Air Separators and Expansion Tank: 2-inch thick mineral fiber.
5. Existing piping: Re-insulate or repair existing pipe insulation where piping connections are made. Mineral Fiber Pipe Insulation.

B. Duct Systems

1. Ducts Connected to Booster Coils located in Crawlspace: Mineral Fiber Blanket Insulation 1-1/2 inches thick.
2. Existing supply ducts: Re-insulate or repair existing duct insulation where duct connections are made. Mineral Fiber Blanket Insulation 1-1/2 inches thick.

END OF SECTION 15080

SECTION 15110 - VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes valves not specified elsewhere.

1.2 REFERENCES

- A. ASME B16.3 (American Society of Mechanical Engineers) - Malleable Iron Threaded Fittings.
- B. AWS (American Welding Society) - Welding and Brazing Qualifications.
- C. MSS SP-67 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Butterfly Valves.
- D. MSS SP-71 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
- E. MSS SP-80 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Bronze Gate, Globe, Angle and Check Valves.
- F. Section 15075: Mechanical Identification. For WORK hereunder.

1.3 SUBMITTALS

- A. General: Provide submittal procedures according to Conditions of Contract and Division 1 Specifications Sections.
- B. Product Data: Submit Manufacturers catalog information with valve data and ratings for each service.

1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of valves. Neatly record actual location of valves and valve tag numbers on piping plans and piping diagrams. Submit as part of record As-built set.
- B. Operation and Maintenance Data: Submit installation instructions, spare parts lists, exploded assembly views.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.

PART 2 - PRODUCTS

2.1 GATE VALVES

- A. Manufacturers:
 - 1. Nibco.
 - 2. Milwaukee.
 - 3. Powell.
 - 4. Hammond.
- B. Up To and Including 2 inches: MSS SP-80, Class 125, bronze body, bronze trim, hand-wheel, inside screw, solid wedge disc, threaded ends. 1" diameter and smaller valves may have soldered ends.
- C. 2-1/2 inches and Larger: MSS SP-70, Class 125, iron body, bronze trim, outside screw and yoke, hand-wheel, solid wedge disc with bronze seat rings, flanged ends.

2.2 GLOBE VALVES

- A. Manufacturers:
 - 1. Nibco.
 - 2. Milwaukee.
 - 3. Powell.
- B. Up To and Including 2 inches: MSS SP-80, Class 125, bronze body, bronze trim, hand-wheel, bronze disc, threaded ends. 1" diameter and smaller valves may have soldered ends.
- C. 2-1/2 inches and Larger: MSS SP-85, Class 125, iron body, bronze trim, hand-wheel, outside screw and yoke, renewable bronze plug-type disc, renewable seat, flanged ends.

2.3 BALL VALVES

- A. Manufacturers:

1. Nibco.
2. Stockham.
3. Hammond.

- B. Construction, 3 inches and Smaller: MSS SP-110, Class 150, 400 psi CWP, bronze, two piece body, chrome plated brass ball, full port, teflon seats and stuffing box ring, blow-out proof stem, lever handle, threaded ends. 1" diameter and smaller valves may have soldered ends.

2.4 SWING CHECK VALVES

- A. Up To and Including 2 inches:

1. Manufacturers:

- a. Nibco.
- b. Milwaukee.
- c. Hammond.

2. MSS SP-80, Class 125, bronze body and cap, bronze swing disc with rubber seat, threaded ends. 1" diameter and smaller valves may have soldered ends.

- B. 2-1/2 inches and Larger:

1. Manufacturers:

- a. Nibco.
- b. Milwaukee.
- c. Hammond

2. MSS SP-71, Class 125, iron body, renewable disc seal and seat, flanged ends.
Construction:

2.5 SPRING LOADED CHECK VALVES

- A. Up To and Including 2 inches:

1. Manufacturers:

- a. Nibco.
- b. Milwaukee.
- c. Hammond.

2. Class 125, bronze body. Stainless steel stem and 316 Stainless steel spring with rubber seat, threaded ends. 1" diameter and smaller valves may have soldered ends.

- B. 2-1/2 inches and Larger:

1. Manufacturers:

- a. Nibco.

- b. Milwaukee.
 - c. Hammond
2. Class 125, iron body silent check, bronze trim, stainless steel springs, bronze disc, Buna N seals, flanged ends.

2.6 RELIEF VALVES

A. Temperature and Pressure Relief:

1. Manufacturers:
 - a. Watts.
2. Construction: AGA Z21.22 certified, bronze body, Teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, temperature relief maximum 210 degrees F, capacity ASME SEC IV certified and labeled. Size per ASME requirements.

2.7 FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe 2 inches and Under:

1. Ferrous Piping: 150 psig malleable iron, threaded.
2. Copper Pipe: Bronze, soldered joints.

B. Flanges for Pipe Over 2 inches:

1. Ferrous Piping: 150 psig forged steel, slip-on.
2. Copper Piping: Bronze.

C. Gaskets: 1/16-inch thick preformed neoprene.

D. Accessories: Steel bolts, nuts, and washers.

E. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify Piping System is ready for installation.

3.2 INSTALLATION

- A. Install valves with stems upright or above horizontal, not inverted.
- B. Valves shall be same size as connected piping unless shown otherwise.

- C. Install ball valves for 3-inch pipe size and under for shut-off and to isolate equipment, part of systems, or vertical risers. Install rising stem gate valves for water service main, domestic water service connection, and pipe sizes over 3-inch for shut-off and to isolate equipment, part of systems, or vertical risers. Butterfly valves acceptable only where specifically stated.
- D. Install globe or ball valves for throttling, bypass, or manual flow control services.
- E. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- F. Install unions downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
- G. Provide spring loaded check valves on discharge of water pumps. Install minimum 4 pipe diameters downstream from pump discharge or elbows.
- H. All swing check valves installed in horizontal position.
- I. Provide flow controls in water re-circulating systems where indicated.
- J. Use 3/4-inch gate valves with cap and hose end adaptor for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. Install vacuum breaker on all drain valves on domestic water systems.

END OF SECTION 15110

SECTION 15120 - PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes pressure gages and pressure gage taps, thermometers and thermometer wells, expansion tanks, air separators, air vents, strainers, access doors, flowsetters, water feeders, and relief valves.
- B. Related Sections:
 - 1. Section 15180 – Heating Piping: Execution requirements for piping connections to products specified by this Section.
 - 2. Section 15140 – Domestic Water Piping: Execution requirements for piping connections to products specified by this Section.

1.2 REFERENCES

- A. ASME (American Society of Mechanical Engineers) - Boiler and Pressure Vessel Codes, SEC VIII-D - Rules for Construction of Pressure Vessels.
- B. ASTM E1 - Standard Specification for ASTM Thermometers.

1.3 SUBMITTALS

- A. General: Provide submittal procedures according to Conditions of Contract and Division 1 Specifications Sections.
- B. Product Data: Submit for manufactured products and assemblies required for this Project.
 - 1. Manufacturer's data indicating use, operating range, total range, accuracy, and location for manufactured components.
 - 2. Submit product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
 - 3. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each specialty.
 - 4. Submit schedule of pressure gage and thermometers detailing service and scale.
- C. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures, application, selection, and hookup configuration. Include pipe and accessory elevations.

1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of components, instrumentation and flowsetters.
- B. Operation and Maintenance Data: Submit instructions for calibrating instruments, installation instructions, assembly views, servicing requirements, lubrication instruction, and replacement parts list.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing WORK of this section with minimum three years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Particular care shall be taken in storage and handling of such materials to maintain its clean condition. Provide temporary end caps and closures on piping and fittings until ready for immediate use. Maintain in place until installation. Store piping, materials, and equipment in clean, enclosed from weather, location at all times. Piping is not to be stored in direct contact with dirty surfaces or on dirt floor. If piping, equipment, and components are found to be improperly stored they shall be removed from the project immediately and new materials shall be used.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Do not install instruments when areas are under construction, except for required rough in, taps, supports and test plugs.

1.8 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.9 EXTRA MATERIALS

- A. Supply two complete spare automatic and manual air vents and one package of air vent o-rings, minimum six per package.
- B. Supply one spare pressure gage.

- C. Supply one spare thermometer.

PART 2 - PRODUCTS

2.1 PRESSURE GAGES

A. Manufacturers:

1. Trerice.
2. Weiss.
3. Weksler.
4. Ashcroft.

- B. Gage: UL listed with bourdon tube, rotary brass movement, brass socket, front calibration adjustment, black scale on white background.

1. Case: Steel, cast aluminum, or fiberglass-reinforced polypropylene.
2. Bourdon Tube: Brass or stainless steel.
3. Dial Size: 4 inch or 4-1/2 inch diameter.
4. Mid-Scale Accuracy: One percent.
5. Scale: Psi.

2.2 THERMOMETERS, DIGITAL TYPE

A. Manufacturers:

1. Weiss.

- B. Thermometer: Adjustable angle, digital solar powered thermometer, with positive locking device.

1. Stem: Brass, 3/4 inch NPT, 3-1/2 inch long.
2. Accuracy: 2 percent.
3. Calibration: Both degrees F and degrees C.

2.3 THERMOMETER SUPPORTS

- A. Socket: Brass separable sockets for thermometer stems with or without extensions as required

2.4 TEST PLUGS

A. Manufacturers:

1. Pete's Plug.
2. Sisco.
3. Universal Lancaster.

- B. 1/4 inch NPT or 1/2 inch NPT brass self sealing fitting and screw type sealing cap for receiving 1/8 inch outside diameter pressure or temperature probe with Nordel core for temperatures up to 350 degrees F.

2.5 EXPANSION TANKS (ET)

- A. Manufacturers:
 - 1. Amtrol.
 - 2. Taco.
- B. ET-1 (Heating Water): Replaceable Bladder type: Welded steel, tested and stamped in accordance with ASME SEC 8-D; rated for working pressure of 125 psig, with replaceable bladder.
- C. ET-2 (Domestic water): Diaphragm type: Welded steel, tested and stamped in accordance with ASME SEC 8-D; rated for working pressure of 100 psig, with flexible butyl diaphragm sealed into tank. Potable domestic water use. Pre-pressurized at 40 psi.
- D. Accessories: Pressure gage and air-charging fitting.
- E. Size: See Schedules.

2.6 WATER FEEDER

- A. Manufacturers:
 - 1. Bell & Gossett
 - 2. Watts, Model U5LP.
- B. Construction: Cast brass or bronze body, adjustable, low inlet pressure check valve or spring assembly and built-in removable strainer, threaded connections, suitable for feedwater control of heating water systems. Seat, stem, and strainer brass or stainless steel construction.
- C. Capacity: 1/2-inch size. Set for 15 psig no flow pressure.

2.7 AUTOMATIC AIR VENT

- A. Manufacturers:
 - 1. Hoffman, Model 79.
 - 2. Honeywell Braukman, Model EA-79.
 - 3. Spirotherm, Spirotop.
- B. Automatic Air Vent; Float Type:
 - 1. Brass body, solid non-metallic float, vented top threaded for connection of drain. Automatic air vent suitable for system operating temperature and pressure; with isolating valve.

2.8 MANUAL AIR VENT

A. Manufacturers:

1. Hoffman Model 500.
2. Bell & Gossett Model 17SR.
3. Taco Model 417.
4. Substitutions: Not Permitted.

B. Manual Air Vent; Washer Type: Brass with hydroscopic fiber discs, vent ports, adjustable cap for manual shut-off, and integral spring loaded ball check valve.

2.9 AIR SEPARATORS (AS-1)

A. Manufacturers:

1. Spirotherm - Spirovent High Velocity Drain

B. Air Separators, Dirt/Water type:

1. Steel construction for 150 psig maximum operating pressure. Integrated brass venting mechanism on top. Removable lower head with flanges to clean inside body. Threaded blowdown connection port at bottom.
2. High Velocity Type: Suitable for 10 feet per second inlet velocity. 5-inch size.
3. Air and dirt eliminator: Copper bundle designed to suppress turbulence and provide high efficiency. Shall be capable of removing 100% of free and entrained air, and 99.6% of the dissolved air. Dirt separation shall be at least 80% of all particles 30 micron and larger within 100 passes.

2.10 STRAINERS

A. Manufacturers:

1. Hoffman.
2. Spiray/Sarco
3. Mueller.

B. Size 2 inch and Under: Screwed brass body for 125 psig working pressure, Y pattern with 1/32 inch removable stainless steel perforated screen.

2.11 FLOWSETTERS

A. Manufacturers:

1. Bell & Gossett Circuit Setter.
2. Armstrong CBV.
3. Taco Accuflo.

- B. Angle or straight pattern, inside screw globe or ball valve for 125 psig working pressure, with bronze body and integral union for screwed connections, renewable composition disc, plastic wheel handle for shut-off service, and lock-shield key cap and set screw memory bonnet for balancing service. 1/2 inch or 3/4 inch may be sweat type. Valve bodies to have differential read-out ports and caps. Provide three probe adapters for meter reading. Provide two spare read-out port caps.

2.12 PRESSURE RELIEF VALVES

A. Manufacturers:

1. Watts.
2. Bell & Gossett.
3. Consolidated.

- B. Bronze body, stainless steel stem and springs, automatic, direct pressure actuated capacities ASME certified and labeled.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Flush entire existing heating system prior to connecting to new boiler room heating system. Access to pool and temporary shutdown of pool heating system will be required to complete existing piping system flushing.
- B. Install gage taps in piping where gages are required.
- C. Install pressure gages with 1/4-inch needle valve or ball valve to isolate each gage except for boiler water gage. Extend nipples to allow clearance from insulation.
- D. Heating water system does contain glycol. Contractor is provide propylene glycol in a mixture of 40% glycol to water to refill the entire system.
- E. Provide heating system pressure-reducing stations with pressure reducing valve, bypass with valve, strainer and pressure gage on upstream side, relief valve and pressure gage on downstream side of pressure reducing valve.

- F. Install thermometers in piping systems in sockets in short couplings. Ensure sockets allow clearance from insulation.
- G. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets.
- H. Coil and conceal excess capillary on remote element instruments.
- I. Provide instruments with scale ranges selected according to service with largest appropriate scale. Normal measurement point to be mid scale.
- J. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- K. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- L. Locate test plugs where indicated.
- M. Provide air separator on suction side of main heating pumps.
- N. At automatic air vents, provide enlarged air collection standpipes and install drainage tubing to nearest drain as detailed or shown.
- O. Provide drain and hose connection with valve on strainer blowdown connection.
- P. Pipe relief valve outlet to floor sink.
- Q. Where piping penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent WORK with stuffing or fire stopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- R. Install chrome plated steel escutcheons at all finished surfaces.
- S. Access doors: Install for access to mechanical equipment that requires access for operation, maintenance, or replacement. Coordinate requirements for maintaining fire rating around access door and through related construction.

3.2 CLEANING

- A. Flush entire existing heating system prior to connecting to new boiler room heating system.
- B. Clean all strainers immediately after pump start-up. Verify with School Maintenance after complete.

3.3 PROTECTION OF INSTALLED CONSTRUCTION

- A. Do not install hydronic pressure gauges until after systems are pressure tested.

END OF SECTION 15120

SECTION 15130 - PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes pumps.
- B. Related Sections:
 - 1. Section 15180 – Heating Piping: Execution requirements for connection to pumps specified by this Section.
 - 2. Division 16 – Electrical: Product and Execution Requirements that apply to this section.
 - 3. Section 17000 – Building Automation Controls: Product and Execution Requirements that apply to this section.

1.2 REFERENCES

- A. UL 778 (Underwriters Laboratories, Inc.) - Motor Operated Water Pumps.
- B. NEMA – National Electrical Manufacturers Association.

1.3 PERFORMANCE REQUIREMENTS

- A. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading at any point on the pump curve in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
- B. Pumps used for domestic water service shall be of all bronze construction.

1.4 SUBMITTALS

- A. General: Provide submittal procedures according to Conditions of Contract and Division 1 Specifications Sections.
- B. Product Data: Submit certified pump curves showing performance characteristics with pump and system operating point plotted. Include efficiencies, specific NPSH curve and impeller size when applicable. Include electrical characteristics and connection requirements. Submit also, manufacturer model number, dimensions, service sizes, and finishes.
- C. Manufacturer's Installation Instructions: Submit application, selection, and hookup configuration with pipe and accessory elevations. Submit hanging and support requirements and recommendations.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Submit installation instructions, servicing requirements, assembly views, lubrication instructions, and replacement parts list.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing WORK of this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.8 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.9 EXTRA MATERIALS

- A. Supply one complete spare pump for P-1, P-3.

PART 2 - PRODUCTS

2.1 SYSTEM LUBRICATED CIRCULATORS

- A. Manufacturers:
 - 1. Armstrong, Series SS.
 - 2. Bell & Gossett, Booster Series.
 - 3. Grundfos.
 - 4. Taco 00 Series.
- B. Type: Horizontal shaft, single stage, direct connected with wet rotor motor for in-line mounting, for 140-psig maximum working pressure, 230 degrees F maximum water temperature. All bronze for domestic hot water recirculation.
- C. Casing: Bronze with flanged pump connections.
- D. Shaft, Rotor: Ceramic.
- E. Bearings: Metal Impregnated carbon (graphite) and ceramic.

- F. Motor: Impedance protected, non-overloading at any point on the pump curve.
- G. Performance: See Schedules.
- H. Electrical Characteristics:
 - 1. See Schedules on drawings.
 - 2. Motor: 3250 rpm.
 - 3. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lubricate pumps before start-up.

3.2 FIELD QUALITY CONTROL

- A. Lubricate pumps before start-up.
- B. Motors: Ensure proper alignment and rotation.
- C. Verify existing power requirements on-site.

3.3 COORDINATION

- A. Coordinate this work with the work of other trades, and make arrangements for the complete and proper accomplishment of all related work. Coordinate required control interlocks with automatic controls contractor.

END OF SECTION 15130

SECTION 15180 - HEATING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes systems, accessories, chemical feed units, pipe and pipefittings for heating piping.
- B. Related Sections:
 - 1. Section 15060 – Hangers and Supports: Product requirements for piping hangers and supports for placement by this section.
 - 2. Section 15080 Mechanical Insulation: Product requirements for Piping Insulation for placement by this section.
 - 3. Section 15120 – Piping Specialties.

1.2 REFERENCES

- A. ASME (American Society of Mechanical Engineers) - Boiler and Pressure Vessel Codes, SEC IX - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
- B. ASME B16.18 (American Society of Mechanical Engineers) – Cast Copper Alloy Solder Joint Pressure Fittings.
- C. ASME B16.22 (American Society of Mechanical Engineers) – Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- D. ASME B31.9 (American Society of Mechanical Engineers) - Building Services Piping.
- E. ASME SEC VIII-D (American Society of Mechanical Engineers) - Boilers and Pressure Vessels Code, Rules for Construction of Pressure Vessels.
- F. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- G. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- H. ASTM F708 - Design and Installation of Rigid Pipe Hangers.
- I. AWS A5.8 (American Welding Society) - Brazing Filler Metal.
- J. MSS SP58 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Pipe Hangers and Supports - Materials, Design and Manufacture.
- K. MSS SP69 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Pipe Hangers and Supports - Selection and Application.

- L. MSS SP89 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Pipe Hangers and Supports - Fabrication and Installation Practices.
- M. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- N. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- O. ASTM B32 - Solder Metal.
- P. ASTM B88 - Seamless Copper Water Tube.
- Q. AWS D1.1 (American Welding Society) - Structural Welding Code.

1.3 SYSTEM DESCRIPTION

- A. The heating water system contains glycol.
- B. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- C. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
- D. Use ¾-inch gate valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.

1.4 SUBMITTALS

- A. General: Provide submittal procedures according to Conditions of Contract and Division 1 Specifications Sections.
- B. Product Data: Submit data on pipe materials, pipefittings, valves, insulation, equipment, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.
- C. Manufacturer's Installation Instructions: Provide complete installation instructions.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of valves, equipment and heating accessories.

- B. Operation and Maintenance Data: Submit instructions for installation and changing components, spare parts lists, exploded assembly views.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Fabricator or Installer: Company specializing in performing WORK of this section with minimum three years documented experience approved by manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Particular care shall be taken in storage and handling of such materials to maintain its clean condition. Provide temporary end caps and closures on piping and fittings until ready for immediate use. Maintain in place until installation. Store piping in clean, enclosed from weather, location at all times. Piping is not to be stored in direct contact with dirty surfaces or on dirt floor. If piping and components are found to be improperly stored they shall be removed from the project immediately and new materials shall be used.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system Protect

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Do not install underground piping when bedding is wet or frozen.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.1 HEATING WATER PIPING, ABOVE GROUND

- A. Copper Tubing: ASTM B88, Type L hard drawn. (Up to and Including 3-inches size)
 - 1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
 - 2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F. Mechanical press fit joint with gasket equivalent to PROGRESS acceptable.

- B. Steel Pipe: ASTM A53, Schedule 40, black.
 - 1. Fittings: ASTM B16.3, malleable iron or ASME A234, forged steel welding type.
 - 2. Joints: Threaded for piping 2-inches and under. AWS D1.1, welded for pipe over 2-inches.

2.2 STRAINERS

- A. Manufacturers:
 - 1. Hoffman.
 - 2. Spiray/Sarco
 - 3. Mueller.
- B. Size 2 inch and Under:
 - 1. Screwed brass or iron body for 125 psig working pressure, Y pattern with 1/32 inch removable stainless steel perforated screen.
- C. Size 2-1/2 inch to 4 inch:
 - 1. Flanged iron body for 125 psig working pressure, Y pattern with 3/64 inch removable stainless steel perforated screen.

2.3 EQUIPMENT DRAINS AND OVERFLOWS

- A. Copper Tubing: ASTM B88, Type DWV hard drawn.
 - 1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
 - 2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.

2.4 CHEMICAL FEED UNITS

- A. Manual Shot Feeders: Vertical unit wide mouth top and bottom drain. For introduction of batch chemicals and glycol into a closed loop water system. Complete unit with isolation valves on inlet and outlet, air purge and drain connections, funnel. Working pressure up to 250 psi. Capacities: 5 gallon.
- B. Provide propylene glycol for refill of heating water system, approximately 40 gallons of propylene glycol required. Verify quantity on-site.
- C. Provide testing kit in waterproof case with minimum of five years of materials of semi annual testing.

2.5 UNIONS, FLANGES, AND COUPLINGS

- A. Unions for Pipe 2 inches and Under:

1. Ferrous Piping: 150 psig malleable iron, threaded.
2. Copper Pipe: Bronze, soldered joints.

B. Flanges for Pipe Over 2 inches:

1. Ferrous Piping: 150 psig forged steel, slip-on.
2. Copper Piping: Bronze.
3. Gaskets: 1/16-inch thick preformed neoprene.

C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.6 FIRE STOP SYSTEMS

A. Manufacturers:

1. Hilti.
2. Dow Corning.
3. Fyre Putty.

B. General Purpose Fire Stopping Sealant: Water based, non-slumping, premixed sealant with intumescent properties, rated for 3 hours per ASTM E814 and UL 1479.

C. General Purpose Vibration Resistant Fire Stopping Sealant: Silicone based, non-slumping, premixed sealant with intumescent properties, vibration and moisture resistant, rated for 3 hours per ASTM E814 and UL 1479.

D. Fire rated Stuffing: Non-combustible mineral wool insulation.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- E. After completion, fill, clean, and treat systems.

3.2 INSTALLATION

- A. See plans for information on existing piping material. Install similar piping type as specified hereunder for each system. Install dielectric unions where required for connection to dissimilar materials.
- B. Route piping parallel to building structure and maintain gradient of 1/4 inch per ten feet of length. Arrange to drain at low points.
- C. Install piping to conserve building space, and not interfere with use of space.
- D. Group piping whenever practical at common elevations.
- E. Coordinate piping locations with all trades.
- F. Sleeve pipe passing through partitions, walls and floors.
- G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- H. Branch piping connected to sides of mains. Connections off of top or bottom not permitted. When approved by the Engineer, branch piping may be connected to side of mains at a 45-degree angle when limited by space.
- I. Sleeve pipes as required by Section 15060 – Hangers and Supports.
- J. Seal penetrations as required by Section 15060 – Hangers and Supports.
- K. Where piping penetrates 1-hour wall, run insulation through penetration. Seal penetration with fire stopping insulation and seal with fire stopping sealant. If sleeve is used as required in concrete penetrations, seal opening between pipe and sleeve with fire stopping insulation and seal with fire stopping sealant. Seal as required by manufacturers UL fire rated assembly listing.
- L. Provide chrome plated escutcheons at all exposed, uninsulated piping penetrations through walls, floors, ceilings, partitions, and structural components.
- M. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 15060 – Hangers and Supports and 15080 – Mechanical Insulation.
- N. Provide access doors where valves and fittings are not exposed or accessible.
- O. Slope piping at 1/4" per 10' and arrange systems to drain at low points.
- P. Prepare uninsulated pipe, fittings and supports ready for finish painting. Refer to Division 9
- Q. Piping Tests: All heating piping tested hydrostatically at 125 psi for a minimum of four hours. System shall remain tight for test period without leaks, displacement, or straining. Equipment, gages, and thermometer wells rated for a lesser pressure suitably protected during tests. Leaks developed during tests shall be corrected without caulking and test restarted until a perfectly tight system is obtained. Enclosed piping tested before concealing. Tests performed in presence of OWNER.

- R. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.
- S. Install valves with stems upright or horizontal, not inverted.

END OF SECTION 15180

SECTION 15190 - FUEL PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes piping, oil day tank, and appurtenances for the fuel oil piping system.
- B. Related Sections:
 - 1. Drawings and general provisions of the Contract, including General, Supplementary Conditions, and all Division Specification Sections, apply to this Section.

1.2 REFERENCES

- A. ASME B16.18 (American Society of Mechanical Engineers) - Cast Copper Alloy Solder-Joint Pressure Fittings.
- B. ASME B16.22 (American Society of Mechanical Engineers) - Wrought Copper and Bronze Solder-Joint Pressure Fittings
- C. ASME B16.26 (American Society of Mechanical Engineers) - Cast Bronze Fittings for Flared Copper Tubes.
- D. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- E. AWS A5.8 (American Welding Society) - Brazing Filler Metal.
- F. NFPA 30 (National Fire Protection Association) - Flammable and Combustible Liquids Code.
- G. NFPA 31 (National Fire Protection Association) - Installation of Oil Burning Equipment.
- H. UL 142 (Underwriters Laboratories, Inc.) - Steel Aboveground Tanks for Flammable and Combustible Liquids.

1.3 SUBMITTALS

- A. General: Provide submittal procedures according to Conditions of Contract and Division 1 Specifications Sections.
- B. Shop Drawings: Indicate tanks, system layout, pipe sizes, location, tappings, controls and elevations. Manufacturer to provide wiring diagrams for specific project detailing all accessories.
- C. Product Data: Submit data on pipe materials, pipe fittings, valves and accessories. Provide manufacturers catalog information and warranty data. Indicate valve data and ratings.

1.4 CLOSEOUT SUBMITTALS

- A. See Division 1 for specific requirements regarding: Closeout procedures.
- B. Project Record Documents: Record actual locations of valves, piping system, storage tanks, and system components.
- C. Operation and Maintenance Data: Submit installation instructions, spare parts lists, exploded assembly views, day tank. Submit wiring diagrams for the specific day tank. Provide complete operating instructions and completed warranty information.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with NFPA 30 and NFPA 31.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. See Division 1 for specific requirements regarding: Product storage and handling requirements.
- B. Accept valves on site in shipping containers with labeling in place. Inspect all equipment for damage.
- C. Protect piping and fittings from soil and debris with temporary end caps and closures. Maintain in place until installation. Provide temporary protective coating on cast iron and steel valves.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Do not install underground piping when bedding is wet or frozen.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 WARRANTY

- A. See Division 1 for specific requirements regarding: Product warranties and product bonds.

PART 2 - PRODUCTS

2.1 ABOVEGROUND FUEL OIL PIPING AND VENT PIPING

- A. Steel Pipe, ASTM A53 or ASME B36.10 Schedule 40 black.
 - 1. Fittings: ASTM B16.3, malleable iron, or ASTM A234/A234M wrought carbon steel and alloy steel welding type.
 - 2. Joints: NFPA 30, threaded.

2.2 FLANGES, UNIONS, AND COUPLINGS

- A. Pipe Size 2 inches and Under: Ferrous pipe: 150-psi malleable iron threaded unions.

2.3 PIPE HANGERS AND SUPPORTS

- A. Wall, Floor and Trench Support: Cast iron pipe clamp
- B. Floor Saddle: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and steel support.

2.4 BALL VALVES

- A. Manufacturers:
 - 1. Nibco.
 - 2. Stockham.
 - 3. Hammond.
- B. MSS SP-110, Class 150, 400 psi CWP, bronze, two piece body, chrome plated brass ball, full port, teflon seats and stuffing box ring, blow-out proof stem, lever handle, threaded ends. Listed for use with fuel oil.

2.5 CHECK VALVES

- A. Manufacturers:
 - 1. Firomatic.
 - 2. Nibco.
 - 3. Milwaukee.
- B. Up to 2 inches: MSS SP-80, Class 150, bronze body and cap, soft neoprene seat, threaded ends. Suitable for tight shutoff

2.6 FUSIBLE VALVES

- A. Manufacturers:
 - 1. Firomatic.
- B. Nonferrous body, with wheel handle and fusible element to close the valve automatically above 165F. Suitable for manual operation. UL Listed.

2.7 FUEL OIL SYSTEM SPECIALTIES

- A. Vent Cap: Screened air vent for downward venting, T design. Cast-iron construction with screened outlets. Similar to Emco A-0785, Clay & Bailey 300.

2.8 DAY TANK

- A. Manufacturers:
 - 1. Simplex Model SST.
- B. Complete Unit consisting of welded steel tank, pump and motor, gage, float switches, tappings, and controls. With vent, inlet, overflow, oil suction, oil return, and drain tappings. Three oil supply tappings and drop tubes are required. One oil return tapping and drop tube is required. Control panel mounted on the top of the tank, containing gage, control switch, press-to-test-button, and indicating lights for low fuel, power on, pump running, and overflow. Unit prewired and internally piped. Tank epoxy coated inside and painted outside. Tank capacity for 50 gallons. 1800 rpm maximum motor. Supply pump direct connected, to deliver 2 gpm. Overflow pump to deliver 7-1/2 gpm. Motor for 120 volt single power. Maximum of 1/2 hp. Explosion-proof motor.
- C. Controls: Manual starter with ON-OFF switch on cover located on mounting board. Float switch in tank to operate oil pump and normally closed solenoid shutoff valve to maintain liquid level in tank. Float switch in tank to activate light for high liquid level in tank. At high level, overflow pump to operate. Float switch in tank for low liquid level to operate light and to operate buzzer located on boiler room. Buzzer and required relay is included hereunder including all necessary wiring and installation. Connection required for automatic controls monitoring of high and low level alarms. Responsibility for extra contacts hereunder. Coordinate with Automatic Controls for connection.
- D. Responsibility for complete and operating system, including wiring and installation of all accessories, lights, buzzers, alarms, etc. not covered in ELECTRICAL WORK is included hereunder. Coordinate with Electrical.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. See Division 1 for specific requirements regarding: Coordination and project conditions.

3.2 PREPARATION

- A. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION

- A. General:
 - 1. Install in accordance with manufacturers recommendations and installation instructions for complete conformance with warranty requirements. Complete written verification of compliance and submit to tank manufacturer in accordance with warranty requirements. Submit duplicate to OWNER and in O&M manuals.
 - 2. Install in accordance with Alaska Department of Environmental Conservation and EPA standards and requirements.
 - 3. Install vacuum gages with 1/4 inch needle valve or ball valve.
 - 4. Provide instruments with scale ranges selected according to service with largest appropriate scale. Normal measurement point to be mid scale.
 - 5. Adjust gages to final angle, clean windows and lenses, and calibrate to zero.
 - 6. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
 - 7. Route piping in orderly manner and maintain gradient.
 - 8. Install piping to conserve building space and not interfere with use of space.
 - 9. Group piping whenever practical at common elevations.
 - 10. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
 - 11. Sleeve pipes through concrete foundation walls.
 - 12. Provide access to valves and fittings.
 - 13. Install valves with stems upright or horizontal, not inverted.
 - 14. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.
 - 15. CONTRACTOR shall deliver to OWNER and provide copy for O&M manuals completed warranty information and certification.
 - 16. Install permanent metal threaded caps in place of all unused ports on day tank and where day tank manufacturer provided only plastic caps.
- B. Fuel Oil Piping

1. Apply joint compound, similar to Permatex No. 2, to male threads. Teflon tape not allowed.
2. Test piping under vacuum exceeding 20 inches of mercury or under pressure exceeding 50 psig. Piping shall remain under test for three hours without leakage.

C. Specialties

1. Oil tank gage rod stored in Mechanical Room.
2. Day tank installed in strict accordance with manufacturer's instructions.

D. Building Automation System

1. Day Tank: BAS Contractor shall display high and low level alarms on graphics system. Provide all necessary contacts for BAS system as required. Assist Control Contractor as required.

END OF SECTION 15190

SECTION 15510 - HEATING BOILERS AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes boilers, controls and boiler trim, hot water connections, fuel burning system and connections, and chimney connections.
- B. Related Sections:
 - 1. Division 3 – Cast-in-Place Concrete: Execution requirements for concrete housekeeping pads specified by this section.
 - 2. Section 15140 – Domestic Water Piping: Execution requirements for cold water piping connections to boilers specified by this section.
 - 3. Section 15120 - Piping Specialties: Product requirements for pressure gages required by this section.
 - 4. Section 15180 – Heating Piping: Execution requirements for hot water piping for piping connections to boilers specified by this section.
 - 5. Section 15190 – Fuel Piping: Execution requirements for oil piping connections to boilers specified by this section.

1.2 REFERENCES

- A. ASME SEC IV (American Society of Mechanical Engineers) - Boiler and Pressure Vessels Code - Rules for Construction of Heating Boilers.
- B. ASME SEC VIII DIV 1 (American Society of Mechanical Engineers) - Boilers and Pressure Vessels Code - Rules for Construction of Pressure Vessels.
- C. NFPA 31 (National Fire Protection Association) - Installation of Oil Burning Equipment.
- D. UL 726 (Underwriters Laboratories, Inc.) - Oil-Fired Boiler Assemblies.

1.3 SUBMITTALS

- A. See Division 1 for specific requirements regarding: Contractor Submittals: Submittal procedures.
- B. Product Data: Submit general layout and dimensions. Include size and location of water, fuel, electric and vent connections, electrical characteristics, weight and mounting loads.

- C. Test Reports: Indicate specified performance and efficiency is met or exceeded. Provide combustion test that includes boiler firing rate, over fire draft, heat input, burner manifold gas pressure, percent carbon monoxide (CO), percent carbon dioxide (CO₂) percent oxygen (O), percent excess air, flue gas temperature at outlet, ambient temperature, net stack temperature, percent stack loss, percent combustion efficiency, nozzle data and heat output.
- D. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Manufacturers Field Reports: Indicate condition of equipment after start-up including control settings and performance chart of control system.

1.4 CLOSEOUT SUBMITTALS

- A. See Division 1 for specific requirements regarding: Project Close-out: Closeout procedures.
- B. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.

1.5 QUALITY ASSURANCE

- A. Conform to ASME SEC IV and UL 726 for construction of boilers.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc., as suitable for the purpose specified and indicated.
- C. Perform Work in accordance with State standard and requirements.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Accept boilers and accessories on site in factory shipping packaging. Inspect for damage.
- B. Protect boilers from damage by leaving packing in place until installation.

1.8 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.9 MAINTENANCE SERVICE

- A. Provide service and maintenance of boilers, burners, trim, and controls for one year from Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 BOILERS

- A. Manufacturers:

1. Weil McClain WTGO.
2. Substitutions: Meet specifications.

- B. Boiler

1. General: Forced draft boiler with insulated jacket, sectional cast iron heat exchanger, fuel oil burning system, refractory and controls and boiler trim.
2. Provide water wall design consisting of water backed combustion area with water circulating around firebox.
3. Fabrication:
 - a. Assembly: Cast iron sections with 30 psig water ASME Boilers and Pressure Vessels Code rating, assembled with push nipples or gaskets and draw rods.
 - b. Provide access for flue passages for cleaning and flame observation ports.
 - c. Jacket: Glass fiber insulated steel jacket, finished with factory applied baked enamel.

- C. Boiler Trim

1. ASME rated pressure relief valve, 30 psig.
2. Water pressure gage. Combination pressure and temperature gage not acceptable. Scale on pressure gage shall be graduated from 1-1/2 to 3 times the pressure relief valve set pressure. 4-inch diameter stainless steel ring and case, bronze tube, brass or bronze movement, brass socket. Front calibration. One percent accuracy. 0-60 psi.
3. Temperature Gage.
4. Burner pressure gage. 4-inch diameter stainless steel ring and case, bronze tube, brass or bronze movement, brass socket. Front calibration. One percent accuracy. 0-400 psi.
5. Electronic float type low water cut-off to prevent burner operation when boiler water falls below safe level. McDonnell Miller. Provide with McDonnell Miller TC4 test-n-check assembly.

6. Operating temperature controller with high and low temperature setpoints. Set to fire at 180F and shutoff at 200F.
7. High limit temperature controller with automatic reset for burner to prevent boiler water temperature from exceeding safe system temperature. Set at 210°F. Honeywell L4006 Series or equal.
8. Extra High limit temperature controller with manual reset for burner to prevent boiler water temperature from exceeding safe system temperature. Set at 225°F. Honeywell L4006 Series or equal.

D. Fuel Oil Burner

1. Burner Operation: Low-Hi-Low fire for ignition. Two position air damper.
2. Oil Burner: High pressure atomizing type for No. 1 or No. 2 fuel oil with combustion air blower, fuel pump, hinged flame inspection port, cadmium sulfide flame sensor, electrodes, ignition transformer, and oil nozzle.
3. Fuel Filter: Filter to be renewable. General 2A-700 or equal.
4. Oil Burner Safety Controls: Energize burner motor and electric ignition, limit time for establishment of main flame, monitor flame continuously during burner operation and stop burner on flame failure with manual reset necessary, solenoid oil delay valve opens after burner motor energized and closes when de-energized.
5. Controls: Pre-wired, factory assembled electronic controls in control cabinet with flame scanner or detector, programming control, relays, and switches. Provide pre-purge and post-purge ignition and shut down of burner in event of ignition pilot and main flame failure with manual reset.
6. Electrical Characteristics
 - a. Division 16: Requirements for electrical characteristics.
 - 1) 1/2 hp
 - 2) 120 volts, single phase, 60 Hz.

E. Boiler Performance

1. See Schedules.
2. DOE seasonal efficiency (AFUE) (Annual Fuel Utilization Efficiency): 82 percent.

- F. Boiler Control: Automatic control by BAS Contractor. Operating and high limit aquastats, low water cutoff, and other safeties by Boiler Manufacturer and installed by Mechanical Contractor. Manual/Auto Switch provided and installed by Automatic Controls Contractor.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with NFPA 31. Provide 30" x 24" minimum size steel drip pan with 1" high welded sides, under the burner. Provide for connection to electrical service. Refer to Division 16.

- B. Install boiler on concrete housekeeping base, minimum 3-1/2 inches high and 6 inches larger on each side than boiler base. Secure to pad in conformance with Seismic Zone 3 requirements.
- C. Provide connection of fuel oil service in accordance with NFPA 31. Provide piping connections and accessories as indicated; refer to Sections 15060, 15120, 15140, 15180, and 15190. Pipe relief valves and drain valves to nearest floor drain. Low water cut off installed above the top of the boiler.
- D. Install burner pressure gage with gage cock.

3.2 DEMONSTRATION AND TRAINING

- A. Demonstrate operation and maintenance procedures.
- B. Provide minimum 2 hours on boiler/burner training.

END OF SECTION 15510

SECTION 15550 - CHIMNEYS

PART 1 - GENERAL

1.1 REFERENCES

- A. NFPA 31 (ANSI Z95.1) (National Fire Protection Association) - Standard for the Installation of Oil Burning Equipment.
- B. UL 103 (Underwriters Laboratories, Inc.) - Standard for Factory Built Low Heat Chimneys.
- C. SMACNA (Sheet Metal and Air Conditioning Contractors' National Association) – Guide for Steel Stack Construction.

1.2 DEFINITIONS

- A. Breeching: Vent Connector.
- B. Chimney: Primarily vertical shaft enclosing at least one vent for conducting flue gases outdoors.
- C. Vent Connector: That part of a venting system that conducts the flue gases from the flue collar of an appliance to a chimney or vent, and may include a draft control device.

1.3 DESIGN REQUIREMENTS

- A. Factory built vents, breechings, and chimneys used for venting natural draft appliances or negative pressure applications shall be UL listed and labeled. Site construction, existing conditions, and measurements provided to factory engineer by Contractor.

1.4 SUBMITTALS

- A. Shop Drawings: Indicate general construction, dimensions, weights, support and layout of breeching. Submit layout drawings indicating plan view and elevations. Factory Engineer to design and provide proper sizing, layout, supports, and fittings for each specific application. Submit calculations of specific layout.
- B. Product Data: Submit data indicating factory built chimneys, including dimensional details of components and flue caps, dimensions and weights, electrical characteristics and connection requirements

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.6 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.1 CHIMNEY

- A. Manufacturers (Positive Pressure – 1-inch Insulation):
 - 1. Selkirk MetalBestos Model SS.
 - 2. Ampco.
 - 3. Schebler
 - 4. No Substitutions.
- B. Provide double wall metal chimney, tested and UL listed, for use with building heating equipment, in compliance with NFPA 211.
- C. Fabricate with 1-inch airspace between walls. Construct inner jacket of 20 gage ASTM A167 Type 304 or Type 316 stainless steel. Construct outer jacket of 24 gage Type 316 stainless steel. Outer jacket may be aluminized steel when enclosed in shaft and in Boiler Room. Outer jacket and all components must be stainless steel Type 316 exposed outdoors.
- D. Accessories, UL labeled, fabricated of same materials as chimney:
 - 1. Support System.
 - 2. Cleanout Cap: Manifold Tee, Reducer, 90 degree elbow.
 - 3. Stack Cap: Stainless Steel.
 - 4. 45 degree entry tee for Boiler #2.
 - 5. Storm flashing and counterflashing.
 - 6. Wall penetration and guide assemblies, wall support assemblies.
 - 7. Drain Section. Cleanout cap with tee.
 - 8. Appurtenances as required to install system required.
 - 9. Extend chimney up to a minimum 6 feet height above m roof. Provide stainless steel rods and reinforcement as required and recommended by manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with NFPA 31.
- B. Install breeching with minimum of joints. Align accurately at connections, with internal surfaces smooth.
- C. Install and secure chimney with support secured to roof and wall structure rigidly with suitable guys, ties, braces, hangers and anchors as designed by manufacturer. Chimney supported as necessary from structure.

- D. Pitch chimney connectors with positive slope up from fuel-fired equipment to vertical chimney.
- E. Level and plumb chimney.
- F. Clean breeching and chimneys during installation, removing dust and debris.
- G. At appliances, provide slip joints permitting removal of appliances without removal or dismantling of breeching, breeching insulation, or chimneys.
- H. A drain at bottom of chimney is required. Run drain to floor sink.
- I. Install flashing to roof surfaces as detailed and required.
- J. Chimneys higher than four feet above roof surface to be secured to roof with minimum of two guy bracings per manufacturers instructions.
- K. Coordinate with boilers and arrangement on-site prior to designing and procuring chimney system. Coordinate with Factory Engineer for all actual on-site dimensions.
- L. Maintain clearances to combustibles as required by manufacturer.

END OF SECTION 15550

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes metal ductwork and casing and plenums.
- B. Related Sections:
 - 1. Section 15060 – Hangers and Supports: Product requirements for hangers, supports and sleeves for placement by this Section.

1.02 REFERENCES

- A. ASTM A36 - Structural Steel.
- B. ASTM A90 - Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.
- C. NFPA 90A (National Fire Protection Association) - Installation of Air Conditioning and Ventilating Systems.
- D. NFPA 90B (National Fire Protection Association) - Installation of Warm Air Heating and Air Conditioning Systems.
- E. SMACNA (Sheet Metal Air Conditioning Contractors' National Association) - HVAC Air Duct Leakage Test Manual.
- F. SMACNA (Sheet Metal Air Conditioning Contractors' National Association) - HVAC Duct Construction Standards - Metal and Flexible.
- G. UL 181 (Underwriters Laboratories, Inc.) - Factory-Made Air Ducts and Connectors.

1.03 SUBMITTALS

- A. General: Provide submittal procedures according to Conditions of Contract and Division 1
- B. Product Data: Submit data for duct materials, duct fittings, duct construction, duct connectors.
- C. Product Data: Submit data for duct materials, duct fittings, duct construction, access doors, and duct connectors.

1.04 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.05 QUALITY ASSURANCE

- A. Perform WORK in accordance with SMACNA - HVAC Duct Construction Standards - Metal and flexible.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing WORK of this section with minimum three years documented experience.
- C. All sheet metal workers shall have a minimum documented sheet metal fabrication and installation experience in commercial or industrial facilities of 3 years or be enrolled in an Alaska Department of Labor approved Sheet Metal Apprentice program. The ratio of on-site workers shall not exceed 3 apprentices or sheet metal workers for every one foreman. A foreman is defined as a sheet metal worker with minimum 3 years experience as detailed above or is an approved Journeyman.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Do not install duct sealant or metal foil tape when temperatures are less than those recommended by manufacturers.
- B. Maintain temperatures during and after installation of duct sealant or metal foil tape.
- C. Particular care shall be taken in storage and handling of such materials to maintain its clean condition. Provide temporary end caps and closures on ductwork and fittings until ready for immediate use. Maintain in place until installation. Store ductwork in clean, enclosed from weather, location at all times. Ductwork is not to be stored in direct contact with dirty surfaces or on dirt floor. If ductwork and components are found to be improperly stored they shall be removed from the project immediately and new materials shall be used.

1.08 PERFORMANCE REQUIREMENTS

- A. No variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is permitted except by written permission.

1.09 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.01 DUCT MATERIALS

- A. Manufacturers:
 - 1. Acme Manufacturing Co.
 - 2. Semco
 - 3. United McGill Sheet Metal
- B. Galvanized Steel Ducts: ASTM A525 and ASTM A527 galvanized steel sheet, lock-forming quality, having G60 zinc coating in conformance with ASTM A90.
- C. Fasteners: Rivets, bolts, or sheet metal screws.
- D. Hanger Rod: ASTM A36; steel or continuously threaded.

2.02 DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- B. Construct T's, bends, and elbows with minimum radius 1-1/2 times centerline duct width. Where not possible and where rectangular elbows are used, provide airfoil-turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fiber insulation.
- C. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- D. Flanged closures must be SMACNA "J" rated with minimum 1-3/8 inch flange. Flange shall be gasketed. Corners bolted. Metal cleat for application around perimeter of transverse joint.
- E. Transverse joints: Ductmate proprietary duct connections will be accepted. Ductwork constructed using these systems will refer to manufacturers guidelines for sheet gage, intermediate reinforcement size and spacing, and joint reinforcement. TDF shall be constructed in accordance with SMACNA – HVAC Duct Construction Standards Manuals T-24 flange. Basis for evaluating a substitution shall be Ductmate Joining System, all steel construction. Ductmate system shall utilize minimum 20 gage steel companion angles, 12 gage steel corner pieces, and an integral polymer mastic seal. Acceptable joining systems: Ductmate 35, Nexus, Accuct, or TDF. TDC is not acceptable.
- F. Longitudinal seams and fitting: Pittsburgh lock or snap lock shall be used on all longitudinal seams. Use Pittsburgh only on fittings, snap lock is not acceptable.

2.03 DUCT, CASING AND PLENUM SEALANTS

- A. Foil Tape: 2-mil aluminum foil self-adhesive tape. Similar to Fasson, Polyken.
- B. Sealant: UL listed vinylacrylic or copolymer based duct sealer. Similar to Durodyne DDS-181, Uni-mastic 181.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify sizes of equipment connections before fabricating transitions.

3.02 INSTALLATION

- A. Install and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible. See Section 3.2.D. for requirements. Use double nuts and lock washers on threaded rod supports.
- B. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system. Check daily or more frequently that sealing of ducts is intact.
- C. Duct Sealing:
 - 1. Seal all longitudinal and latitudinal joints of metal ducts with foil tape or two coats of sealant. Apply sealant in accordance with manufacturer's recommendations. Apply second coat of sealant after first coat has completely cured. Inspect seams with ductwork pressurized and reapply as required for an airtight application.

3.03 SCHEDULES

- A. Ductwork Material Schedule
 - 1. Equipment and Material
 - a. Supply Fan AHU: Steel
- B. Ductwork Pressure Class Schedule
 - 1. Air System Pressure Class
 - a. Supply Fan AHU: 2 inch wg

END OF SECTION 15810

SECTION 15950 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes testing, adjusting, and balancing of air and hydronic systems, measurement of final operating condition of HVAC systems.
- B. Scope of Work: Adjust and balance each of the three duct booster coils ducts but not individual grilles. Adjust and balance building hydronic systems. Existing adjustment dampers may not be shown. Flow rates for all hydronic systems are shown on the schedules. Coordinate with contract document requirements.
- C. Related Sections:
 - 1. Drawings and general provisions of the Contract, including General, Supplementary Conditions, and all Division Specification Sections, apply to this Section.

1.2 REFERENCES

- A. ASHRAE 111 (American Society of Heating, Refrigerating and Air-Conditioning Engineers) - Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-conditioning, and Refrigeration Systems.
- B. NEBB (National Environmental Balancing Bureau) - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

1.3 SUBMITTALS

- A. General: Provide submittal procedures according to Conditions of Contract and Division 1 Specifications Sections.
- B. Test Reports: Indicate data on forms prepared following NEBB Report forms.
- C. Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
- D. Prior to commencing WORK, submit report forms or outlines indicating adjusting, balancing, and equipment data required.
- E. Submit draft copies of report for review prior to final acceptance of Project. Upon completion of WORK if balancing report submittal is not approved, all return trips to site for additional WORK and resubmittal of report to meet specified parameters shall be done at no additional cost to the OWNER. Provide final copies for ARCHITECT and for inclusion in operating and maintenance manuals.

- F. Provide reports in soft cover, letter size, binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
- G. Include detailed procedures, agenda, sample report prior to commencing system balance.

1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of flow measuring stations, balancing dampers and flow setters.

1.5 QUALITY ASSURANCE

- A. Perform WORK in accordance with NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.
- B. Certificates of current calibration of equipment submitted prior to adjustment.

1.6 QUALIFICATIONS

- A. Agency: Company specializing in the testing, adjusting, and balancing of systems specified in this section with minimum three years documented. Provide documentation with references meeting experience requirements for approval.

1.7 SEQUENCING

- A. Sequence balancing between completion of systems tested and Date of Substantial Completion.
- B. Coordinate adjustment with building automation control system (BAS) Subcontractor. BAS Subcontractor and controls contractor shall be on-site throughout adjustment to operate controls for all required testing scenarios.

1.8 SCHEDULING

- A. See Division 1 for specific requirements regarding: Coordination and project conditions.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that systems are complete and operable before commencing WORK. Ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Filters have been replaced immediately prior to adjustment of air systems.
 - 5. Duct systems are clean of debris.
 - 6. Fans are rotating correctly.
 - 7. Air coil fins are cleaned and combed.
 - 8. Access doors are closed and duct end caps are in place.
 - 9. Air outlets are installed and connected.
 - 10. Duct system leakage is minimized.
- B. Submit field reports. Report defects and deficiencies noted during performance of services, which prevent system balance.

3.2 PREPARATION

- A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to ARCHITECT to facilitate spot checks during testing.

3.3 INSTALLATION TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 5 percent of design.
- B. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.4 ADJUSTING

- A. Adjust building HVAC system including existing air handling units, and all heating units as shown on the drawings and as directed in Article 1.1 SUMMARY above.
- B. Assist Automatic Control Contractor with differential setpoints and measurements, minimum flow rates, etc.
- C. Ensure recorded data represents actual measured or observed conditions.
- D. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

- E. Make all necessary changes to fan sheaves and belts, including procurement, to achieve design conditions.
- F. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- G. Final measurements shall be taken and recorded after systems have been completely adjusted.
- H. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.5 ADJUSTMENT PROCEDURE

A. Specific Requirements:

- 1. Notify the ARCHITECT seven days prior to beginning WORK at the site. Provide a schedule of when each phase of the WORK will be performed and when inspection by the ARCHITECT will be required. As the WORK proceeds, provide the ARCHITECT daily progress updates.
- 2. Notify the ARCHITECT of locations where objectionable noise is generated by the mechanical systems prior to completing adjustment.
- 3. Inspection: The Adjustment Subcontractor shall not conclude WORK at the site until the ARCHITECT has inspected the WORK. Minimum of two weeks notice is required.
 - a. Provide personnel and equipment to verify to the ARCHITECT that the systems are adjusted properly. The BAS Subcontractor shall be on-site during the inspection.
 - b. Disapproval of the adjustment submittal by the ARCHITECT will require readjustment by the CONTRACTOR and re-inspection at no additional cost to the OWNER.
 - c. Inspection Requirements: The systems will be checked by the CONTRACTOR with the ARCHITECT present for proper adjustment at each of the required adjustment procedures.

B. Air System Procedures

- 1. General
 - a. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities.
 - b. Make air quantity measurements in main ducts by pitot tube traverse of entire cross sectional area of duct in accordance with NEEB Requirements.
 - c. Adjustment and inspection of the air systems shall occur with all doors and windows closed and all ceiling tiles in place.
 - d. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
 - e. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

- f. Perform duct traverses at booster coils and at outside air inlet.
- 2. AHU Adjustment: Perform in the following sequence.
 - a. Achieve the design flow rates for all outlets.
 - 1) AHU: Adjust the sheave so that design cfm is achieved.

C. Water System Procedure

- 1. General
 - a. Adjust water systems, after air balancing, to provide design quantities.
 - b. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow-metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
 - c. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
 - d. Effect system balance with automatic control valves fully open or in normal position to heat transfer elements.
 - e. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
 - f. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.
- 2. Pumps:
 - a. Adjust for design GPM.
 - b. Measure pressure difference across pump.

3.6 REPORT FORMS

- 1. Title Page:
 - a. Name of Testing, Adjusting, and Balancing Agency
 - b. Address of Testing, Adjusting, and Balancing Agency
 - c. Telephone and facsimile numbers of Testing, Adjusting, and Balancing Agency
 - d. Project name
 - e. Project location
 - f. Project Architect
 - g. Project Engineer
 - h. Project Contractor
 - i. Project altitude
 - j. Report date

2. Summary Comments:
 - a. Design versus final performance
 - b. Notable characteristics of system
 - c. Description of systems operation sequence
 - d. Summary of outdoor and exhaust flows to indicate amount of building pressurization
 - e. Nomenclature used throughout report
 - f. Test conditions

3. Instrument List:
 - a. Instrument
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Range
 - f. Calibration date

4. Electric Motors:
 - a. Manufacturer
 - b. Model/Frame
 - c. HP/BHP and kW
 - d. Phase, voltage, amperage; nameplate, actual, no load
 - e. RPM
 - f. Service factor
 - g. Starter size, rating, heater elements
 - h. Sheave Make/Size/Bore

5. V-Belt Drive:
 - a. Identification/location
 - b. Required driven RPM
 - c. Driven sheave, diameter and RPM
 - d. Belt, size and quantity
 - e. Motor sheave diameter and RPM
 - f. Center to center distance, maximum, minimum, and actual

6. Pump Data:
 - a. Identification/number
 - b. Manufacturer
 - c. Size/model
 - d. Impeller
 - e. Service
 - f. Design flow rate, pressure drop, BHP and kW
 - g. Actual flow rate, pressure drop, BHP and kW
 - h. Discharge pressure
 - i. Suction pressure

- j. Total operating head pressure
 - k. Shut off, discharge and suction pressures
 - l. Shut off, total head pressure
7. Heating/Booster Coil Data:
- a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Air flow, design and actual
 - f. Water flow, design and actual
 - g. Water pressure drop, design and actual
 - h. Entering water temperature, design and actual
 - i. Leaving water temperature, design and actual
 - j. Entering air temperature, design and actual
 - k. Leaving air temperature, design and actual
 - l. Air pressure drop, design and actual
8. Air Moving Equipment
- a. Location
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Arrangement/Class/Discharge
 - f. Air flow, specified and actual
 - g. Air flow at inlet and outlet of fan unit.
 - h. Return air flow, specified and actual
 - i. Outside air flow, specified and actual
 - j. Return air temperature
 - k. Outside air temperature
 - l. Required mixed air temperature
 - m. Actual mixed air temperature
 - n. Required supply air temperature.
 - o. Actual supply air temperature.
 - p. Design outside/return air ratio
 - q. Actual outside/return air ratio
 - r. Total static pressure (total external), specified and actual
 - s. Inlet pressure
 - t. Discharge pressure
 - u. Sheave Make/Size/Bore
 - v. Number of Belts/Make/Size
 - w. Fan RPM
9. Exhaust Fan Data:
- a. Location
 - b. Manufacturer
 - c. Model number

- d. Serial number
 - e. Air flow, specified and actual
 - f. Total static pressure (total external), specified and actual
 - g. Inlet pressure
 - h. Discharge pressure
 - i. Sheave Make/Size/Bore
 - j. Number of Belts/Make/Size
 - k. Fan RPM
10. Duct Traverse:
- a. System zone/branch
 - b. Duct size
 - c. Area
 - d. Design velocity
 - e. Design air flow
 - f. Test velocity
 - g. Test air flow
 - h. Duct static pressure
 - i. Air temperature
 - j. Air correction factor

END OF SECTION 15950

SECTION 17000 – BUILDING AUTOMATION SYSTEM AND AUTOMATIC CONTROLS

PART 1 - GENERAL

1.1 OVERVIEW

- A. Furnish all labor, materials, equipment, and service necessary for a complete and operating HVAC control system for the Mosquito Lake School in the Haines School District consisting of a Direct Digital Control (DDC) Building Automation System (BAS) for the entire School Building. This project involves the installation of a new direct digital control (DDC) system for the new building addition and replacement of existing electric controls in the existing school. The new system will have (1) local BAS lap top computer with network capability for interface to the building using Ethernet or equivalent type data connections. This specification describes the primary products and performance of the direct digital control system. Associated sequence of operation, descriptions, and schematic control diagrams detail the scope of work for this project.

1.2 QUALITY ASSURANCE

- A. The control Subcontractor shall maintain an office in Juneau or Anchorage with repair parts and maintenance personnel to ensure prompt response to an emergency call during the warranty period. The contractor shall maintain a complete sales, engineering, installation, and service organization.
- B. The control Subcontractor shall hold a license to design and install control systems for that manufacturer.
- C. All work described in this section shall be installed, wired, circuit tested and calibrated by factory trained electricians and mechanics qualified for this work and in the regular employment of the temperature control system manufacturer or its exclusive factory authorized installing contracting field office (representative). The installing office shall have a minimum of five years of installation experience with the manufacturer and shall provide documentation in submittal package verifying longevity of the installing company's relationship with the manufacturer. Installation shall not be subcontracted unless specifically approved in advance. Supervision, calibration and checkout of the system shall be by the employees of the local exclusive factory authorized temperature control contracting field office (branch or representative). The employees of the installing office shall be factory trained with training certification documentation provided in submittal package.
- D. All materials and equipment used shall be standard components, of regular manufacture for this application. All systems and components shall have been thoroughly tested and proven in actual use.
- E. The control Subcontractor shall hold a license to design and install control systems for that manufacturer.

- F. The automatic control system shall be installed by trained, qualified personnel and commissioned by factory trained technicians.

1.3 SYSTEM DESCRIPTION

A. Scope of Work:

1. This specification describes the primary products and performance of the automatic control system. Sequences of operation and the schematic control diagrams shown on Drawings detail the scope of work for this project.
2. The DDC system shall provide stand-alone DDC control for all designated equipment described in the sequence of operation and shown on the control schematics. The distributed DDC equipment shall be networked to Global Digital Controllers located in the High School and connected to the host computer to provide a complete facility management system.
3. The WORK includes installation of a DDC system for the addition and removal of pneumatic devices and equipment as shown and installing new equipment, sensors, and materials for the existing control system including circulating pumps, heating units, and the ventilation systems. New wiring will need to be installed concealed above classroom, corridor, and other occupied room accessible ceilings. Wiring shall be concealed in the vertical drops in the rooms. Where walls prohibit concealing wiring in wall cavities and in Mechanical rooms, wiring shall be installed in surface mount conduit. Thermostats (typically installed at 60-inches above finished floor) shall be replaced with DDC thermostats (adjustable type to be installed at 48-inches above finished floor).
4. Modem communication shall be available for backup if a problem arises with the communication bus.
5. The BAS shall be connected to GDC and lap top host computer for remote monitoring, control and data trending. Location of computer ports shall be coordinated by contractor with Owner.
6. Provide a UPS (Uninterruptible Power Supply) and high quality surge suppressor upstream of the power connection for the DDC system capable of holding all programmed settings and sequences for 36 hours minimum. Provide UPS for each building DDC system as applicable. See Electrical.
7. The BAS system shall be BACnet compatible, capable of remote monitoring and future expansion by any other BACnet compatible DDC system. The BAS system shall also include all elements necessary to monitor, control, and program this system remotely using web based software, Tridium 'VyKion' software or approved equivalent.
8. The control system shall accommodate simultaneous multiple user operation with multiple users having access to all valid data and an operator shall be able to log onto any workstation on the control system. Access to control system data should be limited only by operator password.
9. The control system shall be designed such that each mechanical system will be able to operate under stand-alone control. In the event of a network failure, or the loss of any other controller, the control system shall continue to independently operate under control.

1.4 COORDINATION

- A. Equipment: Control Subcontractor shall supply control equipment for installation by equipment suppliers and Mechanical Subcontractor where required. This includes all control equipment installed in piping systems such as thermostat wells and automatic valves. Control Subcontractor shall also coordinate locations of control equipment, including, but not limited to, thermostats, damper and valve actuators, thermostat bulbs and averaging elements.
- B. During the adjustment of the mechanical systems, air and water, the BAS Subcontractor shall provide a trained technician on-site to help the adjuster with their balancing procedures including any software required to interface with the control sequences. Responsibility for coordination of the times is included under the automatic controls.

1.5 ACCEPTABLE MANUFACTURERS

- A. Alerton (ATS Alaska, Inc.) for Standardization

1.6 SUBMITTALS

- A. Shop drawings of the entire control system shall be submitted and consist of a complete list of equipment and materials, including manufacturer's catalog data sheets and installation instructions. Terminal identification for all control wiring shall be shown on the shop drawings. Prior to installing the automatic control systems, submit the following for review and approval:
 - 1. Control valve and control damper schedules.
 - 2. Product data/specification sheets for control system components and field devices.
 - 3. Control system installation drawings showing the equipment controlled, the locations of field devices, field wiring, layout drawings, riser diagrams, sequence of operation, and bill of materials.
- B. Upon completion of the work, provide a complete set of drawings on compact disc media. Drawings shall be provided as AutoCAD compatible files.

1.7 OPERATION AND MAINTENANCE MANUALS

- A. Operation and maintenance manuals shall be submitted for review and approved before the final inspection and Owner training.
- B. The operation and maintenance manuals shall include the following information:
 - 1. A user's guide to operate the building management system. The guide shall include the following: log on procedure; viewing system information; viewing and acknowledging alarms; changing a setpoint; printing a trend or report; overriding a point.
 - 2. Manufacturers data for all control components and maintenance information for all control components requiring periodic maintenance.
 - 3. Complete system "As-Built" control drawings.
 - 4. Complete software "As-Built" diagrams.

1.8 WARRANTY

- A. A warranty period of one year shall commence upon acceptance of the systems by the OWNER. The warranty shall consist of providing parts and labor as required to repair or replace parts of the control system that prove to be faulty due to defective materials or improper installation practices or troubleshooting control sequences that are not operating as specified. Included is reprogramming of the system software to include changes in the point descriptions as requested by the Owner. This warranty excludes normal routine maintenance.
- B. Operator workstation software, project software, database, and firmware updates shall be provided to the Owner at no additional charge during the warranty period. Written authorization by Owner must, however, be granted prior to the installation of such changes.

1.9 TRAINING

- A. See Article 3.7 for Training.

PART 2 - PRODUCTS

2.1 FACILITY MANAGEMENT SYSTEM HOST STATION SOFTWARE (CHS)

- A. Graphics shall be provided for the Host computer workstation. The software shall provide the following functions and features:
 - 1. Run in a Microsoft Windows operating environment.
 - 2. Provide color graphics of controlled systems, facility wide access and coordination of global control strategies, and centralized documentation.
 - 3. Provide for assigned password names and codes to limit the access into particular applications and functions of the system. Allow discrete menus into the system for each user.
 - 4. Provide dynamic graphics with “system penetration” method of obtaining system information. Provide dynamic graphic screens of mechanical equipment and DDC controlled systems. Maximum of 128 dynamic points displayed on one screen.
 - 5. Provide display and modification of individual dynamic system points from within any specific dynamic graphic display.
 - 6. Provide help window displays for each point displayed on the screen. User editable information specific to the point and its’ relationship to the system currently displayed.
 - 7. Provide centralized scheduling and modification of the time clock functions.
 - 8. Provide alarm management and system exception annunciation with real time trending and reports.
 - 9. CONTRACTOR shall provide a 2 year subscription service for any and all software upgrades that are available from the manufacturer following the final acceptance of the BAS system. Service shall include installation of the software on-site and all necessary equipment to upgrade the system. Copies of the software shall be provided to the OWNER and the Operating and Maintenance manuals shall be updated appropriately.
- B. Dynamic Graphics:

1. Upon entering the graphics program floor plans shall be shown with all terminal equipment locations, ALL room temperatures, and any alarm features at the actual physical locations and not in a tabulated format. The floor plan layout shall be shown accurately and as shown on the contract documents with the actual room numbers listed. Mechanical equipment systems shall have their own screens with all control points, adjustable set points, and alarms shown.
2. The user will be able to zoom in to the building from the site plan and then zoom in to a particular area for closer inspection and then further zoom in on this area and so on until the detailed color graphic display of a desired portion of the facility is represented. The operator shall be able in this manner to "penetrate" to any desired system information without being required to enter any commands via the keyboard. A maximum of 70 dynamic points shall be displayable on any one screen.
3. As a minimum, a graphic screen shall be designed showing the entire facility, each major piece of mechanical equipment within each building, all of which will display the data for each area dynamically.
4. Equipment Diagrams: Provide a diagram of each piece of equipment similar to the schematic diagrams shown on the drawings. Display all monitored points, setpoints, control points, schedules, and alarms. Setpoints and schedules shall be adjustable from the equipment diagram. Provide a colored status indicator for the filters with green indicating clean and red indicating dirty.

C. Centralized Scheduling and Modification:

1. Calendars shall be provided for displaying and modification of any of the Mechanical Systems Controller (MSDCs) time clock functions. The user shall be able to view an entire month's scheduling at a time. Holidays and Special functions shall be clearly marked on the calendar. Calendars shall be displayed by area served. A list of "served areas" shall be displayable at any time by clicking on a button on the calendar. The user shall only have to click on a "served area" to view its time clock schedule. A dynamic graphic shall be attached to each calendar allowing the user to view this "served area's" real time statistics, a link shall be provided on this same graphic screen to take the User back to the schedule.
2. Schedule changes may be made by clicking on a day or week and entering the new schedule. Changes shall be permanent or for "one time" or multiple occurrences of varying parameters. Global changes shall be allowed for similar or dissimilar schedules. There shall be no limit to the number of calendars allowed.

D. Alarm and System Exception Annunciation:

1. All alarms shall be displayed on the main alarm screen and be tied into the fire alarm sequence. Alarms shall be acknowledged by the operator in a manner equal to the existing alarm interface.

E. Trend Management and Reports:

1. The BAS system shall be provided with the ability to trend and produce reports with the new points installed under this project.

2. The CHS shall automatically perform time based periodic collection of real time point data and subsequently store it to the systems hard disk. There shall be two modes of operation; local collection shall allow the CHS to directly query the MSDCs for individual point samples; remote collection shall mean that the MSDCs collect and store trend data on individual points and then release the entire trend table(s) upon a request from the CHS. Manipulation and archiving of both types of data collection shall be treated commonly.
3. The report section of the CHS shall be the "gateway" to the CHS's database for all solicited and unsolicited data collected, and shall provide an easy means of reporting and information management.
4. The report generator shall be an integral part of the CHS, systems that use third party packages (such as Excel) for report manipulation shall not be acceptable.
5. Reports on historical trend data shall allow for daily, weekly, monthly and yearly reporting. These reports shall be completely flexible on the data items to be reported on. The user shall be able to select from a list of predefined reports or select data items on-the-fly. The selection of data items shall not be restricted by panel source. Reports may be up to 25 columns and infinite in length. Reports must be capable of reporting on data that has been collected at varying time intervals. Line interpolation shall be used when data samples are not present for a specific time placement, blank data rows for any time slot in the data columns will not be accepted. Report generator shall allow an operator to easily and quickly define the contents of a report as well as define a print time and date if so desired. Information contained in the reports shall be derived from alarm history, CHS or SDC generated exceptions, trend data and timed overrides.

F. Multi-tasking:

1. The CHS shall be capable of true multi-tasking capabilities. The User shall be able to use other non-related programs in the CHS while still running all CHS applications with no interruptions. This shall include the use of real time data in other applications. This CHS shall allow Spread Sheet programs to gather data from the MSDCs dynamically while running a dynamically updating Graphic screen. Up to 16 applications may collect data dynamically and simultaneously from the MSDCs. The CHS shall have the ability to allow the passing of data freely to MS Windows applications which incorporate the use of Dynamic Data Exchange.

2.2 MECHANICAL SYSTEMS CONTROLLERS (MSDCs)

A. General:

1. Controls shall be microprocessor based, Air Handler Digital Controllers (AHDC's). AHDC's shall be provided for Air Handling Units and pump control, and other applications as shown on the drawings. AHDC's shall be based on a minimum 16 bit microprocessor working from software program memory which is physically located in the AHDC. The application control program shall be resident within the same enclosure as the input/output circuitry which translates the sensor signals. All input/output signal conversion shall be performed through a minimum of a 10 bit A to D converter. All input points shall be universal in nature allowing their individual function definition to be assigned through the application software. All unused input points must be available as universally definable at the discretion of the OWNER. If the input points are not fully universal in nature, unused points must be equal in quantity between Analog Inputs and Digital Inputs.
2. Subcontractor shall provide a minimum of one AHDC controller per air handling system as shown on the drawings.
3. Spare points: AHDC's shall have minimum 10% spare capacity for Analog Inputs and Analog Outputs.
4. The BAS Subcontractor shall provide and field install all AHDC's specified under this section. Mechanical equipment manufacturers desiring to provide AHDC type controls as factory mounted equipment, shall provide a separate bid for their products less all controls, actuators, valve assemblies and sensors, which are specified to be provided by the Bas/Temperature Subcontractor.
5. All input/output signals shall be directly hardwired to the AHDC. Troubleshooting of input/output signals shall be easily executed with a volt-ohm meter (VOM). As a result of this intent, it is specified that power line carrier systems, or other systems which command multiple outputs over a single pair of wires, shall not be utilized.
6. AHDC's shall be in continuous direct communication with the network which forms the facility wide Building Automation System. The AHDCs shall communicate with the SDC at a baud rate of not less than 19,200 baud.

B. Non-Volatile Memory:

1. All control sequences programmed into the AHDC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained. Power failures shall not cause the AHDC memory to be lost, nor shall there be any need for batteries to be recharged or replaced to maintain the integrity of the controller database. The AHDC shall allow for the creation of unique application control sequences. Systems that only allow selection of sequences from a library or table, are not acceptable.
2. All control sequences shall be fully programmable at the AHDC, allowing for the creation and editing of an application control sequence, while at the unit.

C. Service Port:

1. The AHDC shall be provided with an interface port for the HHOT. The interface port shall allow the HHOT to have full functionality as described in the HHOT section of this specification. From the interface port, the HHOT shall be able to directly access any AHDC, LIDC, UDC or VAVDC in the network.

D. Trending:

1. The AHDC shall provide an input/output point trending utility that is capable of accumulating 48 analog point samples and 10 digital point samples, per input/output point. Each sample shall be taken on a user defined interval, ranging from 1 second to 255 hours per sample. The digital readings shall be on a change of state occurrence for the digital points. All samples shall be recorded with the engineering units for the value, along with a time and date identifier for each sample taken. The samples shall be protected against loss due to power interruptions through a battery or capacitor backup method for a minimum of 30 days.
2. Systems unable to provide the above capability shall provide for the individual input/output point trending at the SDC. Specifics as to how each AHDC point will be trended, at the SDC, shall be provided in the submittal documents. Included in the explanation shall be the sample intervals, the memory allocation in the SDC and the number of AHDC's per SDC that can be expected.

E. Diagnostics:

1. The AHDC shall provide LED indication of transmit/receive communications performance, as well as for the proper/improper operation of the controller itself.

F. Controller Location:

1. To simplify controls and mechanical service troubleshooting, the AHDC shall be mounted adjacent to the air handling system. The AHDC shall be provided in a NEMA approved enclosure. The AHDC shall be constructed in a modular orientation such that service of the failed components can be done quickly and easily. The modular construction should limit the quantities of printed circuit boards to a maximum of two. All logic, control system, power supply and input/output circuitry shall be contained on a single plug-in circuit board. When required to replace a printed circuit board, it shall not be necessary to disconnect any field wiring. This shall allow all controls maintenance and troubleshooting to be made while at the air handling unit. The AHDC shall be directly wired to sensory devices, staging relays or modulating valves for heating and cooling.
2. For compatibility to the environment of the air handling unit, AHDC's shall have wide ambient ratings. AHDC's shall be rated for service from -40 DegF (Degrees Fahrenheit) to 140 DegF.
3. Subcontractor shall submit description of location of AHDC's on all mechanical and air handling equipment.

2.3 GLOBAL DIGITAL CONTROLLER (GDC)

- A. Provide a microprocessor based, direct digital controller to integrate and communicate with all microprocessor based controllers on the network. All communication interface programs shall be resident within the global controller. The following functions and features shall be provided:
1. Multi-tasking, 16-bit microprocessor operating from software program memory resident in the controller. 80186 Microprocessor with 12 MHZ clock frequency. Global controllers shall exist at the LAN level with the stand-alone digital controllers.
 2. The GDC shall provide alarming, point trending, and energy report generation capabilities. Alarming points shall be uniquely definable, with multiple alarms assignable to a single point. The quantities of trended point values shall be limited only by total controller memory space. If necessary, a GDC may be dedicated fully to a trending task, allowing all controller memory to be available for the trend storage. Each unique trend report shall contain a minimum of 4 different points and minimum of 128 samples per point. Trending frequency for each report shall be operator definable from a sample once a second to a sample one every 24 hours. Trend reports shall be internally formatted by the GDC and shall be reportable directly to a serial printer, a VT-100 display terminal, or any other device capable of receiving a formatted ASCII data file.
 3. All control sequences programmed into the GDC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery to be retained. Power failures shall not cause the GDC memory to be lost, nor shall there be any need for batteries to be recharged or replaced to maintain the integrity of the controller database.
 4. The GDC shall be provided with a battery-backed clock that is capable of maintaining the time of day and calendar for up to thirty days upon loss of power to the GDC without loss of setting. The battery for the time clock shall be field replaceable by the customer.
 5. The GDC shall have a complete set of energy and facility management capabilities including maintenance time reminders, energy reports, and trend reports. The energy management functions shall include duty cycle, temperature compensated duty cycling, optimum start/stop, electric demand limiting, enthalpy changeover, and calendar scheduling.
 6. The GDC shall have a keypad and display.

2.4 BUILDING AUTOMATION SYSTEM (BAS) COMMUNICATIONS

- A. The distributed stand-alone DDC controller trunk communications shall consist of a multi-drop RS-485 bus architecture. The distributed DDC controllers shall provide communication transient protection.
- B. A high-speed Network Interface Module (NIM) shall be provided to support either Ethernet or Echelon communication. (BAS LAN) The NIM shall support a variety of cabling types. Minimum connectivity shall be provided for 10 Base 2 (ThinNet RG-58 A/U Coaxial cabling with BNC connectors) or 10BaseT (Twisted – Pair RJ-45 UTP cabling).

- C. Portable operators terminal: (1) Required. Provide a portable microcomputer processor as the local workstation with minimum of 1 Gbytes RAM, 80 GB hard drive, 17 inch diagonal active matrix VGA color screen and 3-1/2 inch, 144 meg double sided, double density disk drive, and CD-RW drive. The computer shall contain a rechargeable battery package, spare battery, full ASCII alphanumeric 85 key keypad with separate cursor control keys, and integrated track pad. The computer shall operate for a minimum of 3 hours without recharging or connection to line voltage power. The computer shall be Internet CAT-5 NIC ready with necessary hardware and software, wireless network card, and future PCMCIA slot for network card for hard connection. The contractor shall coordinate with Owner to connect the computer to the networks and to implement on the Owners networks prior to Substantial Completion. IBM, Dell, Hewlett Packard, or approved equal. Provide with DDC operational software and diagnostic software for field troubleshooting equipment, trending, and editing software. (1) Computer shall be provided and usable for interface with BAS system. Each computer shall have all necessary software and graphics capabilities loaded and operational.
- D. Provide a man-machine interface on each BAS controller equivalent to a keypad entry type system for on-site manipulation and monitoring in addition to a computer interface port.

2.5 SENSING AND CONTROL OUTPUT REQUIREMENTS

- A. Sensing: All sensing inputs shall be provided via industry standard signals. Temperature, humidity, differential pressure signals, flow meters, and other signal inputs shall be one of the following types: 0-20 mA; 4-20 mA; 0-5 VDC; 0-12 VDC; 1000 ohm platinum (at 0 C, 2.62 ohms/°C); 1000 ohm Balco (2.2 ohms/°F); 10 k ohm Thermistor (at 25°C/77°F). All signal inputs shall be compatible with the controllers used and with the requirements for readout of variables in true scaled engineering units as specified.
- B. Control Outputs:
1. The control panel shall internally provide test points for the circuits driving the equipment contactor, for the purpose of troubleshooting the 120 VAC circuit to the contactor. All such relays shall be of modular construction that can be easily and quickly replaced on an individual basis if the module were to be damaged.
 2. Modulating outputs shall be industry standard 0-5 VDC, or 0-12 VDC with defineable output spans to adapt to industry available control products. Milliamp outputs of 0-20 mA or 4-20 mA are also acceptable. Drive open/Drive closed type modulating outputs are acceptable for selected terminal unit control.

2.6 SENSORS

- A. General:
1. Provide sensors with specified output type for remote sensing of temperature, humidity, pressure, and flow rate. Suitable for medium where used, system conditions, and ambient temperature.
 2. Provide two wire temperature and humidity sensors.
- B. Space Temperature:

1. Accessible adjustment (55-85F range) with thermometer indicator on cover. Minimum 0.1% accuracy. Removable covers. 3F throttling range. BAS monitoring and remote temperature override capability on ALL thermostats. Locking guards on all thermostats located in Commons, Hallways, Vestibules, and Public Restrooms.
 2. Local control thermostats: Thermistor or RTD with 50-80°F range, accuracy of +/-0.4°F over full range, and maximum drift of 0.1°F/year. Removable covers with tamper proof fasteners. Siebe TS-5700 series, TS-8000 series, Mamac TE 205 series or equal. Provide sensors with temperature indication and adjustable setpoint integral with cover. Locking guards on all thermostats located in Commons, Hallways, Vestibules, and Public Restrooms.
- C. Duct Air Temperature, Probe Type:
1. With separable, perforated bulb guard. Thermistor or RTD with minimum 32-150 F range, accuracy of +/-0.4 F over full range, and maximum drift of 0.1F/year. Siebe TS-5700 series, Siebe TS-8000 series, Mamac TE 205 series or equal.
- D. Duct Air Temperature, Averaging Type: For mixed air and low limit temperature sensor.
1. Provide averaging bulb thermostats for mixed air and low limit thermostats with element installed to cover the cross-section of the duct.
 2. RTD continuous sensing element with appropriate range, accuracy of +/- 0.75 F over full range, and maximum drift of 0.1 F/year. Siebe TS-8000 series or equal.
- E. Fluid Temperature:
1. Thermistor or RTD with minimum 30-230 F range, accuracy of +/-1.0 F over full range, and maximum drift of 1F per year. Siebe TS-8000 series, Mamac TE 205 series or equal. Provide appropriate thermal well for the pressure application to allow removal of the sensing element without draining the system. Wells filled with heat conductive compound.
- F. Outside Air Temperature:
1. Platinum RTD with minimum -58-110 F range, Accuracy of +/-1.0 F over full range, and maximum drift of 1F per year. Hy-Cal RTS-5737-W or equal. Provide sunshield and weatherproof box for exterior location as required.
- G. Fluid Pressure:
1. Semi-conductor strain gauge pressure transducer with range 150% of operating pressure and over pressure tolerance of 200% of range pressure, +/-2% accuracy over full range, and maximum drift of 1% full range per year. Kele PTX1E, Mamac PR262, or equal.
 2. Provide with brass or stainless steel snubber and pigtail on steam applications.
 3. Coordinate tap requirements with the mechanical contractor. Provide with gate or ball valve isolation.
- H. Air Differential Pressure:

1. Semi-conductor strain gauge pressure transducer with range 150% of operating pressure and over pressure tolerance of 200% of range pressure, +/-2% accuracy over full range, and maximum drift of 1% full range per year. Mamac PR-274/275 or equal.
2. Provide static pressure tips with integral compression fittings for reference tubing at duct penetrations.

2.7 SWITCHES

- A. Low Temperature Limit Switch: 4-wire, two SPDT switches, main contacts open on temperature below setpoint, pilot contacts close. Auto-reset unless otherwise indicated. Extended length capillary type element with any one foot at setpoint causing trip. Freeze protection low limit minimum range 0-60°F. Suitable for ambient temperatures -40 to 140°F. Siebe T-5232 or equal.
- B. Differential Pressure Switch - Air: Diaphragm operated single pole double throw snap switch. Siebe PC-301 or equal. Provide static pressure tips with integral compression fittings for reference tubing at duct penetrations.
- C. Differential Pressure Switch - Liquid: Brass bellows operated single pole double throw switch. Where differential pressure is 10 PSI or less provide United Electric J21K Series or equal. Where differential pressure is greater than 10 PSI provide Penn P-74FA-5 or equal. Provide with gate or ball valve isolation.
- D. Selector Switches:
 1. Rotary switch, stackable contact blocks, 30.5 mm operator. Square D class 9001 or equal.
- E. Push Button Switches:
 1. Momentary contact, stackable contact blocks, 30.5 mm operator. Square D class 9001 or equal.
- F. Current Sensing Switches:
 1. Current operated solid state switch with adjustable set-point from 1 to 135 amps. Power and status LED's, non-polarity sensitive. For detecting belt loss and motor failure. Veris H-708 solid-core, H-908 split-core or equal.

2.8 CONTROL VALVES

- A. Automatic Valves: For water or steam, as applicable, suitable for system conditions. 2-inch and smaller: Brass body, threaded, installed with union on each connection. 2-1/2 inch and larger: Iron body, flanged. Seats and discs or plugs of nonferrous metals. Modulating or positive acting as required. See Contract Documents for operation and capacity.
- B. Positive-acting: Flat, single discs with renewable composition faces.
- C. Modulating: Single or balanced, parabolic or V-notched inner valve plug. Steam valves single seat type for tight shutoff.

- D. General: For steam or hot water as applicable.
1. Non-terminal unit control valves (1/2" through 3") sizes shall have cast bronze bodies with static pressure rating conforming to ANSI B16.15- 1971 250 PSIG rating. Maximum water pressure shall be 400 PSIG with 40 to 150°F water, decreasing to 321 PSIG at the maximum water temperature of 281°F.
 2. All valves shall have stainless-steel stems, brass or stainless-steel throttling plugs, bronze valve seats, and spring-loaded Teflon -cone packing. Two-way valve plugs for non-steam applications shall have composition disks.
 3. All valves shall be fully modulating unless otherwise indicated. CONTROL CONTRACTOR is responsible for the selection of the proper control valves for the project including sizing, pressure rating, flow coefficient, flow characteristic, close-off rating, and actuator selection.
 4. All two-way valves shall have contoured or characterized throttling plugs with linear (for steam applications) or equal- percentage flow characteristics.
 5. All three-way shall have brass or stainless steel linear throttling plugs with stainless steel stems.
- E. Positive Acting Control Valves for Finned Tube, Convectors:
1. Forged brass body, stainless steel base and bearing plate, electrolyte nickel brass stem, paddle and stem seal assembly compatible with heating system fluid, fully rated for 300 psi operating pressure limit. High temperature model if needed for 250°F fluid temperature. Powerhead replaceable without removal of valve body from system and secured to valve body with machine screws and sealed with O ring. Maximum close-off pressure rating of 20 psi minimum. Minimum Cv rating of 1.0, maximum of 7.0. Manual opening lever on all normally-closed valves. Available with sealed or unsealed end switches if required by the application.

2.9 DAMPER AND VALVE ACTUATORS

- A. General:
1. Where exposed to outdoor air or air temperatures lower than 50°F, provide completely weatherproof actuators with internal heaters to allow normal operation at -50°F.
 2. Provide spring return to normal position type actuators with variable air volume terminal units actuators return to closed position.
- B. Modulating Electronic Actuators:
1. Modulating actuators for control dampers and control valves over 1-1/4" to convert electronic 1-10 VDC, or 4-20 mA analog signal to a linear, positive positioning stroke. Direct mount type with appropriate valve and damper linkage kits as needed. Siebe MS-7203, MS-7433 or equal.
 2. Modulating actuators for control valves up to 1-1/4" to be hydraulic type with spring return. Proportional control by variable Vdc input signal. Siebe MP-5213 or equal.
- C. Two-Position Electronic Actuators:

1. Two-position actuators for larger valves and dampers shall be gear train type or direct mount type as required. Siebe MA-418 or Siebe MA-7000 series or equal. Provide integral, adjustable end switches as required for the application.
2. Two-position actuators for small valves and dampers shall be direct mount type or hydraulic type as required. Siebe MA-5000 or Siebe MA-7000 series or equal. Provide integral, adjustable end switches as required for the application.

2.10 WIRING

- A. Includes all control wiring to complete the system and provide control arrangements specified or shown on the drawings. Power or interlock wiring shall be run in separate conduits from sensor and communications wiring.
 1. Low-voltage Control Wiring (12-24v): Protected in exposed locations including, but not limited to, mechanical rooms and storage rooms. Plenum rated cable installed in ceiling plenums above ceilings. Motor disconnect switch shall also disconnect control circuit. Indicating lights wired from the motor terminals or from the last controlling device to the motor to show actual operation. All low voltage control wiring 18 AWG minimum.
 2. 110-volt and larger Control Wiring: 12 AWG minimum if directly operating a motor, and 14 AWG minimum if controlling relays and holding coils.
- B. Control Power: Control Power will be provided under the Electrical Division for new panel locations. The power will be available in J-boxes located in the Mechanical Rooms. Provide the electrical connection between all automatic control equipment and the control power J-boxes. In locations where existing panels are being replaced with new panels, Control Contractor to disconnect 120volt control power and reconnect power to new panel in same location.

PART 3 - EXECUTION

3.1 WIRING AND RACEWAYS

- A. General:
 1. Provide wiring, conduits and raceway complying with the National Electrical Code, Division 16, State and Local Codes and Ordinances. See electrical drawings for hazardous (classified) locations.
 2. Low voltage wiring to the perimeter heat and booster coil automatic valves and thermostats shall be installed in conduit exposed in room where walls are concrete and are not available to conceal wiring and where hard ceilings, without access from accessible ceiling space, are not scheduled for removal and routing around inaccessible space is not possible.
 - a. New wiring will need to be installed concealed above classroom, corridor, and other occupied room accessible ceilings. Wiring shall be concealed in the vertical drops in the rooms. Cutting and Patching required. Where concrete and CMU walls prohibit concealing wiring in wall cavities and in Mechanical rooms, wiring shall be installed in surface mount conduit.

- b. Where wiring is to be installed inaccessibly above new hard ceiling, install wiring in conduit.
3. Use EMT, metal duct, IMC, rigid conduit, surface metal raceways, or totally enclosed metal through with flexible metal tubing as required by Division 16.
4. Provide wire with copper stranded conductors. Provide color or number coded jackets.
5. Provide 20 gauge minimum foil-shielded cable rated 100 VDC at 80 C. for input/output wiring.
6. Provide communications network wiring meeting the gauge, impedance, capacitance, resistance and shielding requirements specified by the manufacturer of the connected devices.
7. Plenum rated cable is acceptable in concealed, accessible areas such as suspended ceilings.
8. Install wiring in a neat and orderly manner generally running piping and wiring along building lines.
9. Seal conduit penetrations at rated walls with fire-stopping installed in accordance with fire-stopping manufacturers UL listed installation requirements.
10. Wire all electrical controls and switches furnished under this section of the Specifications.
11. Support and conceal wiring in finished areas.
12. Provide humidity sensor in existing High School Gym.

3.2 COORDINATION

- A. Coordinate this work with the work of other trades, and make arrangements for the complete and proper accomplishment of all related work. Coordinate required control interlocks with HVAC manufacturers or local representatives as necessary.
- B. Mechanical Subcontractor Responsibilities: Installs automatic valves and separable wells that are supplied by the Temperature Control Subcontractor.
- C. Electrical Contractor Responsibilities: Provide hard connection electrical interface from smoke sensors to fire alarm system and then to respective air-handling unit system with interconnection for complete shutdown of that fan system; supply fan, return, and exhaust fan if applicable. BAS contractor will provide DDC wiring for connection to fire alarm panel for secondary fan shutdown through BAS system.
- D. Boiler Control System: Burners, boilers, and trim are provided by Mechanical Contractor, however, boiler control system and all Control Shop Drawings, control wiring installation, automatic control testing and training, and correct operation of automatic boiler controls is included hereunder. Control Contractor is responsible for coordinating with Mechanical Contractor for all necessary internal wiring diagrams for use in preparing Control Shop Drawings. Responsibility for correct operation of burner, pump, and heating plant operation included hereunder.

3.3 COORDINATION

- A. Coordinate this work with the work of other trades, and make arrangements for the complete and proper accomplishment of all related work.

3.4 TESTING AND ADJUSTING

- A. Upon completion of the control installation, start up the system, perform necessary testing, and adjust the system to ensure proper operation.
- B. Coordinate the final adjustments and “fine tuning” of control functions and devices so the mechanical systems and the control systems operate and respond as an integrated comfortable and energy efficient component of this facility.

3.5 ACCEPTANCE TESTING

- A. Point Verification:
 - 1. To verify end-to-end operation of the system, the Subcontractor shall provide a hard copy of an All Points Summary Listing to the OWNER of each part or system to be placed in warranty by the OWNER. For CHS systems, the Subcontractor shall additionally provide a print screen of the process display showing real time dynamic point information for all points on the subsystem(s) to be accepted.
- B. Sequence Verification:
 - 1. The CONTRACTOR shall notify the OWNER of systems which perform all specified sequences. The ARCHITECT shall verify all sequences of operation and place the system into warranty acceptance test.

3.6 TRAINING (BAS)

- A. After substantial completion and prior to final completion of the installation, operating personnel of the School District Maintenance shall be instructed on site in the sequence of operation and maintenance of the system hardware and software by the Subcontractor's qualified representative. A minimum 4 hours of training is to be provided. Coordinate with owner to determine the nature of training to be provided and acceptable dates for training.
- B. Subcontractor is to provide minimum of 7 days notice to the School District prior to training and warranty visits. Training dates to be approved in advance by the OWNER.

3.7 WARRANTY ACCESS

- A. The Owner shall grant to the Subcontractor, reasonable access to the BAS system during the warranty period. The owner shall provide, at no cost to the Subcontractor, a dedicated voice grade telephone extension for remote telecommunications during this period.
- B. The Subcontractor shall provide and implement an auto-answer, auto-dial modem system for purposes of remote diagnostics and notification of desired exceptions. Modem shall provide the following functions:
 - 1. Access to the entire facility control system by the Subcontractor to provide service and diagnostic support.

2. Access by the OWNER from off-site for similar purposes and for remote operation, monitoring, and adjustment of facility functions.
3. Auto-dial out of desired exceptions to a remote site, or to an OWNER specified set of phone numbers for business hours, or off-hours reporting.

3.8 SEQUENCE OF OPERATIONS

- A. AHU: Magnetic Starter with HAND-OFF AUTO switch. In AUTO position the fan operates according to occupied schedule and smoke sensor and low limit safeties. In HAND position the fan operates according to its safeties.
 1. Mixed Air Temperature. During Occupied schedule, Outside air damper, return air, and relief air dampers modulate to maintain an adjustable 60F mixed air temperature.
 2. Booster Coils: During Occupied schedule, Wall mounted room thermostat with override and duct supply air thermostat to modulate the three-way mixing valve to maintain a supply air reset temperature: At 30F outside air temperature the supply air temperature to be 95F and modulate to 65F at 60F outside air temperature. Reset schedule adjustable.
 3. Exhaust fan EF to operate whenever AHU operates on occupied schedule.
 4. Unoccupied Schedule: Below an adjustable set point of 55F from any of the room thermostats, AHU fan is operate with mixing dampers positioned to full recirculation position and three mixing valves positioned to full heating.
- B. Heating Plant: Low water cutoff, high limit thermostats, and operating thermostat to be wired in series for the burner operation.
 1. Boiler pumps P-1, P-2: The boiler pumps are to operate in a lead lag fashion switched monthly, whenever the common immersion thermostat in the heating supply, set at 190F calls for heating.
 2. Magnetic Starter with HAND-OFF AUTO switch. In AUTO position whenever any of the room thermostats call for heating the lead pump shall operate. If the lead pump does not operate after adjustable 1 minute the lag pump shall operate. Lead and lag pumps shall switch designation every month. In HAND position the pump operates.
- C. Convectors: Room thermostat opens automatic valve to full heating upon a drop below setpoint.
- D. Day tank: BAS monitors operation and high level float switch.

END OF SECTION 17000