

**SECTION 15600
MECHANICAL**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

General Provisions of Contract, including General and Supplementary conditions and General Requirements (if any) apply to work specified in this Section.

1.02 ALTERNATES

There are alternates that apply to this section of the project. See Part 4, "ALTERNATES".

1.03 DEFINITIONS

ATC Automatic Temperature Control
EC Electrical Contractor (Division 16)
GC General Contractor
HC Heating (mechanical) Contractor
PC Plumbing Contractor
VFD Variable Frequency Drive

1.04 DESCRIPTION OF WORK

A. Work Included

1. Furnish all labor, materials, equipment, transportation and perform all operations required to install complete heating, ventilating, heat recovery and air conditioning systems in the buildings, in accordance with these specifications and applicable drawings.
2. It is the intent of the drawings and specifications to provide for the installation of a heating system which is safe, quiet, and economical in operation and complete in all respects. As required by Maine State Housing Authority guidelines, the heating system shall provide a uniform temperature of not less than 70°F. in all living spaces as may be noted on the drawings, when the outside temperature is -2°F. (as specified in accordance with the ASHRAE 99% scale.)
3. All temperatures are expressed in degrees Fahrenheit.
4. Perform demolition and removal as required.
5. Work to be performed shall include, but is not limited to, the following:
 - a. Provide and install forced hot water heating and ventilating system in building areas indicated on drawings.
 - b. Provide and install forced air heat recovery systems in building areas indicated on drawings.
 - c. Provide and install direct expansion air conditioning system in building areas indicated on drawings (see Part 4, "ALTERNATES")

- d. Pipe, valve and fittings
- e. Hot water specialties
- f. Circulating pumps and boiler work
- g. Radiation
- h. Unit ventilators (see Part 4, "ALTERNATES")
- i. Unit heaters and cabinet unit heaters
- j. Insulation
- j. Fans
- l. Sheetmetal
- m. Temperature control
- n. Tests and balance

- 6. Specifications and accompanying drawings do not indicate every detail of pipe, valves, fittings, hangers, ductwork and equipment necessary for complete installation; but are provided to show general arrangement and extent of work to be performed.
- 7. Before submitting proposal, Mechanical Contractor shall be familiar with all conditions. Failure to do so does not relieve Mechanical Contractor of responsibility regarding satisfactory installation of the system.
- 8. Mechanical contractor shall be responsible for rigging to hoist his own (and his sub-contractors') materials and equipment into place.
- 9. Mechanical contractor and his sub-contractors shall be responsible for start-up of all equipment provided under this section.

B. Related Work Described Elsewhere

- 1. Excavation and backfill
- 2. Cutting and patching
- 3. Firestopping between building construction and pipe sleeves and between building construction and ductwork, Section 07900.
- 4. Electrical conduit and wiring, except as noted below
- 5. Roofing, curbs, curb openings and framing of openings.
- 6. Setting of sleeves in masonry work (sleeves provided by Mechanical Contractor)
- 7. Door louvers
- 8. All finish work

C. Commissioning

- 1. A commissioning agent has been retained by and works directly for the Owner. The commissioning agent's primary responsibility shall include ensuring the mechanical systems function as designed. A full scope of the agent's duties may be provided on request.
- 2. This contractor shall provide documentation on mechanical equipment that may be requested by the commissioning agent with notification provided to the Architect of such.
- 3. Should the commissioning agent requested changes or alterations to the mechanical systems, said changes or alterations must be authorized by the Architect or Engineer of record prior to work. See part 1.17, "CHANGE ORDERS".

4. The scope of the mechanical contractor's responsibility regarding commissioning shall be (but not limited) to:
 - a. Attend commissioning meetings.
 - b. Coordinate factory start up of the variable frequency drives, heat recovery and boiler systems to include the commissioning agent. Coordination shall include as a minimum 1 week notice of factory start up tests.
 - c. Coordinate and provide at least one week notice of testing and balancing contractor being on site to allow the commissioning agent to observe the process.
 - d. Complete one page check lists on boilers, hot water heat pumps and controls.
 - e. Demostate all sequences of operation of the heat recovery equipment and all equipment within the boiler room.

D. Mechanical Electrical Work

1. Provide and erect all motors, temperature controls, limit switches as specified.
2. Power supply to switches, fused switches, outlets, VFD's, motor starters, to line terminals of equipment, and all related wiring and fuses to properly connect and operate all electrical equipment specified shall be furnished and installed under Division 16, "ELECTRICAL" (Division 16). Division 16 shall not mount electrical equipment to indoor mechanical equipment without the consent of Division 15. Division 16 shall not drill wiring holes in equipment casings but shall make use of factory wiring knockouts when present. Coordinate all wiring between Mechanical and Electrical to provide a complete and operating system.
3. VFD's shall be provided by Division 16 where indicated on mechanical plans and/or in this section. VFD's shall have 4-20 Ma inputs, 0-10 vdc inputs and integral LAN card with network cable port for connection to ATC system computer.
4. All wiring provided under this section shall be in accordance with the latest rules and regulations of the National Fire Underwriters, National Electric code, State of Maine Oil Burner Code, and Local Codes Division 16. Install all wiring under the supervision of the Division 16. Any wiring that is not installed according to these standards, and which does not match wiring installed by Division 16 in type, quality and appearance shall be corrected by Division 16 at the expense of this section.
5. Automatic Temperature Control (ATC) Systems

Electric wiring shall be furnished and installed by ATC Contractor under supervision of Division 16. Any wiring that is not installed according to these standards, and which does not match wiring installed by Division 16 in type, quality and appearance shall be corrected by Division 16 at the expense of this section.

6. Boilers

Division 16 shall provide a separate circuit breaker for each boiler and wire to line terminals on unit control. Oil burner contractor shall provide all other wiring, including control and safety circuits, low water cut-offs and fusible switches.

7. Fans

- a. Single phase 120 volt units: Division 16r to wire to unit mounted disconnect switch with overload protection provided with unit.
- b. Three phase units: Division 16 shall provide combination disconnect switches with magnetic starters unless specifically indicated otherwise, and wire power to supply through to line terminals on unit motor. Starters shall have auxiliary contactors for Automatic Temperature Control interlocks. Temperature Control Contractor SHALL COORDINATE his requirements with Division 16 as soon as possible after award of contract. Fans shall operate as indicated on "FAN SCHEDULE", drawing M14 and as indicated in "Automatic Temperature Control" section of this specification.
- c. Division 16 to provide 120 volt power from exhaust fans to motor operated dampers associated with each fan, where provided. Dampers and actuators to be provided by ATC Contractor.

8. Automatic Temperature Control (ATC) Panels

Division 16 shall provide a dedicated 120 volt, 15 amp circuit breaker for each temperature control panel. Wiring from circuit breaker to temperature control panels will be provided and installed by the ATC Contractor. Division 16 shall also provide a duplex convenience receptacle on a separate circuit within 6 feet of each panel.

9. Unit Ventilator (see Part 4, "ALTERNATES")

Division 16 shall wire to line terminals in unit junction box. Service switch and remote speed control switch.

10. Circulating Pumps

Division 16 shall provide and wire disconnect switches and magnetic starters where indicated on equipment schedules and/or in this section. Each magnetic starter to have Hand-Off-Automatic switch and automatic re-start feature in event of power failure.

Division 16 shall provide and wire disconnect switches and VFD's where indicated on equipment schedules and/or in this section.

11. Unit Heaters

- a. Cabinet Type: Division 16 shall wire to disconnect switch provided with unit.
- b. Propeller type: Division 16 shall provide and wire service switch with

overload protection.

12. All motors 1/3 HP and smaller shall be wired for 120 volt, 1 phase, 60 hz; motors 1/2 hp and larger shall be wired for 208 volt, 3 phase, 60 hz, unless specifically shown otherwise. Three phase motors shall be inverter ready for variable frequency drives. Minimum guaranteed three phase motor efficiencies shall be as follows:

<u>HP</u>	<u>1200 RPM</u>	<u>1800 RPM</u>
1	81.5	85.5
1½	85.5	86.5
2	86.5	86.7
3	88.5	87.5
5	87.4	88.5
7½	89.4	91.0
10	89.7	91.7

1.05 PERMITS

- A. This Contractor shall be responsible for providing and filing all Plans, Specifications and other documents, pay all requisite fees and secure all permits, inspections and approvals necessary for the legal installation and operation of the systems and/or equipment furnished under this Section of the Specifications.
- B. The Contractor shall frame under glass/ clear plastic all permits, secured by him, adjacent to the respective system and/or equipment and required to be displayed by Code, law or ordinance. Those permits secured but not required to be displayed shall be laminated in plastic and included in the Owner's maintenance manual.

1.06 CODES, ORDINANCES AND PERMITS

- A. All work performed under this Section of the Specifications shall be done in accordance with applicable National, State and local Codes, Laws and Ordinances. The following abbreviations are used for reference to standards which are to be followed:

AABC	Associated Air Balance Council
ADA	Americans With Disabilities Act
AMCA	Air Movement & Control Association
ANSI	American National Standards Institute
ARI	Air Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BOCA	Building Officials and Code Administrators
NEC	National Electrical Code
NFPA	National Fire Protection Association
NEMA	National Electrical Manufacturer's Association
OSHA	Occupational Safety and Health Act
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
UL	Underwriter's Laboratories

- B. The latest issue of each Code in effect at the time of bidding shall be used. Code requirements are the minimum quality and/or performance acceptable. Where the Specifications and/or Drawings indicate more stringent requirements, these requirements shall govern.

1.07 QUALITY ASSURANCE

- A. Qualification of Workpersons

Use sufficient qualified workpersons and competent supervisors in execution of this portion of the work to ensure proper and adequate installation of system throughout.

- B. Work performed shall conform with all Local and State Rules and Regulations, as well as those of the National Fire Protection Association (N.F.P.A.).
- C. Piping design shall conform to ANSI, ASME B31.9 and AWS D10.9 codes.
- D. Expansion tank shall conform to ASME Section VIII Code.
- E. Air separator and domestic storage water heaters shall conform to ASME Boiler and Pressure Vessel Code.
- F. Welding standards shall conform to ANSI Boiler Code, Section IX, B31.1

1.08 MATERIALS AND SUBSTITUTIONS

All materials and equipment shall be new and of the latest design of respective manufacturers. **All materials and equipment of the same classification shall be the product of the same manufacturer**, unless specified otherwise.

- A. Any proposal for substitution of Mechanical equipment, materials or vendors shall be made in writing PRIOR TO OPENING OF BIDS, see Division 1. Submit full details for consideration and obtain written approval of the Architect. The phrase "or approved equal" shall be defined to mean that the Architect, not the contractor, shall make final determination whether or not substitute materials are an equal to that which is specified. The contractor shall be responsible to certify within his submittals that any equipment to be considered as an "approved equal" meets or exceeds the requirements of this specification in all aspects and will physically fit within the space provided and still provide adequate space adjacent to the equipment for service. If requested by the Architect the contractor shall provide said certification in the form of scale drawings before review will be made. Architect will not be responsible to provide drawings for substituted materials unless the substitution is agreed upon prior to opening of bids. Architect's decision on acceptability of substitute materials shall be final.
- B. Approval by Architect for such substitution shall not relieve Mechanical Contractor from responsibility for a satisfactory installation and shall not affect his guarantee covering all parts of work

- C. Any material or equipment submitted for approval which are arranged differently or is/are of different physical size from that shown or specified shall be accompanied by shop drawings indicating different arrangements of size and method of making the various connections to equipment. Final results will be compatible with system as designed.
- D. Materials and equipment determined as an “approved equal” and/or substitutions must meet the same construction standards, capacities, code compliances, etc. as the equipment (i.e. Manufacturer, model, etc.) specified.
- E. Any additional cost resulting from the substitution of equipment, regardless of acceptance by the Architect or Engineer, shall be paid by this Contractor.
- F. All materials not specified otherwise shall be manufactured within the United States and supplied locally (within the State of Maine) when available. It is preferable to obtain materials that are manufactured within 500 miles of the work site when practical.

1.09 PLANS AND SPECIFICATIONS

Mechanical Contractor shall provide his sub-contractors with a copy of the ENTIRE portion of Part 1 of this specification, portions of this specification and copies of drawings which pertain to the equipment to be supplied at no cost to the sub-contractor. Provide ATC Contractor with entire set of Electrical plans and specifications. Provide Testing and Balancing sub-contractor with copies of shop drawings indicating coil gpm' s, fan and HRU air volumes, etc. Failure to do so may result in the Architect providing the required materials at the Contractor' s expense.

1.10 SHOP DRAWINGS & SUBMITTALS

- A. As soon as possible after award of Contract (but not longer than 21 calendar days), before any material or equipment is purchased, Mechanical Contractor shall submit to the Architect no less than ten (10) copies of shop drawings for approval. If shop drawings are not submitted within the allotted time frame all substitutions included in the late shop drawings will be invalid and the equipment specified must be provided. Any costs resulting from delays in the project schedule due to failure to submit shop drawings related to this section in a timely manner shall be the responsibility of the Mechanical Contractor. Shop drawings shall be properly identified and shall describe in detail the material and equipment to be provided, including all dimensional data, performance data, fan curves, pump curves, computer selection print-outs, etc. Capacities indicated are minimums. Equipment submitted with capacities below specified parameters will be refused.
- B. Corrections or comments made on the shop drawings do not relieve the contractor from compliance with requirements of the drawings and specifications. Shop drawing review is only for review of general conformance with the design concept of the project and general compliance with the information given in the contract documents. The contractor is responsible for confirming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction; coordinating his work with that of all other trades and performing his work in a safe and satisfactory manner.
- C. All related items shall be submitted as a package. Partial submission shall not be reviewed until the package is complete, as itemized in paragraph "H" below.
- D. Should any materials or products be purchased and/or installed without prior review and

comment the contractor shall be required to remove or replace those products and/or materials if directed by the Architect at his own expense. If the materials are not removed (or replaced) or if the project is delayed as a result the Architect reserves the right to order the withholding of payment until the situation is resolved in a manner satisfactory to the Architect.

- E. Mechanical shop drawings shall be separate from Plumbing shop drawings. All submittals shall have a clear area on the front no less than 4inches x 3inches to be reserved exclusively for the Engineers' shop drawing stamp or they will be refused for re-submittal.
- F. Submittals must be original documents or good quality photocopies of original documents (photocopies of color samples are not acceptable). Faxed copies of submittal sheets will be refused.
- G. Review must be obtained on the following items:
 - 1. Ductwork and Accessories
 - a. Registers and grilles
 - b. Duct access doors
 - c. Volume control dampers (manual and automatic)
 - d. Duct sealant
 - e. Fire dampers and sleeves
 - f. Turning vanes
 - g. Flexible duct
 - h. Kitchen range hoods and accessories
 - i. Backdraft dampers
 - j. Louvers and brick vents - provide color chips (photocopies not acceptable) – provide samples if substituting
 - k. Filters
 - l. Vents from gas heating appliances
 - m. Exterior vent hoods from dryers and range hoods.
 - 2. Mechanical Equipment (sound data must be provided with all interior motorized equipment).
 - a. Full warrantee information must be included with all submittals.
 - b. Heat recovery units and accessories - provide curves for fan wheels submitted and computer selection printouts.
 - c. Air conditioning units and accessories - provide computer selection printouts.
 - d. Fans and accessories - provide full fan curves and computer selection printouts.
 - e. Cabinet unit heaters - provide color chips (photocopies not acceptable)
 - f. Horizontal unit heaters
 - g. Unit ventilators - provide color chips (photocopies not acceptable)
 - h. Pumps and accessories - provide full pump curves and computer selection printouts.
 - i. Boiler/Burner units and accessories, confirmation of start-up and State Inspection
 - j. Domestic hot water storage heaters and accessories

- k. Equipment identification tags
3. Piping and Accessories
- a. Pipe, valves, unions and flanges
 - b. Manual balancing valves with read-out gauge and pressure tapings. Provide a schedule clearly indicating every valve, its location, GPM, size and pressure drop.
 - c. Automatic Balancing valves
 - d. Air vents (automatic and manual)
 - e. Air separator
 - f. Relief valves
 - g. Expansion tank and accessories
 - h. Pipe hangers and insulated pipe supports
 - i. Pressure gauges and thermometers
 - j. Triple duty valves
 - k. Pressure reducing valves
 - l. Pipe flexible connectors
 - m. Pipe and valve markers
 - n. Backflow preventer
 - o. Flow control valves
 - p. Underground piping system
 - q. PEX tubing, fasteners, connectors and accessories
4. Terminal Units
- a. Convectors
 - b. Finned radiation
 - c. Hot water heating coils - provide computer selection printouts.
5. Insulation
- a. Pipe
 - b. Duct
 - c. Pipe fittings
 - d. Smoke pipe and air separator
6. Automatic Temperature Control (ATC) System

1.11 PRODUCT HANDLING

A. Protection

Use all means necessary to protect heating, ventilating and air conditioning materials before, during and after installation and to protect the installed work and materials of all other trades.

B. Replacements

In the event of damage, immediately make all repairs and replacements necessary to the approval of the Architect at no additional cost to the Owner.

1.12 AS-BUILT DRAWINGS

Keep in good condition at the job, apart from all other prints used in actual construction, one complete set of all blueprints furnished for this job. On this special set of blueprints, record *completely and accurately* all differences between the work as actually installed and the design as shown on the drawings. These record prints must be kept up to date by recording all changes within one week of the time that the changes are authorized. At the completion of the work, this set of drawings shall be delivered to the Architect for the Owner electronically in the form of CAD drawings. If a complete record of changes is not made and electronic CAD drawings not provided by the Mechanical Contractor, a record shall be made by the Engineers, and *the cost of the record shall be paid by the Mechanical Contractor*. Copies of the mechanical CAD drawings may be made available electronically to the Mechanical Contractor if desired. Drawings shall be dated accordingly and clearly identified as "AS-BUILT". Contact the Architect directly or the Engineer via e-mail at mechsyst@maine.rr.com. Specify required CAD format when requesting the files. CAD drawings were generated using AutoCAD 2006 and utilize both paper space and model space with external references to various other drawings. Files will be compressed and will require "WinZip" (<http://www.winzip.com>) for extraction. A release form will be provided which must be signed and returned to the Engineer prior to transfer of files.

1.13 MAINTENANCE MANUAL

A. On completion of this portion of the work, and as a condition of its acceptance, submit for approval two copies of a manual describing the system. Mechanical equipment manuals shall be separate from plumbing manuals. All manuals shall be original copies, not photocopies or they will be refused for re-submittal. Prepare manuals in durable 3-ring binders approximately 8½ inches by 11 inches in size with at least the following:

1. Identification on the front cover and spine stating general nature of the manual.
2. Neatly typewritten index.
3. Complete instructions regarding operation and maintenance of all equipment involved.
4. Complete nomenclature of all replaceable parts, their part numbers, current cost, and name, address and telephone number of nearest vendor of parts.
5. Copy of all guarantees and warranties issued.

6. Where contents of manuals including manufacturer's catalog pages, clearly indicate the precise item included in this installation and delete, or otherwise clearly indicate, all manufacturers' data with which this installation is not concerned.
- B. In addition to above, provide two (2) separate offset style binders properly identified, each containing a copy of all reviewed shop drawings and catalog cuts. (NOTE: May be incorporated in Maintenance Manuals, if binders are of adequate size.)

1.14 OBJECTIONABLE NOISE AND VIBRATION

Mechanical equipment shall operate without objectionable noise and vibration. Should objectionable noise or vibration be transmitted to any occupied part of the building by apparatus, piping or ducts, as determined by the Architect, the necessary changes eliminating the noise or vibration shall be made by this Mechanical Contractor at no extra cost to the Owner.

1.15 GUARANTEE

This Contractor shall guarantee all materials and workmanship furnished by him or his sub-contractors to be free from all defects for a period of no less than one (1) year from date of final acceptance of completed system and shall make good, repair or replace any defective work which may develop within that time at his own expense and without expense to the Owner. Any additional costs required to extend manufacturer's guarantee and warranty for the period specified, shall be included in Contractor's base bid.

1.16 MINOR DEVIATIONS AND DISCREPANCIES

- A. The drawings are intended to indicate only diagrammatically the extent, general character and approximate locations of mechanical work. Work indicated, but having minor details obviously omitted, shall be furnished complete to perform the functions intended without additional cost to the Owner. Follow the architectural, structural, plumbing and electrical drawings so that work under this section is properly installed and coordinated with other Sections.
- B. The drawings and specifications are complimentary to each other and what is called for in one, shall be as binding as if called for by both. In the event of conflicting information on the mechanical drawings, or between drawings and specifications, or between trades, that which is better, best or most stringent shall govern.
- C. Questions to the Architect or Engineers are encouraged, but any answers or advice is non-binding. Therefore, inquires about such items should be made at least 4 days prior to when bids are due to allow time for a clarifying addendum to be issued.
- D. Any conflicts arising from duplication of equipment specified in different portions of the specifications shall be brought to the attention of the Architect prior to submitting bids. Failure to do so does not relieve the Contractor from responsibility of providing said materials and equipment and a credit will be taken for the duplicated item(s).

1.17 CHANGE ORDERS

- A. No change shall be made from the work, equipment, or materials under this section except as directed in writing by the Architect or Engineer of record.
- B. All requests for change in contract price and scope shall be accompanied by a breakdown list of materials with unit and extended prices and labor hours with unit and extended price, plus markups that have been applied.

1.18 COORDINATION

- A. Contractor shall be responsible to coordinate his work with that of other trades to adjust to field conditions prior to commencing work. If a reasonable solution cannot be achieved without compromising the integrity of the intended design or would result in additional cost the Architect must be notified immediately prior to commencement of work. Failure to do so does not relieve the Contractor from providing and installing the systems to the satisfaction of the Architect at no additional cost.
- B. Contractor shall be responsible to review job conditions and identify conflicts and/or obstructions to ductwork and piping prior to fabrication. If conflicts and/or obstructions are noted the Architect must be notified immediately prior to commencement of work. The cost of any fabrication work performed without confirmation and notification of conflicts and/or obstructions shall be the responsibility of the contractor.

1.19 WORKPLACE SAFETY

Mechanical contractor shall be responsible for the safety of his workpeople.

1.20 INTENT

It is the intent of the drawings and specifications to provide for the installation of a heating, ventilating and heat recovery system which is safe, quiet, and economical in operation and complete in all respects. This system will provide a uniform temperature of 70 degrees F. (75 degrees F for elderly) in all living spaces as may be noted on the drawings, when the outside temperature is -2 degrees F. All materials and equipment necessary to accomplish the intent shall be furnished and installed by the contractor.

PART 2 - PRODUCTS

2.01 PIPING

A. General

Provide and erect in accordance with best practice of trade all hot water supply and return, drain and vent piping shown on the plans and as required to complete intended installation. Contractor shall make offsets as shown or required to place all piping in proper position to avoid other work, and to allow application of insulation and finish painting.

B. Pipe Materials:

- | | | |
|----|---|--|
| 1. | Heating hot water within boiler room, above grade, 2½ inches and larger | Schedule 40 standard weight black steel, ASTM 12 |
| 2. | Heating hot water outside boiler room (above grade), cold water, drains from relief valves and automatic vents. | Type "L" hard drawn copper tubing with sweat fittings. |
| 3. | Heating water, above grade, 200°F. maximum. | PEX crosslinked flexible tubing, ASTM F876 and F877. |
| 4. | Heating hot water (below grade) | PEX crosslinked flexible tubing, ASTM F876 and F877. Preinsulated. |
| 5. | Refrigerant | Type "L" hard drawn copper tubing. |

C. Pipe Fittings:

- | | | |
|----|---------|--|
| 1. | Screwed | ASTM 125# cast iron screwed, ASTM A126, ASA B16.1 |
| 2. | Welded | Standard weight butt weld carbon steel, ASTM A234, ANSI B16.9 from A106 Gr. B. seamless Tube |
| 3. | Unions | 250 malleable iron, brass to iron seats |
| 4. | Flanges | 150# forged steel slip-on ASTM A234 |
| 5. | Sweat | Cast bronze or wrought copper made up with 95-5 solder |

6. Connections to equipment 2 inches and smaller - screwed unions, 2½ inches and larger – flanged
 7. Refrigerant Cast bronze or wrought copper, long radius elbows, made up with Sil-Fos silver solder.
- D. All mains 2½ inches and larger (within boiler room) shall have welded connections using standard factory-fabricated tees, elbows, reducers, and caps. Branch outlets in welded sizes shall be made with tees for full size or one size reduction and with either "Weldolets" and "Threadolets" or factory shaped nipples for all other sizes. All welds shall be made by welders certified by the State of Maine and shall be capable of welding in any position "in the field". All welds shall conform with the rules set forth in the Standard Manual on Pipe Welding of the Heating, Piping and Air Conditioning Contractors national Association. All slip on fittings shall be back welded. Fire extinguishing equipment shall be kept within 25 feet of welding areas at all times. Contractor shall take additional measures when welding close to wood structures to protect the wood from igniting.
- E. All metallic piping 2 inches in size and smaller shall be type "L" hard drawn copper tube with sweat fittings.
- F. The Mechanical Contractor may, at his option, use schedule 40 standard weight black steel, ASTM 12, with threaded fittings in lieu of copper within the building. His option of steel or copper MUST be stipulated in his bid and thereafter no deviation will be acceptable. If steel is to be used, the piping system shall be 100% steel with no mixture from copper to steel.
- G. The Mechanical Contractor may also, at his option, use an IPS Grooved Piping System in lieu of welded, flanged and threaded connectors for steel piping 2 inches in size and larger. If this system is to be utilized contractor must state so very clearly in his bid and the system shall be 100% grooved. System shall employ grooved mechanical pipe couplings, fittings, valves and other grooved components. All grooved components shall be of one manufacturer, and conform to local code approval and/or as listed by ANSI-B-31.1, B-31.3, B-31.9, ASME, UL/ULC, FM, IAPMO or BOCA. Grooved end product manufacturer to be ISO-9001 certified. Grooved couplings shall meet the requirements of ASTM F-1476. System shall be by Victaulic or approved equal.
1. Pipe shall be Schedule 40 standard weight black steel, ASTM 12 - Roll or cut grooved-ends as appropriate to pipe material, wall thickness, pressures, size and method of joining. Pipe ends to be grooved in accordance with Victaulic current listed standards conforming to ANSI/AWWA C-606.
 2. Mechanical couplings shall be manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure-responsive synthetic rubber, grade "E" EPDM. There shall be two type of couplings utilized:
 - a. Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1, B31.9, and NFPA 13. Victaulic Style 07 (Zero-Flex®).

- b. Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three Couplings shall be placed in close proximity to the vibration source. Victaulic Style 75 or 77.
3. Flange Adapters: For use with grooved end pipe and fittings, for mating to ANSI Class 125 / 150 flanges. Victaulic Style 741.
4. Grooved End Fittings: Fittings shall be cast of ductile iron conforming to ASTM A-536, Grade 65-45-12.
5. Hole-Cut Branch Outlets: Branch reductions on 2 inch through 8 inch header piping. Bolted branch outlets shall be manufactured from ductile iron conforming to ASTM A-536, Grade 65-45-12, with synthetic rubber gasket, and heat treated carbon steel zinc plated bolts and nuts conforming to physical properties of ASTM A-183. Victaulic Style 920 / 920N.
6. Grooved End Valves
 - a. Butterfly Valves are permissible only with this type of piping system, and shall be used for 2 inch and larger piping only. Valves shall be 300 psi CWP (2068 kPa) suitable for bidirectional and dead-end service at full rated pressure. Body shall be grooved end black enamel coated ductile iron conforming to ASTM A536. Disc shall be electroless nickel plated ductile iron with blowout proof 416 stainless steel stem. Disc shall be offset from the stem centerline to allow full 360 degree seating. Seat shall be pressure responsive EPDM. Valve bearings shall be TFE lined fiberglass, and stem seals shall be of the same grade elastomer as the valve seat. Valve operators shall be lever handle or gear operator, with memory stop feature. (Valve with EPDM seat is UL classified in accordance with ANSI/NSF-61.) Victaulic Vic®-300 MasterSeal™. Do not utilize butterfly valves in sizes under 2 inches.
 - b. Check valves in 2½ inch and 3 inch sizes shall be spring assisted, PPS coated ductile iron body, ASTM A-536, Grade 65-45-12, aluminum bronze non-slam tilting disc, stainless steel spring and shaft, EPDM rubber seat, 300 psi (2065 kPa). Victaulic Series 716.
 - c. Check valves in 4 inch through 12 inch sizes shall be spring assisted, black enamel coated ductile iron body, ASTM A-536, Grade 65-45-12, EPDM elastomer encapsulated ductile iron disc, stainless steel spring and shaft, welded-in nickel seat, 300 psi (2065 kPa). Victaulic Series 716.
7. Grooved End Specialties

Dielectric waterways: 1 inch through 8 inch sizes, grooved, plain end, or threaded end, ASTM A-53 carbon steel or ASTM A-536 ductile iron body, zinc electroplated, with LTHS high temperature stabilized polyolefin polymer liner. Victaulic Style 47.

8. Assembly
 - a. Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove.
 - b. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified.
 - c. See the latest copy of Victaulic's Field Assembly and Installation Instruction Pocket Handbook (I-100).
 - d. All grooved components (couplings, fittings, valves, gaskets, and specialties) shall be of one manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
 - e. Manufacturer shall provide on-site training for contractor's field personnel by a factory-trained representative in the proper use of grooving tools, application of groove, and product installation. Manufacturer's authorized representative shall periodically visit the job site and inspect installation. Contractor shall remove and replace any improperly installed products.

2.02 VALVES

A. General

1. Valves shall be provided as shown and as required to make the installation and its apparatus complete in operation, locate to permit easy operation, replacement and repair. All pressures specified are steam working pressure.
2. All valves must be so constructed that they may be repacked under pressure while open.
3. Globe valves shall be installed in all lines where regulation is required.
4. Check valves shall be installed in all lines where flow may reverse from intended direction.
5. Except for above or as otherwise noted on drawings, ball valves shall be installed in all supply and return lines and on all drain lines.
6. All valves to comply with federal specifications and be so listed.
7. Butterfly valves shall not be used with exception to a grooved piping option as previously outlined.

B. Types and Manufacturers

All valves shall be of one manufacturer and by one of the manufacturers listed. The following list is provided as a means of identifying the quality and type required.

1. Gate Valves 2 inches in size and smaller shall have bronze bodies, rising stem, solid wedge, union bonnet, rated for 150# WSP, 300# WOG:

	<u>Soldered Ends</u>	<u>Screwed Ends</u>
Milwaukee	1169	1151
Stockham	B-124	B-120
NIBCO	S-134	T-134
Hammond	IB648	IB629

2. Globe Valves 2 inches in size and smaller shall have bronze bodies, union bonnet, renewable composition disc for service intended, rated for 150# WSP, 300# WOG:

	<u>Soldered Ends</u>	<u>Screwed Ends</u>
Milwaukee	1590-T	590-T
Stockham	B-24-T	B-22-T
NIBCO	S-235-Y	T-235-Y
Hammond	IB423	IB413T

3. Globe Valves 2½ inches in size and larger shall have iron bodies, union trim, OS&Y, bolted bonnet, solid disc, gland packed, flanged ends. Rated for 125# WSP, 200# WOG:

	<u>Flanged Ends</u>
Milwaukee	F-2981
Stockham	G-512
NIBCO	F-718-B
Hammond	IR116

4. Plug type Globe valves 2 inches in size and smaller shall have bronze bodies, union bonnet, stainless steel plug type disc and seat. Rated for 150# WSP, 300# WOG:

	<u>Soldered Ends</u>	<u>Screwed Ends</u>
Milwaukee	591-A	
NIBCO	T-256-AP	

5. Ball valves 1¼ inches in size and smaller shall have bronze bodies, Type 316 stainless steel stems and balls, reinforced Teflon seats and seals, blow-out proof stems and adjustable stem gland. Shall be equipped with suitable packing for service intended. Ports shall be "full port". Rated for 400# WOG and 350°F:

	<u>Soldered Ends</u>	<u>Screwed Ends</u>
Milwaukee	BA-350S	BA-300S
Apollo	82-200	82-100
Watts	B-6081	B-6080
NIBCO	-----	-----
Hammond	8614	8604

6. Ball valves 1½ and 2 inches in size shall have bronze bodies, two piece, standard port, Type 316 stainless steel stems and balls, reinforced Teflon seats and seals, blow-out proof stems and adjustable stem gland. Shall be equipped with suitable packing for service intended. Rated for 400# Bar non-shock cold working pressure.

	<u>Soldered Ends</u>	<u>Screwed Ends</u>
Apollo	70-200	70-300
Watts	B-6000-SS	B-6001-SS
NIBCO	S-580-66	T-580-66
Hammond	8513	8503

7. Ball valves 2½ inches in size and larger shall have carbon steel bodies, Type 316 stainless steel stems, Type 351 stainless steel balls (vented), glass filled Teflon seats and seals and blow-out proof stems. Shall be equipped with suitable packing for service intended. Rated for 150# WOG and 350°F:

	<u>Flanged Ends</u>
Apollo	88-140
Watts	CF-1500-150-02-T316
NIBCO	F-510-CS-R-66-FS

8. Check Valves 2 inches in size and smaller shall be horizontal swing type with bronze body, Teflon disc. Rated for 125# WSP, 200# WOG:

	<u>Soldered Ends</u>	<u>Screwed Ends</u>
Milwaukee	1509-T	509-T
Stockham	B-310-T	B-320-T
NIBCO	S-413-Y	T-413-Y
Hammond	IB945	IB904

9. Check valves 2½ inches in size and larger shall be horizontal swing type with iron body, bronze trim and flanged ends. Rated for 125# WSP, 200# WOG:

	<u>Flanged Ends</u>
Milwaukee	F-2974
Stockham	G-931
NIBCO	F-918-B
Hammond	IR1124

2.03 INTERIOR HANGERS AND SUPPORTS

A. General

- All interior hangers and supports shall be specially manufactured for that purpose and shall be the pattern, design and capacity required for the location of use.
- Piping specified shall not be supported from piping of other trades.
- Hangers shall be steel, adjustable clevis type; plain for steel pipe and copper plated for copper tubing. Carpenter & Paterson, Inc., Fig. 100 (Fig. 100 CT copper plated) or approved equal. Hangers on hot water and drain piping shall be sized for the

piping only (not including insulation). Hangers on cold water piping, and where specifically indicated on drawings, shall be sized to include the insulation and include thermal hanger shields (insulated pipe supports).

4. Thermal hanger shields shall be Carpenter & Paterson, Inc., Fig. 265P or approved equal.
5. Exposed vertical risers $\frac{3}{4}$ inch and smaller shall be supported at the mid-point between floor and ceiling with split ring type hangers; copper plated for copper tubing. Carpenter & Paterson, Inc., Fig. 81 (Fig. 81 CT copper plated) or approved equal.
6. Piping suspended from walls, trench walls and partitions shall be supported by steel support bracket. Carpenter & Paterson, Inc., Fig. 69 or approved equal.
7. All steel hangers shall be factory painted.

B. Hanger Rods

1. Hanger rods shall be galvanized all thread rod. Rod size shall be as follows:

<u>Pipe Size</u>	<u>Rod Size</u>
$\frac{1}{2}$ " to 2"	$\frac{3}{8}$ "
$2\frac{1}{2}$ " to $3\frac{1}{2}$ "	$\frac{1}{2}$ "

2. Provide toggle bolts for fastening to concrete blocks and compound anchor shields for bolts for fastening to poured concrete.
3. Provide lag points with rod couplings or side beam connectors with drive screws for fastening to wood.
4. All nuts for hanger rod to be stainless steel.

C. Supports

Provide and install angle iron supports for pipe hangers as required. Angle iron supports shall be adequate size for span and piping or equipment load.

2.04 PIPE SLEEVES AND ESCUTCHEONS

A. Sleeves

1. Mechanical Contractor shall set sleeves for all piping penetrating walls and floors. Sleeves through masonry shall be steel pipe sleeves two sizes larger than the pipe. Pipe passing through walls other than masonry shall be provided with #24 gauge galvanized steel tubes with wired or hemmed edges.
2. Sleeves set in concrete floor shall finish flush with the underside, but extend a minimum of 1 inch above the finish floor. Sleeves set in partitions shall finish flush with each side.

Insert fittings shall be copper or brass, ASTM F 1807
Crimp rings shall be copper (black for PEX systems), ASTM F 1807

- C. PEX tubing must be labeled (on the tubing) as follows:
1. The manufacturer's name or trademark
 2. The standard to which it conforms (ASTM F876, F877, or both)
 3. Tube size and CTS
 4. Material designation code (PEX0006)
 5. Pressure/temperature rating(s)
 6. SDR9

The marking interval shall be not more than five feet.

2.08 UNDERGROUND WATER PIPING (PEX)

A. General

Furnish and install complete system of pre-manufactured, pre-insulated piping as shown on plans. The system shall consist of a polyethylene (PEX) service pipe encased in a multi-layered insulation and a waterproof, corrugated high-density polyethylene (HDPE) outer jacket. The system shall be capable of service temperatures up to 200°F. and working pressure to 125 psi. Underground portions of piping shall be run continuously and joint-free.

B. Properties

1. Tubing shall be PEX as specified in paragraph 2.07, "POLYETHYLENE (PEX) HEATING HOT WATER PIPING - ABOVE GROUND".
2. Insulation shall be closed cell, not less than 2.0 lb/ft³ density, R value of not less than 5.50 with 90mm (2.9 inch I.D.) service pipes. Water absorption shall be not more than 2.0% at 20°F when totally immersed in water for 24 hours.
3. Outer jacket shall be not less than 7.9 inches in diameter and NSF approved.

C. End Caps

End caps shall be provided to protect exposed ends of pipe system from damage and water penetration. Material shall be EPDM rubber and fastened to pipes and jacket with stainless steel draw band style clamps.

D. Sleeves and Compression Wall Seals

Where piping passes through foundation walls (into open basements) and floor slabs provide compression wall seals with a hydrostatic closure device shall consisting of identical interlocking links of solid synthetic rubber compounded to resist ozone, water, chemicals and extreme temperature variations. Each link shall be connected by corrosion resistant bolts and nuts to form a belt which is to fit snugly around the pipe. Under each bolt and nut there shall be a metal pressure plate so that when each nut is tightened the rubber links will expand between the pipe and sleeve to form a continuous, air tight and water tight seal. Device shall be a product of the piping system manufacturer.

- E. System shall be Ecoflex Thermo No. 500008 by Ecoflex Systems (www.ecoflex.com) or approved equal.

2.09 HOT WATER SPECIALTIES

A. Manual Balancing Valves

1. All mains, duct coils and elsewhere as indicated shall be provided with a balancing valve equipped with readout valves to facilitate the connecting of a differential pressure meter where indicated (locate on return lines at each duct coil). Each readout valve shall be fitted with an integral EP check valve designed to minimize system fluid loss during the monitoring process. Each balancing valve shall have an indexing pointer and calibrated name plate to indicate the degree of closure of the precision machine orifice. Each balancing valve is to be constructed with internal O-ring seals to prevent leakage around the rotating element.
2. Valves shall be sized with an operating pressure differential range of 1.50 psig (minimum) to 2.00 psig (maximum).
3. Provide a schedule clearly indicating every valve, its location, GPM, size and pressure drop.
4. Each balancing valve shall be Taco Circuit Setter with a working pressure of 175 psig and a maximum operating temperature of 250°F. Units by Bell & Gossett or Tour and Anderson will be considered.

B. Automatic Balancing Valves

1. All finned radiation, convectors, cabinet unit heaters, unit heaters, unit ventilators and elsewhere as indicated, shall be provided on the return line from each unit with a balancing type valve equipped with readout taps to facilitate the connecting of a differential pressure meter. Valve body shall include a handle ball valve, Y-strainer, flow control cartridge assembly, two (2) pressure/temperature plugs, inlet union and outlet union. Valve bodies shall be line size.
2. Design
 - a. The GPM for the automatic flow control valves shall be factory set and shall automatically limit the rate of flow to within 5% of the specified amount.
 - b. For ½ inch to 2 inch sizes the flow cartridge shall be removable from the Y body housing without the use of special tools to provide access for regulator changeout, inspection and cleaning without breaking the main piping (Access shall be similar to that provided for removal of a Y-strainer screen).
 - c. True operating ranges of 2 - 32 psid or 5 - 60 psid are required. The design flow should be achieved at the minimum psi differential. A 50% safety factor applied to the lower operating range is not acceptable.
 - d. Each valve shall have two PIT ports.
 - e. All automatic flow control devices shall be supplied by a single source and certified flow tests, witnessed by a professional engineer, shall be available.

- f. Provide factory product warranty of not less than five (5) years and free first year cartridge exchange.

3. Construction

- a. Internal wear surfaces of the valve cartridge shall be electroless nickel or stainless steel.
- b. Internal flow cartridge body shall have machined threads so the spring free height may be compensated for without the use of fixed shims. A crimped sheet metal design is not acceptable.
- c. Internal flow cartridge shall be permanently marked with the GPM and spring range.
- d. For ½ inch through 2 inch pipe sizes: An assembly shall consist of a brass Y-type body, integral brass body ball valve and 'O' ring type union. Flow Design "AutoFlow" Model AC or approved equal.
- e. For 2½ inch pipe sizes and larger: Ductile iron body suitable for mounting wafer style between standard 150# or 300# flanges. The long flange bolts and nuts shall be provided with each control valve. Flow Design "AutoFlow" Model WS or approved equal.
- f. All valves shall be factory leak tested at 100 psi air under water.

4. Minimum ratings

- a. ½ inch through 2 inch pipe size: 400 PSIG at 250DF
- b. 2½ inch through 14 inch pipe size: 600 P516 at 250⁰F
- c. 16 inch through 30 inch pipe size: 250 P516 at 250⁰F

5. Flow Verification

- a. Where indicated on the plans, the differential pressure across the Automatic Flow Control Valve shall be measured for flow verification and to determine the amount of system over heading or under pumping.
- b. Flow shall be verified by measuring the differential pressure across the coil served or the wide open temperature control valve and calculating the flow using the coil or valve Cv.

6. Test Kit

A differential pressure test kit shall be supplied to verify flow and measure overheading. The kit shall consist of a 42 inch diaphragm gauge equipped with ten foot hoses and P/T adapters all housed in a vinyl case. Calibration shall be 0-35 PSID for 2-32 PSI spring range or 0 - 65 PSID for 5-60 PSI range.

7. Installation

- a. Install automatic flow control valves on the return lines of coils as indicated on the plans. Balancing valve on supply side is not acceptable.
- b. The standard ports and handles shall clear 1 inch thick insulation. Handle and port extensions are required for over 1 inch thick insulation.

- c. Install, on the supply side of coils, a Y strainer with a brass blowdown valve with $\frac{3}{4}$ inch hose end connection with cap and chain.

B. Radiator Valves

All radiation loops shall be provided with ball valves on both supply and return ends for 125 psig at 250°F. as specified under valves.

C. Drains

Each downfeed convector, cabinet unit heater, unit heater, coil and unit ventilator shall be provided with a drain valve between the shut-off valves and heating equipment at the lowest point in the piping. All low points in piping mains shall be provided with drain valves. Drain valves shall be ball valves as specified under VALVES with hose connections and metal caps. Drain finned radiation with easily accessible drain couplings or drain elbows.

D. Air Vents

1. Air vents shall be installed at the equipment, all high points in the piping as indicated on the plans or as may be required.
2. Automatic air vents shall be Armstrong air vent traps No. 1-AV 2 inch with stainless steel trim. Units by Anderson or Sarco will also be considered. Gate valves shall be installed with each unit and the drains from the vents shall be run as indicated on the plans. An air chamber shall be installed at each air vent and shall be line size for all piping up to 2 inches in size; 2 inch for larger piping. Do not use on glycol systems, use manual vents only.
3. Manual air vents shall consist of air chamber with a Dole No. 14A Coin Valve with copper tube extension. Install valve in accessible location.
4. By-pass type vents shall be installed where shown and as detailed on the drawings. By-pass valves shall be plug-type globe as specified under VALVES.

E. Expansion Tank

Furnish and install vertical pressurized replaceable bladder type water expansion tank pre-charged to pressure indicated on drawings. Tank shall be constructed of steel for 125 psi working pressure in accordance with ASME Code, and have the necessary tappings for water connections and charging valve. Tank shall be furnished with ASME stamp and certification papers. A copy of ASME certification shall be provided with equipment submittal.

1. Tank shall be installed with a manual shut-off valve between the tank and the system and a union between the tank and the valve.
2. Tank shall be Taco CAX series. Units by Bell & Gossett or Wood will be considered. Capacities shall be as shown on drawings.

F. Backflow Preventer

Backflow preventer shall be furnished under division 15400, "PLUMBING".

G. Water Pressure Reducing Valve

Furnish and install a pressure reducing valve with brass body construction and built-in strainer in the cold water piping connected to hot water heating system as shown on the drawings. The valve shall be adjustable and be No. 335, as manufactured by Taco. Units by Bell & Gossett and Watts will be considered. Provide pressure relief valve with operating pressure 100% over system pressure, but not exceeding 100 psi.

H. Multi-Purpose (Triple Duty) Valve

Furnish and install straight pattern multi-purpose valves (check, balance and shut-off) on each pump discharge. Valves shall be sized with an operating pressure differential range of 1.50 psig (minimum) to 2.00 psig (maximum). Taco Model MPV or approved equal by Bell & Gossett.

I. Flow Control Valve

Furnish and install flow control valves with line size cast iron body and threaded ends. Working parts shall be easily removable for inspection and cleaning without removing valve body from the pipeline. Taco Model "Flo-Chek" or approved equal by Bell & Gossett.

J. Air Separator

Furnish and install Taco 4900-AD Series air separator. The unit shall be flanged and contain a micro-bubble air and dirt separator with blow down. Unit to be constructed in accordance with A.S.M.E. boiler and pressure vessel code and stamped 125 psig design pressure. Equal equipment by Bell & Gossett will be considered.

K. Piping Flexible Connections

1. Provide and install flexible connectors on all pumps as indicated on drawings.
2. Units shall be braided flexible connector constructed of stainless annular corrugated metal surrounded with a woven wire braid of high tensile stainless steel.
3. Units shall be line size.
4. Units shall have a minimum working pressure of 150 psig and 250°F, and a capacity of misalignment of 1/8 inch for units 2 inches and smaller, 1/2 inch for units 2 1/2 inches and larger. Units 2 1/2 inches and larger shall be flanged.
5. Units 2 inch and smaller to have screwed connections, 2 1/2 inch and larger to be flanged.
6. Units shall be as manufactured by KEFLEX or approved equal by Flex-Hose Co., Inc.

L. Pressure Gauges

Furnish and install pressure gauges with gauge cocks on piping where shown on drawings. Tubing to pressure gauges shall be of sufficient length to extend beyond pipe insulation and still leave enough space to easily operate the gauge cock. The dial range shall be such that the normal pressure shall be approximately midway of the dial. Gauges shall be Weiss Series 4CTS with 4½ inch dial size, stainless steel or cast aluminum case, with brass "T" handle cocks and bronze pressure snubbers. Units by Ashcroft, Nurnburg & Trerice will be considered.

Pressure range: Water Systems 0-60 psi

M. Thermometers

Furnish and install where indicated on the drawings and in Part 3 - EXECUTION, dial type thermometers with stainless steel case, 4½ or 5 inch dial size, bimetal, universal angle type. Thermometers shall be Weiss 5VBM series. Units by Ashcroft, Nurnburg & Trerice will be considered. Provide and install thermometer wells on supply and return branch piping to duct reheat coils (when present) and two thermometers in boxes for the Owner's use.

Temperature Range: Heating System... 30°F. - 240°F.

2.10 DOMESTIC HOT WATER STORAGE TANKS AND HEATERS

A. Storage Water Heaters

Furnish and install hot water storage tank and heaters of size and capacity, complete with all accessories as shown on drawings.

B. Tanks

Tanks shall have a storage capacity of 119 gallons, installed in a vertical position and constructed of 316L stainless steel in accordance with the ASME Code for Unfired Pressure Vessels to withstand a working pressure of 150 psi. Tanks shall be provided with a heating element, aquastat control tapping, cold water inlet and drain, hot water outlet and T&P relief valve connection. The heating element in the tank shall consist of a 90/10 cupronickel coil. Storage tank shall be covered with a 2 inch thick closed cell foam insulation. Outer covering shall be heavy duty rigid plastic. The entire unit shall carry a manufacturer's lifetime warranty. All connections shall be standard I.P.S. threads. The tanks shall be the dimension as shown on drawings.

C. Relief Valve

ASME temperature and pressure relief valves shall be provided and installed on the domestic hot water outlet by section 15400, "PLUMBING"

D. Units to be Super-Stor model SS-119 or approved equal.

2.11 CIRCULATING PUMPS

A. Circulating Pumps P-1, P-2, P-3, P-4 and P-5

1. Furnish and install hot water circulating pumps of the type, size and capacity shown on drawings. Pumps shall be vertical in-line, TACO KV Series. Pumps shall be compatible for use with Variable Frequency Drives. Pumps by Armstrong, Bell & Gossett or Weinman will be considered.
2. Pumps to be single stage, cast iron, bronze fitted construction. Pump internals shall be capable of being serviced without disturbing piping connections or motor.
3. Impeller shall be enclosed type, dynamically balanced, keyed to shaft and secured with suitable locknut.
4. Pump seals shall be standard single mechanical seal with carbon seal ring and ceramic (or tungsten carbide) seat. Replaceable shaft sleeve shall be furnished to cover wetted area of shaft under seal or packing.
5. Pump bearing frame assembly, as well as the motor, shall be furnished with oil-lubricated sleeve bearings with readily accessible lubrication fittings.
6. Pumps shall be factory tested at the operating condition, name plated for quiet operation as a unit, thoroughly cleaned, and painted with one coat of machinery enamel prior to shipment. Motors shall operate at 1,750 RPM, premium efficiency and conform to minimum efficiency requirements outlined in Paragraph 1.04, subparagraph D, part 12. A set of installation instructions shall be included with each pump at the time of shipment.
7. Pumps shall be mounted independently of the piping system and isolated as indicated on the drawings.

C. Circulating Pumps P-6, P-7 and P-8

1. Furnish and install hot water circulating pumps of the type, size and capacity shown on drawings. Pump shall be TACO 1600 Series Horizontal in-line design. Pumps by Armstrong, Bell & Gossett or Weinman will be considered.
2. Pumps to be single stage, cast iron bronze fitted construction. Pump shall incorporate a disc type lubrication system and be so designed that the bearing assembly can be removed in one piece.
3. The impeller shall be one piece cast bronze, enclosed type, dynamically and hydraulically balanced and keyed to the shaft. Pump shall have a two piece mechanical seal assembly easily replaceable without the use of special tools.
4. Pump bearing frame assembly, as well as the motor, shall be furnished with oil-lubricated sleeve bearings with readily accessible lubrication fittings.

5. Pumps shall be factory tested at the operating condition, name plated for quiet operation as a unit, thoroughly cleaned and painted with one coat of machinery enamel prior to shipment. A set of installation instructions shall be included with at the time of shipment. Motors shall operate at 1,750 RPM. A set of installation instructions shall be included with each pump at the time of shipment.

2.12 BOILER BURNER UNITS

- A. Furnish and install where shown on the drawings, cast iron, direct vent gas fired boiler units. Units shall be condensing type with one piece ceramic burners. Units shall be wired for 120 or 208 volts, 1 phase, 60 hertz power, see "Boiler Schedule", sheet M14.

- B. Compliances

ASME Compliance: Boilers shall bear ASME "H" stamp and be National-Board listed.
FM Compliance: Control devices and control sequences according to requirements of FM.
IRI Compliance: Control devices and control sequences according to requirements of IRI.
Comply with NFPA 70 for electrical components and installation.
CSD-1
SCAQMD Rule 1146.2 for low NOx equipment

- C. Design

Boilers shall be CSA design certified as a condensing boiler. Boilers shall be designed for a minimum of 3:1 continuous turn down with constant CO₂ over the turndown range. Boilers shall operate with natural gas and have a CSA certified input rating as noted on the drawings, and a thermal efficiency rating of 85% at rated input and 94.3% at minimum input. Boilers shall be symmetrically air-fuel coupled such that changes in combustion air flow or flue flows affect the BTUH input without affecting combustion quality. Boilers shall automatically adjust input for altitude and temperature induced changes in air density. Boilers shall use a proven pilot interrupted spark ignition system. Boilers shall use a UL approved flame safeguard ignition control system using UV detection flame sensing. The UV detector shall be air cooled to prevent condensate formation and so designed as to prevent misalignment. The design shall provide for silent burner ignition and operation. Boilers shall be down fired counter flow such that formed condensate always moves toward a cooler zone to prevent re-evaporation. An aluminum corrosion resistant condensate drain designed to prevent pooling and accessible condensate trap shall be provided. Boilers shall be able to vent a horizontal distance of 80 equivalent feet.

- D. Service Access

Boilers shall be provided with access covers for easily accessing all serviceable components. The boilers shall not be manufactured with large enclosures, which are difficult to remove and reinstall. All accesses must seal completely as not to disrupt the sealed combustion process. All components must be accessible and able to adjust with the removal of a single cover or cabinet component.

E. Indicating lights

Each boiler shall include a diagnostic control panel with a full text display indicating the condition of all interlocks and the BTUH input percentage. Access to the controls shall be through a completely removable cover leaving diagnostic panel intact and not disrupted.

F. Components

1. The combustion chamber shall be constructed of cast-iron.
2. Boilers shall be a cast iron sectional unit designed for pressure firing and shall be constructed and tested for 100 P.S.I water working pressure, in accordance with the A.S.M.E. Section IV Rules for the Construction of Heating Boilers. Individual sections will have been subjected to a hydrostatic pressure test of 250 PSIG at the factory before shipment and they shall be marked, stamped or cast with the A.S.M.E. Code symbol. Boilers with less than 250-psi pressure test will not be acceptable for this project. The sections shall be of a down fired counter flow single-pass design. Water ports will be sealed with graphite port connectors. The sections will be fully machined for metal to metal sealing of the gas side surfaces.. The design will provide for equal temperature rise through all sections. The heat exchanger shall be designed to prevent fluid boiling. The iron shall have a minimum thickness of 3/8 inch. The heat exchanger design should have no limitations on temperature rise or restrictions to inlet water temperature and a Cv of 100.
3. Jackets shall be stainless steel.
4. Gas burner shall be constructed of a reticulated Corderite Ceramic. The burner flame shall burn horizontally and be of the pre-mix type with a forced draft fan. Burner shall fire to provide equal distribution of heat throughout the entire heat exchanger. The burner shall be easily removed for maintenance without the disruption of any other major component of the boiler. A window view port shall be provided for visual inspection of the boiler during firing. The gas distribution components and burner shall be enclosed with a cast-aluminum housing.
5. The ignition hardware shall consist of Alumina ceramic insulated ignition electrodes and UV sensing tube permanently arranged to ensure proper ignition electrode and UV alignment.
6. Boilers shall be capable of operating at rated capacity with pressures as low as 2” W.C. at the inlet to the burner pressure regulator.
7. Burners shall be capable of 94.3% efficiency without exceeding a Nox reading above 30ppm.
8. Burners and gas train shall be provided with the following trim and features:
 - a. Burner Firing: Full modulation with 4:1 turndown @ Continuous CO2
 - b. Burner Ignition: Intermittent spark
 - c. Safety Controls: Energize ignition, limit time for establishing flame, prevent opening of gas valve until pilot flame is proven, stop gas flow on ignition failure, and allow gas valve to open.

- d. Flue-Gas Collector: Enclosed combustion chamber with integral combustion-air blower and single venting connection.
- e. Gas Train: Lubricated manual gas valves (2), main gas valve (motorized), 'B' valve, pilot gas pressure regulator, and automatic pilot gas valve. All components to be factory mounted.
- f. Safety Devices: High/Low gas pressure switches, air-flow switch, and blocked flue detection switch. All safeties to be factory mounted.

G. Boiler Trim

- 1. Safety-Relief Valve: ASME rated, factory set to protect boiler and piping as per schedule/drawings.
- 2. Gauge: Combination water pressure and temperature shipped factory installed. LCD inlet/outlet temperature gauges to be an integral part of the front boiler control panel to allow for consistent easy monitoring of temperatures factory mounted and wired.
- 3. Low Water Cut Off to prevent burner operation when water falls below a safe level. Low water cut off shall be factory mounted and wired. Provision for installation of a low water cut off shall be provided.
- 4. Operating controls shall be Honeywell RM7896C series digital flame safe guard. The flame safe guard shall be capable of both pre and post purge cycles.
- 5. Operating Temperature Control shall be a digital controller adjustable from 120 to 240 degrees F. Control shall be factory mounted and sense the inlet and outlet temperature of the boiler through resistance sensors.
- 6. High limit temperature control with automatic reset to limit boiler water temperature in series with the operating control. High limit shall be factory mounted and sense the outlet temperature of the boiler through a dry well.
- 7. Aluminum Condensate Receiver Pan
- 8. Low Air Pressure Switch
- 9. Blocked Flue Detection Switch
- 10. Manual Reset Low Water Cut Off (CSD-1 Factory Mounted and wired)
- 11. Modulation Control
- 12. Temperature/Pressure Gauge
- 13. Manual Reset High Limit
- 14. Air inlet filter
- 15. Inlet/Outlet Temperature Display

16. Full Digital Text Display for all Boiler Series of Operation and Failures
17. Variable Frequency Drive and Combustion Air Fan
18. Condensate Drain

H. Provide the following accessories from the factory for field installation:

1. Air inlet hoods for exterior termination of air intake pipes.
2. Vent termination hoods for exterior termination of vent pipes.
3. FM or IRI controls and gas train.

I. Controls

Each boiler shall maintain set temperature as determined by their own internal controls. A separate Mod-Smart control shall be provided by the factory to sequence the two boilers. The control shall be set up to change lead and lag boilers on each start. The control shall be programmed so that when the lead boiler reaches about 70% of maximum input the second boiler is brought on line and once running then both boilers are run at a reduced input level to match the load requirements.

J. Units shall be Hydrotherm Model KN-10 and KN-20, each shipped in one piece on skids. Start-up and one (1) year's service shall be provided by the Contractor. Units by the following manufacturers will be considered:

1. Aerco KC Series
2. Viessmann Vertomat
3. Lochinvar Intellifin Series (only)
4. Buderus SB Series

K. Testing

Testing all pressure parts of the boilers shall be subjected to hydro-static tests according to ASME Code for low pressure boilers. Field tests shall be limited to maximum working pressure for which each boiler is intended. Contractor shall furnish all equipment, piping, water and labor necessary to perform such tests as may be required by the Boiler Inspector or as directed by Architect. Tests shall be of duration necessary to satisfy Boiler Inspector and Architect.

L. Startup and Commissioning

1. Engage a factory-authorized service representative to provide startup service. Start up to be performed only after complete boiler room operation is field verified to offer a substantial load, and complete system circulation. One-year warranty shall be handled by factory authorized tech.

2. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 16 Sections. Do not proceed with boiler startup until wiring installation is acceptable to equipment Installer.
3. Complete manufacturer's installation and startup checklist and verify the following:
 - a. Boiler is level on concrete base.
 - b. Flue and chimney are installed without visible damage.
 - c. No damage is visible to boiler jacket, refractory, or combustion chamber.
 - d. Pressure-reducing valves are checked for correct operation and specified relief pressure. Adjust as required.
 - e. Clearances have been provided and piping is flanged for easy removal and servicing.
 - f. Heating circuit pipes have been connected to correct ports.
 - g. Labels are clearly visible.
 - h. Boiler, burner, and flue are clean and free of construction debris.
 - i. Pressure and temperature gages are installed.
 - j. Control installations are completed.
4. Ensure pumps operate properly.
5. Check operation of pressure-reducing valve on gas train, including venting.
6. Check that fluid-level, flow-switch, and high-temperature interlocks are in place.
7. Start pumps and boilers, and adjust burners to maximum operating efficiency.
 - a. Fill out startup checklist and attach copy with Contractor Startup Report.
 - b. Check and record performance of factory-provided boiler protection devices and firing sequences.
 - c. Check and record performance of boiler fluid-level, flow-switch, and high-temperature interlocks.
 - d. Run-in boilers as recommended or required by manufacturer.
8. Perform the following tests for each firing rate for high/low burners and for 100, 66, and 33 percent load for modulating burners. Adjust boiler combustion efficiency at each firing rate. Measure and record the following:
 - a. Gas pressure on manifold.
 - b. Combustion-air temperature at inlet to burner.
 - c. Flue-gas temperature at boiler discharge.
 - d. Flue-gas carbon-dioxide and oxygen concentration.
 - e. Natural flue draft (if applicable).
9. Measure and record temperature rise through each boiler.

M. Warranty Period

Manufacturer's standard, but not less than 10 years from date of Substantial Completion on the heat exchanger. Warranty shall be non-prorated and not limited to thermal shock. Additional 21-year thermal shock warranty on heat exchanger.

N. One Year Service

Each boiler-burner unit shall be provided with free service period of one (1) year after acceptance by Owner. This service will include parts replacement and repair, excluding normal maintenance and adjustment. This service shall be a factory authorized service.

2.13 SMOKE PIPE

- A. Smoke pipes shall meet all requirements of a category IV positive pressure smoke venting systems. Furnish and install as indicated on drawings, a double wall, pre-fabricated vent system complete with all required supports, braces, stiffeners and hangers. Sizes indicated on drawings are minimum inside diameters required by the boiler manufacturer. Weather caps (termination hood) shall be provided by the boiler manufacturer. Inner wall shall be AL29-4C stainless steel, no less than 0.024 inches thick. The outer jacket (casing) shall be aluminized steel, no less than 0.024 inches thick. A minimum space of 1 inch shall be provided between the outer and inner walls. System shall be UL-1738 listed and comply with ANSI Z21.47, NFPA 54 and the National Fuel Gas Code. Shop drawings shall carry documentation of such.
- B. Vent pipe and accessories shall be Corr/Guard Model CG by Metal-Fab, Inc. or approved equal by Metalbestos for systems using natural gas and shall be installed in strict accordance with the manufacturer's instructions and all applicable N.F.P.A., B.O.C.A. and local codes and ordinances.

2.14 FINNED RADIATION

- A. Finned pipe radiation shall consist of ¾ inch copper tube with aluminum fins. Each radiator shall have the finned length and heating capacity indicated on the drawings.
- B. Covers for all types shall be 18 gauge steel, residential style with full back plates and continuous dampers. Back plate (factory painted) shall be securely fastened to the wall studs with screws at 48 inch centers maximum. Elements shall be supported by approved slide cradles and universal brackets spaced a maximum of 48 inches on center. Provide return line hangers where shown on drawings. Covers shall have baked enamel finish in white color.
- C. Unless shown differently on the drawings, the covers shall be a minimum of 1'-6" longer than the finned length. End covers or wall sleeve and wall sleeve supports shall be provided for each end of the cover.
- D. All ratings shown on the drawings are based on 170°F. average water temperature with a 20°F. temperature drop and 2.0 gallons per minute flow rate. The following types are based on Haydon to establish a standard:
 - 1. Type "A" to be single tier element, 10¼ high x 3.13/16 inch deep enclosure, 2½ x ¾ inch aluminum fins, 55 per linear foot Haydon Supr-Heat 1000-1A.

2. Type "B" to be single tier element, 7¼ high x 3.3/16 inch deep enclosure, 2.1/8 x 2.1/2 inch aluminum fins, 55 per linear foot. Haydon Heat-Base 750.
- E. Units by Rittling and Sterling will be considered. However, if capacities cannot be met in the lengths indicated, additional lengths must be provided to meet minimum required output at no additional cost. Provide itemized list of exact amount of finned tube and cover to be provided in each room and output capacities

2.15 CONVECTORS

- A. Convectors of the size and types listed on the drawings shall be provided and installed. They shall have removable front panels. Backs and end enclosures of the cabinets shall be constructed of not less than 20 gauge steel. Fronts and tops shall be of not less than 18 gauge steel, if less than 48 inches long and 16 gauge if 48 inches or longer. Elements shall consist of round seamless copper tubes, non-ferrous fins securely fastened to the tubing, taps at each end for venting on up-feed units and drains on down-feed units, with ratings as shown on the drawings. Cabinets shall have baked enamel finish in color to be selected by Architect. Provide not less than two (2) color chip cards with submittals (photocopies not acceptable). Ratings shown on the drawings based on 170°F. average water temperature with a 20°F. temperature drop as indicated on the drawings.
- B. The following types are based on Rittling to establish a standard:
1. Surface mount, wall hung, flat top with front outlet grille and bottom inlet; Type WL.
 2. All units shall be firmly fastened to the wall studs.
- C. Units by Dun-Ham Bush, Sterling, Trane Co. and Vulcan will be considered.

2.16 DUCT HEATING COILS

- A. General
- Furnish and install, where indicated, duct mounted water heating coils, sizes and capacities as indicated on drawings. Coils shall be serpentine type (no headers), 1 row with same end piping connections.
- B. Tube and Fins
- Tubes shall be round, seamless 0.020 inch copper tubing tested at not less than 315 lbs and guaranteed for 250 psig working pressure. Tubes shall be staggered in the direction of air flow. Fins shall be rippled aluminum with full drawn collars to provide a continuous surface cover over the entire tube. The use of internal restrictive devices to obtain turbulent flow is not permitted.

D. Casing

Casing shall be constructed of continuous galvanized steel, designed for slip-in installation. Ductwork shall be fabricated in such a manner to permit vertical removal (from the bottom) of coils.

E. Coils shall be Trane Type T. Units by Carrier, McQuay or York will be considered.

2.17 CABINET UNIT HEATERS

A. Cabinet unit heaters shall be provided and installed where shown and fastened securely. The units shall be mounted as indicated on the drawings and shall include multi-blade centrifugal fans with quiet operating three (3) speed high efficiency direct drive motor, insulated casing, coils of copper tubes with aluminum fins, tamper proof access door to motor control switch. Capacities indicated on drawings to be based on 180°F. inlet water with a 20°F. drop.

B. All units shall be provided with 3 speed fan switch and unit mounted disconnect switch with thermal overload protection, all factory installed and wired.

C. Cabinets shall be 18-gauge steel with exposed corners and edges rounded, easily removed access panels. Finish shall be factory applied baked enamel in color as selected by Architect on visible surfaces of enclosure or cabinet. Provide two (2) color chip cards with submittals (photocopies not acceptable).

D. Cabinet insulation shall be 2 inch thick dual density bonded glass fiber. Exposed side shall be high density erosion proof material suitable for use in airstreams up to 4500 FPM.

E. Coils shall be evenly spaced aluminum fins mechanically bonded to copper tubes, designed for 200 psi and 220 degrees F.

F. Provide two (2) sets of 1 inch *pleated media* throwaway type filters for each unit as specified under paragraph 2.22, "FILTERS". One set to be provided WITH each unit from the manufacturer to be used during construction and the other set installed when project is completed.

G. Units shall be vertical configuration, floor mounted, Rittling Model RF with remote heavy duty line voltage electric thermostat and strap-on aquastat provided by A.T.C. Contractor as indicated. Approved equals by American Air Filter, McQuay or Trane will be considered.

H. Shut-off valve, balancing valve, drain valve with metal cap and air vent shall be provided on each unit.

2.18 HORIZONTAL UNIT HEATERS

A. Furnish and install hot water type horizontal propeller unit heaters as shown. Motors shall be totally enclosed and provided with overload protection and factory wired service disconnect switch.

B. Units shall have coils with copper tubes and aluminum fins. Supply connections shall be in at the rear bottom and return out the rear top.

- C. Provide adjustable, horizontal directional louvers on each unit and controls indicated in "AUTOMATIC TEMPERATURE CONTROL".
- D. Shut-off valve, balancing valve and drain with metal cap shall be provided with each unit.
- E. Units shall be Rittling Model RH. Units by American Air Filter, McQuay or Trane Co. will be considered.

2.19 HEAT RECOVERY UNITS (HRU)

- A. Provide and install rooftop, curb mounted air to air heat recovery units as shown on drawings. Capacities shall be as scheduled on drawings.
- B. Units shall be listed per ANSI/UL 1995, Heating and Cooling Equipment. Energy transfer ratings of the energy recovery wheel shall be ARI Certified. Units shall bear the AMCA Certified Rating Seals for Air Performance. Performance shall be as scheduled on plans. Exhaust discharge and outside air intake shall not be located on the same side of unit casings.
- C. Standard casing panels shall be 20 gauge galvanized steel, lined with ½ inch thick neoprene insulation. Housings shall be supported by a formed structural base forming a pan to ensure weather tight construction. Lifting holes shall be provided at the unit base. Units shall have a weatherproof sheet metal roof. The outdoor air intake opening shall be protected by a galvanized steel sheet metal weather hood and include an automatic shutoff damper with electric operator and time delay relay to give the damper an opportunity to open prior to the fan starting. The exhaust air discharge shall be covered with a gravity back draft damper and weather hood. The exterior of the unit shall be coated with an epoxy primer and a polyurethane enamel painting system for added protection. Painting system shall be rated to meet a 1500-hour salt spray test.
- D. Access to components shall be provided through a large, tightly sealed and easily removable access panel. Access panels shall be constructed of the same materials as the unit casing. The wheel cassette shall be easily removable from the unit. The roof of the unit shall also be removable for access.
- E. The supply air and exhaust air from the building shall be oriented for a vertical inlet and discharge.
- F. Fans shall be double width double inlet design with forward curve type wheels. The blades shall be designed for maximum efficiency and quiet operation. Impellers shall be statically and dynamically balanced.

Fans shall be driven using belts and sheaves. Motors shall be standard NEMA frame with open drip-proof enclosures. V-belt drives shall be designed for a minimum 1.2 service factor.

- G. The rotor media (energy wheel) shall be made of aluminum, coated to prohibit corrosion. All surfaces shall be coated with a non-migrating adsorbent specifically developed for the selective transfer of water vapor. The desiccant shall utilize a 3A molecular sieve certified by the manufacturer to have an internal pore diameter distribution which limits adsorption to materials not larger than the critical diameter of a water molecule (2.8 angstroms). Verification in writing shall be presented from the desiccant manufacturer confirming that

the internal pore diameter distribution inherent in the desiccant being provided limits adsorption to materials not larger than the critical diameter of a water molecule (2.8 angstroms). In addition, the face of the media shall be coated with an acid resistant coating to provide maximum protection against face oxidation. Equal sensible and latent recovery efficiencies shall be clearly documented through a certification program conducted in accordance with ASHRAE 84 and ARI 1060 standards. The media shall be cleanable with low temperature steam, hot water or light detergent, without degrading the latent recovery. Dry particles up to 600 microns shall freely pass through the media. Wheel media shall be independently tested and shown to conform to the requirements of NFPA-90A, documenting a flame spread of less than 25 and a smoke generation rating of less than 50.

Manufacturers using wheels with a rotor based on non-aluminum materials (i.e., paper, plastic or Mylar) that require periodic replacement shall provide the owner with a spare wheel or equivalent wheel segments for future use and storage.

- H. The cross-contamination characteristics of the selected desiccant shall also be certified by an independent third party. If said certification is not available, the outside air requirement for each specified unit shall be multiplied by a factor given in the table below for each desiccant. It shall be the contractor's responsibility to resize the duct work / air conditioning equipment and take responsibility for proper system operation at the higher OA CFM if a desiccant other than 3A is used.
- I. The rotor cassette shall be a sheet metal framework, which limits the deflection of the rotor due to air pressure. The cassette shall be made of galvanized steel to prevent corrosion. The rotor cassette shall be easily removable from the Energy Recovery Unit to facilitate rigging (if necessary) and ease of service. The wheel cassette design shall use pillow block bearings for long life. A non-adjustable purge sector shall be included in the cassette.
- J. Filters shall be 1 inch thick permanent aluminum washable type mounted in the outside air hood and in the return air plenum. The filters shall be listed by Underwriters' Laboratories as Class 2.
- K. Units shall include an integral airflow monitoring station with the ability to read both ventilation and exhaust airflow expressed in CFM. Monitor gauge to be flush mounted on unit exterior and watertight. Monitor shall be SEMCO Model AQFlow or Ruskin Model IAQ50 Integral Monitor/Damper, or approved equal.
- L. Units shall be equipped with a rotation sensor and controller such that should the energy recovery wheel not rotate during a signaled run period, the controller shall send a 24 volt AC signal suitable for operating a relay to be used as an alarm contact. The controller shall not initiate an alarm during a stop/jog function. In addition, this controller shall be equipped with an outdoor air temperature sensor such that the energy recovery wheel can be stopped during moderate temperature periods if desired. The controller shall perform a stop/jog function for the wheel long enough to promote the self-cleaning features of the wheel but not long enough to induce energy recovery. This same temperature controller shall allow the energy recovery wheel to be operated in stop/jog mode during very low temperature periods to prevent freezing of the wheel while still delivering outdoor air through the unit

- M. Units shall be equipped with an outdoor air temperature thermostat such that the energy recovery ventilator can be stopped during very low temperature periods. This thermostat shall stop the both the fans and the energy recovery wheel until the outdoor air temperature rises above the set point, then the unit will restart automatically.
- N. Units shall require a single 60-cycle power connection. See schedule for voltage and phase requirements. The electrical panel shall consist of individual motor contactors, variable frequency drives (VFD) for supply and exhaust fan motors, short circuit and overload protection and control power transformer. VFD's must either be pre-wired at the factory or the cost for field wiring provided by the vendor. VFD's shall be calibrated for 100% and 50% fan operation with inputs for connection to external controls (see paragraph "P" below). The NEMA 3R electrical panel shall be mounted on the unit exterior for ease of access. Unit shall be ETL listed and labeled.
- O. Manufacturer shall warrant to Owner that for a period of not less than eighteen (18) months from the date of shipment the goods to be delivered to Owner will in all material respects be free from defects in material and workmanship when used in a proper and normal manner. Should any failure to conform to the above appear within eighteen months after the date of shipment, manufacturer agrees upon prompt notification thereof during the Warranty Period and confirmation to manufacturer's satisfaction that the goods have been stored, installed, operated and maintained properly and in accordance with standard industry practice, to correct the non-conformity at manufacturer's option either by repairing any defective part or parts or by making available at manufacturer's plant a repaired or replacement part.
- Manufacturer shall warrant to the Owner for a period of not less than 60 months that the wheel contained in the energy recovery unit in all material respects to be free from defects in material and workmanship when used in a proper and normal manner. For warranty purposes the wheel includes, media, desiccant coating, wheel hub, wheel rim and spokes.
- P. Provide a remote control panel for each unit located in the Mechanical Room (1-B01) of Building 1 and 5th floor storage room of Building 2. Panels shall contain:
1. A 24 hour clock with 2 occupied and 2 unoccupied settings to permit the Owner to determine how many hours per day the units shall run at 100% capacity and at 50% capacity. Clock outputs shall be connected to unit VFD's.
 2. Rotation detection
 3. On-Off-Auto switch
 4. Wheel Stop/Jog Frost Protection
- Q. Provide factory authorized start-up and Owner training by a factory authorized representative.
- P. Units shall be Semco FV series for vertical ducting. Units shall be provided with factory insulated curbs not less than 14 inches high. Contractor shall fill the curbs with fiberglass batt insulation for added thermal and sound protection.

Equivalent units by Greenheck will be considered.

2.20 FANS

A. General

1. Fans with capacity and types shown on the drawings shall be provided and installed. All roof curbs, unless otherwise noted, shall be provided by the fan manufacturer and installed by the General Contractor. This Contractor shall furnish the General Contractor with the correct sizes of roof curbs bases for units supplied. In order to establish a standard, fan model numbers indicated below are based on Cook (unless noted otherwise). Equivalent units by Acme and Greenheck ONLY will be considered.
2. Fan selection shall be based on sloping portion of curve with spare capacity of 20% of total CFM and static pressure without increasing motor size. **Provide full fan curves with submittals that shown the entire operating range of the fan - not just the operating point. Fans that are submitted without this data will not be accepted.**
3. All fans shall bear the AMCA Certified Ratings Seal for sound and air performance and shall be listed by the Canadian Standards Association Testing Laboratory (CSA). Sones indicated on drawings are maximum allowable.
4. All roof fans shall be provided by this Contractor with a continuous ½ inch thick neoprene rubber curb gasket covering the full thickness of the curb wall.
5. All fans shown with vibration isolators on drawings shall be provided with spring type unless otherwise indicated.
6. Motor operated dampers shall be furnished by ATC Contractor.
7. Wall caps shall be provided where indicated and shall include weather hoods extending to the bottom of the outlet. Units shall be 26 gauge (min) paintable galvanized steel with 0.020 inch damper. All units for exhaust fans and range hoods shall be identical in appearance and shall be provided by Aldes Ventilation Corp. (<http://www.americanaldes.com>) or Artis Metals Company (<http://www.artiscaps.com/exhaust.html>).
8. Roof curbs shall be not less than 13½ inches high, insulated, self-flashing type designed for EPDM roofing systems. Curbs shall include a damper shelf and be structurally designed to adequately support no less than twice the weight of the equipment to be placed on them.

B. Types

1. BF-1, 2 and 3 shall be in-line, direct driven, centrifugal booster fan. Fantech Model FR 140.

Fans shall be manufactured at an ISO 9001 certified facility. Fans shall be listed by Underwriters Laboratories (UL 705) and UL listed for Canada (cUL 705). Fan shall bear the AMCA certified ratings seal for sound and air performance.

Housing shall be constructed of a UL recognized, thermoplastic resin and be fully vaportight. Unit shall be suitable for temperatures up to 140°F.

Provide units with junction box for field power wiring and integral pressure switch (prewired) to start fan when air flow (from dryer) is detected on inlet side of fan.

2. EF-1, 2, 3 and 6 shall be ceiling mounted, direct driven, centrifugal exhaust fan, Models GC 120-180.

Fans shall be manufactured at an ISO 9001 certified facility. Fans shall be listed by Underwriters Laboratories (UL 705) and UL listed for Canada (cUL 705). Fan shall bear the AMCA certified ratings seal for sound and air performance.

Wheel housing and integral outlet duct shall be injection molded from a specially engineered resin exceeding UL requirements for smoke and heat generation. The outlet duct shall have provision for an aluminum backdraft damper with continuous aluminum hinge rod. The inlet box shall be minimum 22 gauge galvanized steel. Motor shall be isolation mounted to a one piece galvanized stamped steel integral motor mount/inlet. A field wiring compartment with receptacle shall be standard. To accommodate different ceiling thickness, an adjustable prepunched mounting bracket shall be provided. A white, aluminum grille shall be provided as standard. Units shall be shipped in ISTA certified transit tested packaging.

Wheel shall be centrifugal forward curved type, injection molded of polypropylene resin. Wheel shall be balanced in accordance with AMCA Standard 204-96, *Balance Quality and Vibration Levels for Fans*.

Accessories shall include a pre-wired fan speed controller for balancing purposes (all fans) and a time delay switch for EF-1 only.

Motors shall be open drip proof type with permanently lubricated sealed bearings and include impedance or thermal overload protection and disconnect plug. Motor shall be furnished at the specified voltage and phase.

3. EF-5 shall be ceiling mounted, direct driven, centrifugal exhaust fan, Model GC 200-900.

Fan shall be manufactured at an ISO 9001 certified facility. Fan shall be listed by Underwriters Laboratories (UL 705) and UL listed for Canada (cUL 705). Fan shall bear the AMCA certified ratings seal for sound and air performance.

Housing shall be minimum 20 gauge galvanized steel and acoustically insulated. Blower and motor assembly shall be mounted to a minimum 14 gauge reinforcing channel and shall be easily removable from the housing. Motor shall be mounted on rubber-in-shear vibration isolators. Unit shall be supplied with integral wiring box and receptacle. Discharge position shall be convertible from right angle to straight through by moving interchangeable panels. The outlet duct collar shall include a reinforced aluminum damper with continuous aluminum hinge rod and brass bushings. To accommodate different ceiling thickness, an adjustable prepunched mounting bracket shall be provided. A powder painted white aluminum grille shall be provided as standard. Unit shall be shipped in ISTA certified transit tested packaging.

Wheel shall be centrifugal forward curved type, constructed of galvanized steel. Wheel shall be balanced in accordance with AMCA Standard 204-96, *Balance Quality and Vibration Levels for Fans*.

Accessories shall include a pre-wired fan speed controller for balancing purposes.

Motor shall be open drip proof type with permanently lubricated sealed bearings, built-in thermal overload protection and disconnect plug. Motor shall be furnished at the specified voltage and phase.

4. EF-7 shall be equal to ACE-B Series centrifugal roof exhauster. Fans shall be a spun aluminum, roof mounted, direct driven, downblast centrifugal exhaust ventilator.

Fan shall be manufactured at an ISO 9001 certified facility. Fan shall be listed by Underwriters Laboratories (UL 705) and UL listed for Canada (cUL 705). Fan shall bear the AMCA certified ratings seal for sound and air performance.

Fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 16 gauge marine alloy aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. The discharge baffle shall have a rolled bead for added strength. An integral conduit chase shall be provided through the curb cap and into the motor compartment to facilitate wiring connections. Bearings and drives shall be mounted on a minimum 14 gauge steel power assembly, isolated from the unit structure with rubber vibration isolators. These components shall be enclosed in a weather-tight compartment, separated from the exhaust airstream. Unit shall bear an engraved aluminum nameplate and shall be shipped in ISTA certified transit tested packaging.

Wheel shall be centrifugal backward inclined, constructed of 100% aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency.

Wheel shall be balanced in accordance with AMCA Standard 204-96, *Balance Quality and Vibration Levels for Fans*.

Motor shall be heavy duty type with permanently lubricated sealed ball bearings and furnished at the specified voltage, phase and enclosure. A disconnect device/switch shall be factory installed and wired from the fan motor to a junction box. Standard wiring shall comply with National Electric Code and NBFU Standards and the fan shall be listed by Underwriters Laboratories (UL705). Thermal overload protectors shall be standard.

Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy duty regreasable ball type in a cast iron housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.

Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts.

Drives shall be sized for 150% of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan RPM.

Accessories shall include fully insulated roof curbs, gravity backdraft dampers and hinged bases.

5. EF-8 shall be Model CVB all aluminum in-line centrifugal blower.

Fan shall be manufactured at an ISO 9001 certified facility. Fan shall be listed by Underwriters Laboratories (UL 705) and UL listed for Canada (cUL 705). Fan shall bear the AMCA certified ratings seal for sound and air performance.

Unit shall be belt driven, all aluminum construction, fully rotatable housing, designed for operation at any angle, straightening vanes, regreasable bearings (200,000 hour rated) in a cast housing. Provided extended lube lines, motor and belt cover, prewired disconnect, flexible duct connector and rubber-in-shear hanging rod isolators. Fan shall be provided with a five year (minimum) warranty.

Motor shall be 208 volts, 60 hz, three phase, premium efficiency, open drip proof type with permanently lubricated sealed bearings and internal overload protection.

6. SF-1 shall be Model SWD series direct driven propeller fan.

Fan shall be manufactured at an ISO 9001 certified facility. Fan shall be listed by Underwriters Laboratories (UL 705) and UL listed for Canada (cUL 705). Fan shall bear the AMCA certified ratings seal for sound and air performance.

Fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. Motor shall be mounted on a 12 gauge steel wire guard. The wire guard shall be bolted to a minimum 14 gauge wall panel with continuously welded corners and an integral venture. Unit shall bear an engraved aluminum nameplate and shall be shipped in ISTA certified transit tested packaging.

All steel fan components shall be Lorenized™ with an electrostatically applied, baked polyester powder coating. Each component shall be subject to a five stage environmentally friendly wash system, followed by a minimum 2 mil thick baked powder finish. Paint must exceed 1,000 hour salt spray under ASTM B117 test method.

Propeller shall have aluminum blades riveted to a painted steel hub. The hub shall be securely fastened to the motor shaft utilizing two setscrews. Propeller shall be balanced in accordance with AMCA Standard 204-96, *Balance Quality and Vibration Levels for Fans*.

Motor shall be 115 volts, 60 hz, single phase, open drip proof type with permanently lubricated sealed bearings and internal overload protection.

Provide propeller side guard.

7. Range Hoods

Kitchen range hoods shall be designed for under cabinet mounting, convertible for ducted or recirculating operation, provided with sockets for (2) PAR20 lamps, 3 speed fan switch and light switch. Lamps to be provided by Div. 16. Units to be 30 inches wide, baked-on white polyester finish with washable aluminum mesh grease filter. Blower shall be centrifugal.

Units shall be Nutone Allure Model WS130WW with knockouts for both 7 inch diameter and 10 inch x3/4 inch top duct connection or approved equal. Units to be configured as shown on plans.

Wall caps shall be provided where indicated and shall include weather hoods extending to the bottom of the outlet. Units shall be 26 gauge (min) paintable galvanized steel with 0.020 inch damper. All units for exhaust fans and range hoods shall be identical in appearance and shall be provided by Aldes Ventilation Corp. (<http://www.americanaldes.com>) or Artis Metals Company (<http://www.artiscaps.com/exhaust.html>).

2.21 SHEETMETAL

A. General

The work under this section includes all the required sheetmetal and duct work, extensions for grilles, manual dampers, automatic counterbalanced (backdraft) dampers, deflectors, setting of control dampers, grilles, registers, , flexible connections, fire dampers, and louvers, as shown on the drawings or required to make the installation complete in accordance with the intent of the drawings and specifications.

B. Ducts

1. The size of ducts marked on the drawings will be adhered to as closely as possible. The right is reserved to vary duct sizes to accommodate structural conditions during the progress of the work without additional cost to the Owners. The duct layout is schematic to indicate size and general arrangement only. All ducts shall be arranged to adjust to "field conditions". The Sheet Metal Contractor shall coordinate his work with Division 16 and other trades.
2. Medium and low pressure ducts shall be constructed of galvanized steel in accordance with the following table of duct sizes OR the latest SMACNA HVAC Duct Construction Standards for Metal and Flexible Duct, whichever is stricter, unless otherwise shown on drawings.

Low pressure ducts:

<u>Dimensions of Longest Side</u> (inches)	<u>Minimum Sheet</u> <u>Metal Gauge</u>
Up thru 12	26
13 --> 30	24
31 --> 42	22

3. Methods of fabrication and installation shall be in strict accordance with guidelines set forth in the latest SMACNA Guide and Data Book for Low and Medium Pressure Duct Construction unless otherwise shown on drawings. Cross break all ducts with largest dimension being 18 inches and larger. Beaded ducts are not acceptable except for ductwork less than 18 inches in either direction.
4. All dampers and deflectors shall be a minimum of #22 gauge and stiffened as required. Splitter dampers shall not be acceptable.
5. All joints in ducts shall be made air tight, and all branches and turns shall be made with long radius elbows and fittings. Long radius elbows are defined as having a centerline radius of 12 times the width of the duct. If long radius elbows are not used, elbows 18 inches wide and larger shall be provided with fixed double wall airfoil turning vanes designed to reduce the resistance of the elbow to the equivalent of a long radius elbow with a throat radius of not less than duct width. Square elbows less than 18 inches wide shall be provided with single wall turning vanes. Square elbows with outside corners cut at 45° or rounded are not acceptable.
6. All ducts shall be installed with necessary offsets, changes in cross sections, risers, and drops which may be required. They shall be constructed with approved joints and be supported in an approved manner.
7. Round ductwork shall be constructed in accordance with the latest SMACNA HVAC Duct Construction Standards for round and oval duct construction. Ductwork larger than 8 inches in diameter shall employ spiral seams. All turns shall be made with smooth (not segmented), long radius elbows and fittings. All seams shall be type RL-5, grooved seam pipe lock or better. *Lap seams are not permissible*. Gauge thicknesses shall be as outlined in SMACNA for galvanized steel round duct gauge selections for maximum 2 inches w.g. static pressure. Ductwork shall be supported with full wrap-around band and single hanger strap as indicated in Figure 4-4 of the 1985 edition of the SMACNA HVAC Duct Construction Standards handbook.
8. Furnish and install flexible connections on exhaust fans (where indicated), horizontal unit ventilators, horizontal cabinet unit heaters and all Mechanical units. Connections shall be made from Ventglas neoprene coated glass fabric as furnished by Ventfabrics, Inc., or approved equal.
9. Every precaution shall be taken to keep interior of duct system free from dirt and rubbish and to protect all ducts and equipment during construction. At completion, this Mechanical Contractor shall thoroughly clean all equipment to the satisfaction of the Architect.
10. Spaces between ducts and wall or floor construction shall be caulked to make smoke and water tight with 3M brand fire barrier caulk CP25 or putty 303, Ciba-Geigy CS240 Firestop Sealant or approved equal.
11. Testing, Balancing and Leak Testing... See Part 3, EXECUTION

12. Requirements set forth in applicable codes (see part one) shall supercede SMACNA standards.

C. Grilles and Registers

Grilles and/or registers shall be installed at all air supply, relief, return and exhaust openings as shown. All units to be aluminum, except as noted, and provided with baked enamel finish to match color of grille or register and countersunk screw holes. Mounting screws shall be oval head type with head painted to match finish. Unless stated otherwise, the following list is based on model numbers of Anemostat to establish a standard of quality. Krueger, Price and Titus will also be considered for review. If substituting, certified sound criteria shall be included with submittals (and highlighted) indicating CFM and NC levels of each register and grille.

1. Supply Registers: Double deflection; X2HO with opposed blade damper and ¾ inch front blade spacing; front blades set horizontal.
2. Supply Grilles: Double deflection; X2H, ¾ inch blade spacing; front blades set horizontal.
3. Transfer Grilles: X3HD with ¾ inch, 45° front blade spacing, front blades set horizontal.
4. Exhaust and Return Registers: X3HOD with opposed blade damper and ¾ inch, 45° front blade spacing, front blades set horizontal.
5. Heavy Duty Exhaust Grilles: HDD, steel construction with 45° blade spacing, blades set horizontal.

D. Louvers

1. All exterior louvers shall be extruded aluminum construction with interior bird screens and anodized in color to be selected by Architect. Provide not less than 2 color chip cards with submittals for review (photocopies not acceptable). Frames and blades shall a free area of not less than 47% (combination type) and 55% (stationary type) and no less than 0.081 inches thick. The following list is based on model numbers of Ruskin to establish a standard of quality; approved equal units by American Air Warming and Arrow are acceptable.
2. Unit ventilator louver (see Part 4, "ALTERNATES") shall be combination type with front stationary blade with adjustable rear damper. Unit to be 6 inches deep with certified rating of zero water penetration at free area velocity of 900 FPM based on tests in accordance with AMCA Standard 500. Operator to be automatic with motor provided and installed by ATC Contractor. Damper to be low leakage with edge and jamb seals and not exceed leakage of 4 CFM per square foot of face area on a 48 inch wide unit with 2 inches of differential static pressure. Units shall be drainable blade, Model ELC6375DAX.
3. All other louvers shall be stationary blade type. Units to be 6 inches deep with certified rating of zero water penetration at free area velocity of 900 FPM based on tests in accordance with AMCA Standard 500. Units 48 inches and less in width shall be Model ELF6375X. Units greater than 48 inches in width shall have drainable blades, Model ELF6375DX.

4. Frames of all louvers to be box type with factory mounting flanges on head and side jambs with extended sill for units mounted in frame walls.
5. Louvers in doors shall be provided as a part of the door by the General Contractor.

E. Brick Vents

1. All brick vents to be extruded aluminum construction with inside bird screens and anodized finish in color to be selected by the Architect. Provide not less than 2 color chip cards with submittals for review (photocopies not acceptable).
2. All units shall be 8 inches deep and modular in dimension to fit 4 inch standard brick sizes. Units shall be minimum 0.125 inch thick with integral water stop, weep holes and continuous drip edge. Units shall be structurally designed to eliminate need of wall lintels with ¼ inch ribs and full depth headers at 16 inch centers (minimum).
3. Units shall be BVC100 as manufactured by Ruskin or approved equal. Provide sample if substituting.

F. Duct Sleeves

Provide aluminum duct sleeves through outside wall at all locations as shown on drawings.

G. Sealing of Ducts

All interior ductwork (except prefabricated grease ducts and welded duct) shall be sealed with low VOC water based duct mastic, either "MP" (Multi-Purpose), Hardcast "Iron-grip 601", Polymer Adhesive "Airseal #11", or United Duct Seal (United McGill Corp.) water base, latex or acrylic type sealant. All transverse joints to be continuously sealed. Note that, except as noted, oil or solvent based sealants are specifically prohibited for use on this project. Duct tape, in any form or material, is also prohibited.

For exterior applications, "Uni-Weather" (United McGill Corp.) neoprene based sealant shall be used. No other sealants may be used.

All seams and joints in shop and field fabricated ductwork shall be sealed by applying one layer of sealant, then immediately spanning the joint with a single layer of 3" wide open weave fiberglass tape. Sufficient additional sealant shall then be applied to completely imbed the cloth.

All sealants shall be UL rated at no more than flame spread of 5 and smoke developed of 0. At contractor's option Hardcast 1602 sealant tape may be used in lap joints and flat seams.

h. Duct Access Doors

Hinged insulated access doors with seals shall be provided in ducts where indicated on drawings, or as required. Units shall be provided at each manual damper, motor operated damper, duct coil (both sides), duct mounted temperature control device and fire damper unless accessible through grilles and as shown on drawings. Units to be Ruskin Model ADH-22 or approved equal by Elmdor.

I. Motor Operated Dampers

Motor operated control dampers mounted in ductwork shall be provided by ATC Contractor, but installed by this Contractor. Contractor shall seal dampers to ductwork to provide a completely waterproof and airtight seal between damper frames and ductwork.

J. Manual Dampers

1. See Part 3, EXECUTION for installation notes.
2. Manual dampers with smallest dimension 5 inches or less shall be shop fabricated, single 22 gauge blade, 3/8 inch rod, provided with position indicator and locking quadrant.
3. Manual dampers with smallest dimension larger than 5 inches but smaller than 11 inches shall be single blade steel, 16 gauge construction, provided with position indicator and locking quadrant. Unit shall be Ruskin Type MD35 or approved equal.
4. Manual dampers with smallest dimension larger than 11 inches shall be opposed blade steel, 16 gauge construction, linkage concealed in frame, provided with position indicator and locking quadrant. Unit shall be Ruskin Type MD35 or approved equal.
5. Dampers to be installed in aluminum ductwork shall be fabricated of aluminum or isolated from ductwork with rubber grommets between the damper and the duct to prevent oxidation between dissimilar metals.
6. Provide hand quadrants for all manual dampers, Ventline Model 560 or approved equal.

K. Backdraft Dampers

Except where provided with exhaust fans, provide and install automatic counterbalanced backdraft dampers where indicated on the drawings. Unit frames shall be channel type, constructed of 0.090 inch extruded aluminum. Blades shall be 0.025 inch formed aluminum with extruded vinyl edge seals. Unit shall employ aluminum blade linkage concealed in the frame and adjustable zinc plated counterbalance bar on blades (except on top blade). Units shall be capable of being mounted in any position, Ruskin Model CBD2 or approved equal. Contractor shall seal dampers to ductwork to provide a completely waterproof and airtight seal between damper frames and ductwork.

L. Fire Dampers

1. Fire dampers shall be installed to comply with NFPA Code No. 90A and shall bear a U.L. label. Provide fire rated access door at each fire damper not accessible through grille. All dampers shall comply with UL555 for dynamic testing and positive closure under air flow.

2. All fire dampers to be provided by damper manufacturer with integral sleeves and mounting angles. Sleeves provided "in-field" are not acceptable. Models indicated are Ruskin to establish a standard:
 - a. Wall and floor types; Model IBDT, style "B".
 - b. Wall type behind grilles; Model IBD20, Style G
3. Units (not located behind grilles) shall be style "B" with the curtain isolated out of the stream.
4. Provide factory mounted fusible links designed to melt at 165°F. and close the damper.
5. Installation shall be in accordance with damper manufacturer's instructions.

2.22 FILTERS

- A. All cabinet unit heaters with filter banks and unit ventilator (see Part 4, "ALTERNATES") shall be provided with a minimum of three (3) sets of filters with pleated media. One set to be used during construction (and replaced by the Mechanical Contractor during construction if required as determined by the Clerk of the Works and/or the Mechanical Engineer). Second set to be installed a minimum of one (1) day and a maximum of three (3) days prior to testing and balancing and/or final inspection. The third set shall be turned over to the Owner in their original unopened shipping boxes for their future use.
- B. Filters shall be Farr 30/30, Air Guard DP-40 or approved equal; 1 inch thick.

2.23 EQUIPMENT IDENTIFICATION

Tag each new fan (except kitchen range hoods), circulating pump, heat recovery units, boiler, unit ventilator, unit heater, cabinet unit heater and switch with rectangular engraved nameplates with white letters on black, Brady Corp., Seton Name Plate Corp. or approved equals. Nameplates shall be mechanically fastened to equipment (adhesives are not acceptable). Embossed labels are not acceptable.

On Air Handlers, Return Fans and air handling Units nameplates shall be 4 inches by 1½ inches, Setonply Style No. M1774. On all other units nameplates shall be 2½ inches by ¾ inch, Setonply Style No. M1771.

Identify all heating hot water supply and return piping with "Set Mark" full snap-around pipe markers by Seton Name Plate Corporation or approved equal by Brady Corp. Markers shall include both identification and direction of flow. Use yellow background with black letters. Markers shall be no less than 10 feet apart except in boiler rooms and mechanical rooms where they shall be not less than 20 feet apart. Identification shall read "Heating Water Supply" or "Heating Water Return" as applicable. Domestic hot and cold water piping shall be labeled differently from heating water piping.

Tag all valves (if not tagged by valve manufacturer) with 1½ inch round brass tags and #6 bead chains, Seton #M4506. Tag shall be consecutively numbered. DO NOT DUPLICATE EXISTING VALVE IDENTIFICATION NUMBERS. Provide valve charts identifying valve number, valve identification and service. Mount charts in Boiler Room and Mechanical Room in 8½ inch x 10 inch and 8½ inch x 11 inch self-closing aluminum frame with plastic windows. Identify ducts and fire dampers with ventmark HVAC markers.

2.24 INSULATION AND CONDENSATE PROTECTION

A. General

1. Insulation shall be provided for all new metallic hot water supply and return piping, refrigerant piping, outside air intakes, relief ducts and other insulation where shown on drawings.
2. Insulation systems shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less.

B. Hot Water Supply & Return Piping

1. All new metallic hot water supply and return piping, exposed, above ceilings, within walls, pipe chases or pipe enclosures, shall be insulated with heavy density fiberglass pipe insulation with 450°F. temperature rating and factory applied ASJ jacket. Longitudinal jacket flaps to be secured with flare type stainless steel staples. Cut insulation to include pipe hangers.

Insulation thickness for hot water shall be as follows:

<u>Pipe Size</u>	<u>Insulation Thickness</u>
½" - 8"	1½"

Insulation thickness for hot water run-outs off mains and in partitions shall be as follows:

<u>Pipe Size</u>	<u>Insulation Thickness</u>
½" - 1"	1"

2. All fittings shall be wrapped with fiberglass insulation and covered with a one piece PVC insulated fitting cover secured with flare type stainless steel staples.
3. The ends of insulation on exposed pipes at valves, flanges, unions, etc., shall be finished neat with covering to match jacket and secured with mastic.
4. All valves 2½ inches and larger shall be wrapped with fiberglass insulation, covered and finished neat with covering material to match ASJ jacket on pipe insulation and secured with mastic.

5. Valves less than 2½ inches in size, flanges and unions shall not be insulated. Exception: All valves for cold water application shall be insulated.
6. Underground PEX tubing is pre-insulated and not covered under this portion of the specification. Above ground PEX tubing within the buildings shall not be insulated.

C. Duct and Equipment Insulation

1. Insulate the following ducts with 3 inches thick fiberglass duct wrap with factory applied vapor barrier facing:
 - a. Ductwork in Elevator Machine Room 1-B05
 - b. Ductwork from EF-6 (Elevator Machine Room 2-109) above the Living Room in unit 2-103.
 - c. Ductwork associated with dryer exhausts in Building 2 as indicated on enlarged plan on sheet M8.
 - d. Intake plenums behind louvers for SF-1 and boiler combustion air in Mechanical 1-B02.
 - e. All supply ducts between heat recovery units and duct coils.
 - f. Exhaust ducts for apartment range hoods from exterior walls to 72" inside building.
3. Insulate unit ventilator cabinets behind motor and pipe end pockets with fiberglass insulation. Pack each compartment full of insulation before units are mounted against wall.
4. Material to carry U. L. label. All laps to be sealed and held in place with adhesive and flare staples. All lap joints to be folded under before stapling so no raw insulation will be showing. On the bottom of ducts 24 inches or wider, mechanical fasteners shall be provided approximately 12 inches O.C.

D. Air Separator

Air Separator shall be insulated with 2 inch thick heavy density fiberglass insulation with ASJ jacket. Insulation to be securely fastened. Finish cover insulation with 14 ounce re-wettable canvas. Note: Manufacturer's identification plates shall remain exposed with insulation material tapered down to plate and finished as specified above.

E. Condensate Protection

Solder or weld bottom and sides of ducts connected to outdoors to prevent water leaks from rain and snow. Seal duct wrap and liner to minimize condensation.

F. Installation

All insulation work shall be executed by skilled insulation workmen regularly employed in the trade.

2.25 AUTOMATIC TEMPERATURE CONTROL (ATC)

A. General

1. Furnish and install a complete system of electric/electronic temperature controls.
2. The control system shall be manufactured and installed by either of the following (listed alphabetically):
 - a. Barber Colman
Maine Controls
400 Presumpscot Street
Portland, Maine 04103
(207) 774-0220
 - b. Honeywell, Inc.
501 County Road
Westbrook, Maine 04092
(207) 775-3501
 - c. Johnson Controls
39 Salem Street
P.O. Box 840
Lynnfield, MA 01940
1-800-288-1028, ext. 4478
 - d. Siemens Building Technologies
66 Mussey Rd.
Scarborough, Me. 04074
(207) 885-4110
3. The control systems shall be provided and installed by trained control mechanics regularly employed in installation and calibration of ATC equipment by the manufacturer or manufacturer's franchised dealer of temperature control equipment.

NOTE: Control installation is not acceptable by wholesalers, contractors or by any firm whose principal business is not directly involved with the manufacture and installation of ATC systems.
4. Shop drawings of entire control system shall be submitted for approval before work is started.
5. Provide ATC technician to test the complete ATC systems sequences for specified cycles of operation with the Testing and Balancing Contractor.
6. ATC Contractor must, at the end of the warranty period, furnish the Owner with all access codes and passwords assigned to the ATC control systems. ATC Contractor shall also instruct the Owner in the use of all digital control software and provide a backup copy of the final software package to the Owner on CD.

B. Scope

Control system shall consist of all area thermostats, air stream thermostats, valves, dampers, damper operators, relays, transformers, labor, 7day program clocks and other accessory equipment, and a complete system of wiring to fulfill intent of ATC specification. Control shall be provided for, but not limited to the following:

1. Unit ventilator and air conditioning systems (see part 4, "ALTERNATES")
2. Direct radiation
3. Fans operated by automatic temperature control system
4. Cabinet and horizontal unit heaters
5. Heat recovery units
6. Re-set master and sub-master and valve for control of the heating water.
7. Control of circulating Pumps.

C. Incidental Work by Others

1. The following incidental work shall be furnished by the designated contractor under the supervision of the Control Contractor.
 - a. Mechanical Contractor shall:
 - (1) Install automatic valves and separable wells that are specified to be supplied by the Control Contractor.
 - (2) Furnish and install all necessary valved pressure taps, water, drain and overflow connections and piping.
 - b. Sheet Metal Contractor shall:
 - (1) Install all automatic dampers.
 - (2) Provide necessary blank-off plates required to install dampers that are smaller than duct size.
 - (3) Assemble multiple section dampers with required interconnecting linkages and extend required number of shafts through duct for external mounting of damper motors.
 - (4) Provide access doors or other approved means of access through ducts for service to control equipment.
 - c. The General Contractor shall:
 - (1) Provide all necessary cutting, patching and painting.
 - (2) Provide access doors or other approved means of access through ceilings and walls for service to control equipment.
 - d. Division 16 shall:
 - (1) Provide wiring as described in Fan Schedule on sheet M-9.
 - (2) Wire power to all motor operated dampers.

D. Electric Wiring

1. All low voltage and data wiring for installation of temperature controls shall be by ATC Contractor, except as noted. Power wiring for equipment shall be by Division 16, "ELECTRICAL". See Part 1, Paragraph 1.04, sub-paragraph C, "MECHANICAL ELECTRICAL WORK" for specific requirements. Exception: Power wiring from circuit breaker to temperature control panel(s) will be provided and installed by the ATC Contractor.
2. ATC Contractor shall be responsible for coordinating installation of his wiring conduits with Division 16, "ELECTRICAL".

E. Submittal Brochure

1. The following shall be submitted for approval:
 - a. Control drawings with detailed wiring diagrams, including bill of material and description of operation for all systems.
 - b. Panel layouts and name plate lists for all local and central panels.
 - c. Valve and damper schedules showing size, configuration, capacity and location of all equipment.
 - d. Product data for all control system components.

F. Instruction and Adjustment

Upon completion of the project, the Temperature Control Contractor shall:

1. Adjust for use by Owner, all thermostats, controllers, valves, damper operators, and relays provided under this section.
2. Furnish two (2) instruction manuals covering function and operation of control systems for use of the Owner's operating personnel. A competent technician shall be provided for instruction purposes.
3. Provide training in the setting, use and care of the ATC systems. Training shall commence after the Owner has taken possession of the building and shall not exceed three (3) hours. Cost of additional training shall be negotiated between the Owner and ATC Contractor.

G. Guarantee

Control system shall be guaranteed to be free from original defects in both material and workmanship for a period of not less than one (1) year of normal use and service. This guarantee shall become effective starting the date Architect agrees Owner has begun to receive beneficial use of the system.

H. Hazardous Materials

Mercury, or any other material deemed hazardous by the Federal Environmental Protection Agency or the State of Maine Department of Environmental Protection, shall not be used in any components of the ATC system.

I. Control Panels

1. Provide and install surface mounted control panels with dust tight gasketed, hinged door with enamel finish where indicated herein and on the drawings. All switches, relays and equipment necessary for system operation shall be provided in control panel including the following:
 - a. Separate thermometers indicating outdoor air, boiler water and re-set water temperature (on face of panel).
 - b. Pump selector switches (on face of panel)
 - c. Install engraved plastic identifying tags for each switch on unit.
2. All electric wiring within the panel shall be factory wired to terminal strips.

J. Thermostats

1. General

All thermostats shall be mounted at 48 inches above finish floor to top.

2. Apartments and common areas.

- a. Direct Radiation: Thermostats shall be low voltage, digital, single temperature, with large L.E.D. temperature display. Units shall be capable of having a programmed high limit setting of 74°F. with the capability for the Owner to alter as desired.
- b. Thermostats shall not contain mercury or any other toxic material.
- c. Honeywell T8400C1040-TL as modified by E/S Monitrol, Inc. for heating limit only or approved equal (<http://www.esmonitrol.com>).
- d. Provide clear, tamperproof covers in corridors and common areas.

3. Community Room (base bid) – same as apartments and common areas but with clear, tamperproof cover.

4. Community Room (unit ventilator, see Part 4, “ALTERNATES”)

- a. Thermostat shall be low voltage digital, programmable type. Thermostat shall have a seven day programming with two occupied and two unoccupied settings per day. Manual changeover from heating to cooling shall be provided. Fan and outdoor air control shall also be provided.
- b. Thermostats shall have large, lighted digital scale.
- c. Honeywell Visionpro or equal.

5. Unit heaters and fans controlled by thermostats

Heavy duty, line voltage, all metal type. Reverse acting for exhaust fan 3, exhaust fan 7 and supply fan 3.

6. Cabinet unit heaters

- a. These thermostats shall be of the single temperature type intended for use in visible areas.
- b. Heavy duty with concealed adjustment and heavy duty clear plastic tamper proof covers.

K. Low Temperature Safety Thermostat

Electric low temperature warning thermostats shall have 20 ft. low point sensitive elements (not averaging type) installed to cover the entire duct area. These thermostats shall be two position manual reset type. Freeze-Stats shall be provided and wired to shut down the supply fan.

L. Automatic Control Valves

1. Direct radiation

All automatic control valves for direct radiation shall be two position. Valves shall be quiet in operation and fail safe in the normally open position in the event of control power failure. All control valves shall be line size and guaranteed to meet the heating loads as specified. All control valves shall be suitable for the pressure conditions and shall close against the differential pressure involved. Valve operators shall be low voltage. Body pressure rating and connection type (screwed or sweat) shall conform to pipe schedule in this specification.

2. Duct heating coils

All automatic control valves for duct heating coils shall be fully proportioning with modulating plug or V-port inner guides, unless otherwise specified. The valves shall be quiet in operation and fail safe in the normally open position in the event of control power failure. Control valves shall be sized by the control manufacturer for a maximum of 3 psi pressure differential and guaranteed to meet the heating loads as specified. All control valves shall be suitable for the pressure conditions and shall close against the differential pressure involved. Valve operators shall be low voltage. Body pressure rating and connection type (screwed or sweat) shall conform to pipe schedule in this specification.

M. Miscellaneous Devices

Provide all the necessary relays, transformers, valves, positioners, switches, etc. to make a complete and operable system.

N. Dampers

1. Control dampers shall have 16 gauge galvanized frames not less than 2 inches in width with airfoil blades not less than 14 gauge galvanized steel, and shall be adequately braced to form a rigid assembly. No dampers shall have blades more than 6 inches wide. Dampers shall be painted with one coat of lacquer. Dampers shall be two position or proportioning as required by specific application, opposed blade type with linkage concealed within the frame. Oilite bronze bearings shall be

provided at the ends of damper blades. ALL DAMPERS SHALL BE MOUNTED WITH BLADES ORIENTED HORIZONTALLY.

2. Damper operators shall be provided with bracket arrangement for location outside of air stream wherever possible. All damper motors shall be sufficient size to operate dampers, including slow opening and fast closing.
3. Dampers shall be provided with flexible metal edge and jamb seals and neoprene blade edge seals for tight closure. Leakage shall be certified to be no more than 2.0 CFM per square foot at 1 inch w.g. on units 24 inches wide and larger, 3.0 CFM per square foot at 1 inch w.g. on units less than 24 inches wide.
4. Control dampers furnished by the Automatic Temperature Control Contractor shall include motor operated dampers installed in supply fan 1 and 2 ducts. Dampers at all combination wall louvers shall be furnished by manufacturer of louver equipment involved.
5. Dampers shall be Ruskin Model CD60 or approved equal by Air Balance or Arrow.

O. Description of Operation

1. System shall be hot water with water supplied from the boilers at a maximum of 180°F, with 20°F drop through the heating system.
2. Reset Water Control

Provide a control sequence and hardware to maintain the water temperature to the system by modulating (resetting) boiler output temperature. The water temperature shall be reset to provide 180°F water @ 20°F outdoors to 130°F water @ 65°F outdoors (and higher). As the outside temperature falls, the supply water temperature shall be decreased. On a rise in outdoor air temperature, the temperature of the water shall be decreased.

Additional control shall be provided to give priority to domestic hot water. Whenever pumps P-6, P-7 or P-8 activate, the reset water controller shall increase boiler output temperature to 180°F water for as long as required.

Coordinate with boiler manufacturer's literature for required control components and sequences not provided with boilers.

3. Boiler Sequencing Control

Provide a control to sequence boilers as follows; Boiler #2 shall lead in providing heat as required by the building heating systems and domestic hot water. If this boiler is not capable of meeting demand then it shall be deactivated and Boiler #1 shall take the lead. Should boiler #2 not be capable of meeting demand then both boilers shall function together.

During low demand conditions a lead lag controller shall permit lead-lag operation of the boilers. Boiler number 2 shall remain the lead boiler for a set timed interval and when the interval expires Boiler number 1 shall become the lead unit. Set

intervals initially for one week with an override and time adjustment mounted on the face of the ATC panel in the Boiler Room.

Coordinate with boiler manufacturer's literature for required control components and sequences not provided with boilers.

4. Control of Circulating pumps

a. Heating Pumps (P-1, P-2, P-3 and P-4)

Provide pump selector switches (P-2/OFF/P-3) located on face of ATC panel. Pump selected shall run continuously when outdoor temperature is below 62°F. and off above 65°F. (adjustable). Electrical Contractor shall provide a variable frequency drive for each pump. A pressure sensor by ATC shall be installed in the hot water supply main downstream of the pumps. As radiation zone valves close and pressure builds in the supply main a controller shall reduce the speed of the selected operational pump to maintain pressure setting as determined by the controller. Each pump selector switch shall have nameplates identifying pump numbers as well as building numbers served by the pumps.

b. Boiler Circulation Pump (P-5)

Boilers shall be provided with a recirculating pump. When either boiler immersion aquastat calls for heat the pump shall be activated and a flow switch (provided by boiler manufacturer) shall verify flow before permitting burners to ignite. Coordinate with boiler manufacturer's literature for required control components and sequences not provided with boilers.

c. Domestic Hot Water Pumps (P-6, P-7 and P-8)

Each domestic hot water storage heater is provided with it's own pump to supply boiler water to the heat exchanger coil. Each pump shall be controlled by an immersion aquastat (adjustable setpoints) to be provided and installed into the tank by the ATC Contractor. Pumps shall have a high limit (off) of 140 deg. F. and a low limit (on) of 120 deg. F.

d. Domestic hot water recirculation pump (DCP-1)

Pump shall cycle on call from an immersion aquastat (by ATC) to be located in the return water line. Temperature setting shall be adjustable. See plumbing drawings for piping diagrams.

5. Occupied-Unoccupied Control

There shall be no automatic occupied to unoccupied control.

6. Control Panel

Provide a control panel where indicated in Mechanical Room 1-B02. The panel shall contain the hot water reset controller, temperature indicators showing outdoor air temperature, boiler discharge temperature and supply (reset) water temperature. Panel shall also contain controls for EF-4, (locate EF-7 control in Mechanical 2-107) and EF-8. All relays and accessories to accomplish the specified sequence of control shall also be contained in the panel.

7. Direct radiation

All direct radiation shall be controlled by single temperature thermostats and two position zone valves. When a thermostat calls for heat the zone valve opens.

8. Heat Recovery Units

Heat recovery units shall operate from their own internal controls. Each unit will be provided with a factory control panel, each to be mounted adjacent to the ATC panel in the Mechanical Room. Label each panel to coincide with the HRU controlled. ATC contractor shall be responsible to mount panels and provide ATC wiring.

9. Unit Heaters

- a. Horizontal Type: Units to be controlled by heavy duty line voltage thermostats and trap-on aquastat by Temperature Control Contractor.
- b. Cabinet Unit Heaters: Vertical units to be supplied with thermostats furnished and installed by Temperature Control Contractor. Provide each unit with strap-on aquastat.

10. Unit Ventilator (see Part 4, "ALTERNATES")

- a. Controls shall consist of a programmable digital space thermostat (which shall determine occupied/unoccupied periods), a low limit thermostat, damper motor for the outdoor air and return air dampers, electric freeze protection thermostats, mixed air control thermostat, and switches to start and stop the unit motor.
- b. The control cycle shall be ASHRAE "Cycle II". Whenever the unit runs during unoccupied, the outdoor air damper shall be closed. The unit ventilator shall run continuously during occupied and intermittent with 100% return air during unoccupied. During the occupied cycle the thermostat maintains its room temperature setpoint as follows: Whenever the room temperature is below the room thermostat setpoint, the outdoor air and return air dampers are in their full return air position and the coil hot water valve is in the full open position, the unit delivers its full heating capacity. During occupied periods the outdoor and return air dampers open to their scheduled minimum position (10% outdoor air & 90% return air) and the coil valve modulates to provide heat as required by the setpoint of the room thermostat and low limit discharge controller.
- c. As the room temperature reaches the room thermostat setpoint, the outside air and return air dampers are opened to their minimum outdoor air position. On a continued rise in room temperature, the coil valve modulates closed,

followed by modulating of the outdoor air and return air dampers to their full outdoor air position. The freeze protection thermostat (automatic reset) shall stop the unit ventilator motor and close outside air damper whenever the air discharge temperature is less than 40°F (adjustable).

- d. In the cooling mode the outdoor air dampers shall be set to their minimum position and the heating coil valve is fully closed. The compressor/condenser unit shall cycle to provide mechanical cooling as needed.

11. Duct Heating Coils (DHC)

- a. A modulating valve on the hot water supply to each duct heating coil shall modulate to provide heat in response to discharge temperature. Locate the sensor within 20 feet downstream of each coil. Set initially for 75°F.
- b. When outdoor temperature falls below 40°F, the valves shall open to maintain not less than 33.1/3 percent flow through each coil at all times regardless of HRU operation. A freeze protection thermostat shall open the hot water valve 100% if discharge temperature falls below 50°F. If discharge temperature falls to 40°F, power to the HRU shall be interrupted. Provide an alarm relay with a signal to the Community Room Office, exact location to be determined. A delay shall be built into the freeze protection to permit time for the coil to reach initial warm up if the fan has been off for more than one hour.
- c. Mount setpoints for freeze protection and discharge thermostats adjacent to each HRU control panel. Panel for HRU-1 shall be located in Mechanical 1-B02, Building 1. Panel for HRU-2 shall be located in 5th floor storage room, Building 2.

12. Fans shall operate as indicated on "FAN SCHEDULE" on sheet M14. Provide 120 volt motor operated dampers to open when fans cycle (where indicated); wiring by Division 16 unless noted otherwise.

- a. Exhaust Fans 1, 2 & 5 to operate from separate switches provided by Division 16.
- b. Exhaust Fans No.4 and 7 shall be operated from outdoor air sensors. When outdoor air temperature reaches 65°F. (adjustable) motorized dampers shall open and fans shall operate continuously. Locate temperature setpoint and hand-off-auto switch for each fan in ATC panels previously described.
- c. Exhaust Fans 3 & 6 and Supply Fan 1 shall operate from heavy duty, 120 volt reverse acting cooling thermostats.
- d. Exhaust Fan No. 8 shall be operated from a 24 hour time clock located in the control panel in Mechanical Room 1-B02. Clock shall have at least two occupied (on) and two unoccupied (off) setpoints. On the face of the control panel provide a H-O-A switch with an identification tag clearly stating "EF-8 (Parking)". Fan is 208 volts, 3 phase.

PART 3 – EXECUTION

3.01 SURFACE CONDITIONS

A. Inspection

1. Prior to all work of this Section, carefully inspect the installed work of all other trades and verify that all work is complete to the point where this installation may properly commence.
2. Verify that Mechanical systems may be installed in strict accordance with all pertinent codes and regulations and the approved shop drawings.

B. Discrepancies

1. In the event of discrepancy, immediately notify Architect.
2. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.02 INSTALLATION OF PIPING AND EQUIPMENT

A. General

1. All piping shall be installed within building insulation.
2. Size and general arrangements as well as methods of connecting all piping, valves, and equipment shall be as indicated, or to meet requirements for complete installation.
3. All vertical pumps shall be supported independently of the piping system.
4. All piping shall be erected to provide for easy and noiseless passage of hot water under all working conditions. Inverted eccentric reducing fittings shall be used whenever water pipes reduce in size in the direction of flow. Tee fittings with reduction in the main direction of flow (run) are not acceptable.
5. All hot water mains shall be run level or pitch slightly upward so that no air pockets are formed in piping. Mains shall be set at elevations so runouts feeding heating equipment shall have no pockets where air can collect or automatic vents shall be provided.
6. Where preset balancing valves are used, it is critical that there not be two valves installed in series anywhere throughout the piping system.
7. Provide drains with hose threads and metal caps at all low points in the water piping system.
8. In erection of hot water piping care must be taken to make allowance for expansion and contraction; piping shall be anchored as necessary to control expansion.

9. Runouts to hot water radiation shall be size indicated on plans.
10. Install brass fittings at all points of dissimilar piping connections.
11. Install a sufficient number of unions or flanges to facilitate assembly and disassembly of piping and removal of equipment.
12. Install all piping promptly, capping or plugging all open ends and making pipe generally level and plumb, free from traps, and in a manner to conserve space for other work.
12. Inspect each piece of pipe, tubing, fittings, and equipment for defects and obstructions; promptly remove all defective materials from the job site.
13. Install pipes to clear all beams and obstructions; do not cut into or reduce the size of load carrying members without the approval of the Architect.
14. All risers and offsets shall be substantially supported.
15. Make all changes in pipe size with approved reducing fittings.
16. All low points in water piping shall be provided with an accessible plug tee or drain valve.
17. All high points in water piping shall be provided with an accessible automatic vent.
18. Maximum spacing of pipe hangers (for metallic piping) shall be as follows:

<u>Pipe Size</u>	<u>Spacing</u>
½", ¾" & 1"	6'-0"
1¼" & 1½"	8'-0"
2" & 3"	10'-0"
4" and larger	14'-0"

19. Whenever possible valves shall be installed with the operating stems in the upright position, however when conditions dictate it is acceptable to position valves 90° to either side of vertical. Valves shall not be installed with the stems in the downward position.
20. Do not substitute one style of valve indicated on drawings for another unless authorized by the Architect. Example: If a gate valve is shown use ONLY a gate valve or if a ball valve is shown use ONLY a ball valve.
21. Mount in-line air separators 3 inches in size and larger independent of the piping system. Do not obstruct removal area of strainer with pipe hangers, equipment or other piping.

B. Joints and Connections

1. Smoothly ream all cut pipe; cut all threads straight and true; apply best quality Teflon tape to all male pipe threads but not to inside of fittings; use graphite on all plugs.
2. Make all joints in copper tube (water and drains) with 95-5 tin-antimony solder applied in strict accordance with the manufacturer's recommendations.
3. All joints in refrigerant tubing shall be brazed.

C. Fire Safety

Fire extinguishing equipment shall be kept within 25 feet of welding areas at all times. No flammable materials shall be placed within 25 feet of welding areas unless they are physically connected to the building structure. Contractor shall take additional measures when welding close to flammable structures to protect the wood from igniting.

D. Thermometers

1. Install thermometers where indicated on drawings and:
2. Install thermometer wells on supply and return branch piping at all duct hot water heating coils and two (2) thermometers with storage cases for the Owner's use.
3. Install thermometers on hot water piping at each port of reset water valve.

E. PEX tubing

1. Install PEX tubing where indicated on drawings.
2. Tubing shall be supported from building structure only, not from other piping or equipment.
3. Do not support other piping or equipment from PEX tubing.
4. PEX tubing may be threaded through structure with the structure acting as support so long as support is not provided in lengths greater than 32 inches on center. Use protective sleeves or bushings where tubing passes through metal studs. Tubing shall not have sags or low points that would prevent thorough drainage of the system.
5. Support devices shall be a product of the PEX manufacturer. Support devices shall be screwed, not nailed, into wood. Do not attach to the underside of floor decks. It is acceptable to support PEX tubing to the side of steel bar joists with "zip" strip draw bands at 32 inch centers (maximum). Leave adequate provision for pipe insulation.

3.03 PIPING TEST AND ADJUST

- A. During the installation, all hot water supply and return piping shall be tested with water to a pressure of not more than 125 psi and held for a period of not less than four (4) hours. Isolate cast iron boilers and any other piping or devices not designed for this pressure. Do not use compressed air on PEX tubing systems. Any leaks shall be repaired and another test applied to the piping. All piping shall be tested before it is insulated or otherwise concealed. Contractor shall be required to certify in writing that piping has been tested and conforms to these requirements.
- B. Before operating the water system, all of the new piping shall be flushed out to remove oil and foreign materials. This shall be accomplished by circulating a solution of heavy duty detergent by use of Mechanical Contractor supplied pump.
- C. After the installation is complete and ready for operation, the system shall be tested under normal operating conditions in the presence of the Architect and demonstrated that the system functions as designed.
- D. It shall be demonstrated that all parts of heating system have a free and noiseless circulation of steam and water and that all parts are tight. It shall also be demonstrated that all units are functioning properly and that control system operates correctly.
- E. Should any defects in operation develop during the test periods, the Mechanical Contractor will proceed to correct defects immediately. Additional tests will be conducted after correction.

3.04 INSTALLATION OF DUCTWORK AND EQUIPMENT

- A. General
 - 1. Size and general arrangements as well as methods of connecting all registers, grilles, duct coils and equipment shall be as indicated, or to meet requirements for complete installation.
 - 2. Construction standards and sheet metal gauges shall be as outlined in the latest edition of the SMACNA HVAC Duct Construction Standards handbook for metal and flexible ducts unless specifically indicated otherwise.
 - 3. See paragraph 2.21, "Sheetmetal", sub-paragraph F., "Sealing of Ducts" for duct sealing.
 - 4. Manual Dampers
 - a. Manual dampers may be shop-fabricated on units 5 inches in height and less. All dampers larger than 5 inches MUST be pre-fabricated as previously outlined in this specification.
 - b. All manual dampers located within 10 feet of a fan outlet shall have the blades oriented perpendicular to the fan shaft.
 - c. Provide duct access door as large as possible up to 12 inches x 12 inches at EACH manual damper larger than 5 inches.

B. Protection and Cleaning

1. All open ends of ductwork which is to be unattended for 4 hours or more shall be temporarily protected with plastic sheeting and duct tape (or similar method) to reduce the collection of construction dust and debris.
2. All openings in mechanical equipment (unit ventilators, cabinet unit heaters, fans, etc.) shall be covered with cardboard and thoroughly sealed to duct and contaminants with painters tape during the construction period unless work is actually being performed on the equipment.
3. Prior to testing and balancing and at the end of the construction, clean the interiors of all supply and return air ductwork before changing filters in air handling equipment. Careful coordination must be maintained between the time of testing and balancing and final delivery to avoid re-accumulation of dust and debris within the duct systems which will require additional cleaning by the Mechanical Contractor.

C. Testing

1. The ductwork mains in the corridor ceiling of the top floor of each building shall be tested for leakage prior to installation of insulation and concealment.
2. Leakage test procedures shall follow the outlines and classifications in the latest edition of the SMACNA HVAC Duct Leakage Test manual. See Section 4 of the SMACNA leakage test manual for normal duct classifications.
3. Leakage amount shall not exceed the allotted amount for the pressure class or the allotted amount for that portion of the system, whichever is applicable.
4. Any ductwork which fails to meet the allotted leakage level shall be modified to bring it into compliance and shall retest it until acceptable leakage is demonstrated.
5. At completion of construction, Contractor shall provide written certification, on his company letterhead, indicating that all ductwork has been tested according to specified requirements. Document shall include date of test, test pressures used, leakage class and construction class of each section of ductwork tested.
6. All other ductwork must be constructed and sealed to the same standards that were used with the tested sections

3.04 TESTING, ADJUSTING AND BALANCING (TAB)

A. General

1. TAB contractor shall be a subcontractor to the Mechanical Subcontractor.
2. TAB contractor shall perform functional performance test of all Division 15 equipment and entire ATC system for specified operation and control sequences.

3. The mechanical contractor shall startup all Division 15 equipment as required by the equipment specifications. Mechanical contractor shall verify that systems are complete and operable before TAB commencing work. Ensure the following conditions:
 - a. Systems are started and operating in a safe and normal condition.
 - b. Temperature control systems are installed complete and operable.
 - c. Proper thermal overload protection is in place for electrical equipment.
 - d. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - e. Duct systems are clean of debris.
 - f. Fans are rotating correctly.
 - g. Fire and volume dampers are in place and open.
 - h. Air coil fins are cleaned and combed.
 - i. Access doors are closed and duct end caps are in place.
 - j. Air outlets are installed and connected.
 - k. Duct system leakage is minimized.
 - l. Hydronic systems are flushed, filled, and vented.
 - m. Pumps are rotating correctly.
 - n. Mechanical equipment is thoroughly clean and free of debris.
4. TAB Contractor shall submit field reports to General Contractor and Architect. Report defects and deficiencies noted during performance of services which prevent system testing and balance.
5. TAB contractor shall submit all verification and functional performance checklists/results, signed by indicated personnel, organized by system and sub-system.
6. TAB contractor shall submit other reports described below.

B. Work Included

1. Test, adjust and balance all air and water systems, including components to conform to air and water flow rates shown on drawings.
2. Test complete automatic temperature control sequences for specified operations described under AUTOMATIC TEMPERATURE CONTROLS.
3. Complete and submit balance report in spreadsheet format. Report shall be submitted with information noted on one side of sheet only (i.e., backside of sheet shall be blank.).
4. Testing of air and water systems will be done by the same agency.
5. Mechanical Contractor SHALL PROVIDE copies of shop drawings indicating coil gpm's, air handling unit air volumes, etc. to the Testing and Balancing contractor at no cost to the contractor.

6. The Balancing Contractor shall carry an allowance of \$250. which may be used, if directed by the Architect, to change motor drives and belts as job conditions require. The allowance or unused portion shall be returned to the Owner upon acceptance of the system.
7. Careful coordination must be maintained between the time of testing and balancing and final delivery to avoid re-accumulation of dust and debris within the duct systems which will require additional cleaning by the Mechanical Contractor.

C. Quality of Compliance

1. Qualification: TAB Contractor must be independent test and balancing agency.
2. AABC Compliance: Comply with AABC Manual MN-1 "AABC National Standards" as applicable to mechanical and hydronic distribution systems and/or Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA).
3. Industry Standards: Comply with ASHRAE recommendations for measurements, instruments and testing and balancing.
4. Coordination: Work together with Automatic Temperature Control Contractor to adjust set points of various devices to balance system(s) and test ATC sequences of operation. Temperature Control Contractor shall be responsible for balancing return air, exhaust (relief) air and outdoor air dampers on Air Handling Units in order to achieve proper mixed air temperatures.
5. ASHRAE Guideline 1-1996, "The HVAC Commissioning Process".

D. Execution of TAB Work

1. TAB Contractor shall visit job site and determine that control devices, test devices and valves are correctly installed and ready for balancing.
2. Examine each air and hydronic distribution system to see that it is free from obstructions. Determine that all dampers, registers and valves are in a set or full open position; that moving equipment is lubricated, and that required filters are clean and functioning. Request that Installing Contractor perform any adjustments necessary for proper functioning of the system.
3. TAB Contractor shall use test instruments that have been calibrated within a time period recommended by the manufacturer, and have been checked for accuracy prior to start of testing, adjusting and balancing activity.
4. Verify that all equipment performs as specified. Adjust variable type drives, volume dampers, control dampers, balancing valves and control valves as required by TAB work.
5. Test pressure profile of systems by traverse as required.

6. Adjust each register and damper to handle and properly distribute design airflow within 5% of specified quantities. Mark all setpoints.
7. Adjust front and rear discharge louvers on each supply register to distribute air in an even pattern or as indicated on plans.
8. Set all adjustable balancing valves so that each is furnished with design fluid flow within 5% of the specified quantities. Mark all set points.
9. Take readings at pre-set balancing valves and record flow readings.
10. Adjust air discharge patterns of all supply air diffusers, registers and grilles for optimal air diffusion.
11. Document results of all testing on approved TAB report formats and submit 3 copies for approval and record within 15 days of completion of TAB work. Include a warranty period of 90 days, during which time the Architect/Engineer may request a re-check or re-adjustment of any part of the work. Reports shall be compiled on a spreadsheet such as Excel, Quattro-Pro, Lotus, etc. and shall clearly indicate the following *minimum* information:
 - a. Air (Rated and Actual)
 - 1) System/unit name
 - 2) HP, BHP, voltage, amperage and fan rpm
 - 3) Static pressures; suction, discharge and total
 - 4) Total system flow rate
 - 5) Individual terminal flow rates (Terminal readings must show location, make, model and size of register, grille or diffuser).
 - 6) Filter status report
 - b. Water
 - 1) Pump full flow and no-flow suction and discharge pressures.
 - 2) Rated and actual amperage, voltage and total discharge head (TDH).
 - 3) Calibrated balancing device readings will indicate location, size, setting, differential pressure and rated and actual gpm.

Reports to have a minimum of color or must be compatible with monochrome printers. Reports must be submitted to the Architect electronically in addition to hard copies.

E. Drawings

Drawings in CAD format may be made available to the TAB Contractor after the contract for this work is awarded. Contact the Engineer via telephone or at mechsyst@maine.rr.com and request the drawings, indicating CAD format required and a return e-mail address. Files will be compressed and will require WinZip to extract them (available at <http://www.winzip.com>).

F. Acceptable TAB Contractors (listed alphabetically)

1. Central Air Balance
2. Maine Air Balance
3. Tab-Tech International
4. Tekon-Technical Consultants
5. Yankee Balancing

3.05 CLOSING IN UNINSPECTED WORK

A. General

Do not cover up or enclose work until it has been properly and completely inspected and approved.

B. Noncompliance

Should any work be covered up or enclosed prior to all required inspections and approvals, uncover the work as required. After it has been inspected completely and approved, make all repairs and replacements with materials necessary for approval by the Architect and at no additional cost to the Owner.

If it is not practical to uncover the uninspected work it may, at the Architect's discretion, be considered inadequate and credit given to the Owner for the work as if it were not done in satisfactory accordance with the terms of the contract documents.

3.06 TEMPORARY HEATING

- A. Mechanical Contractor shall install the new heating system and related equipment as soon as those portions of the building are ready and the work can be performed.
- B. Mechanical Contractor will be required to permanently connect as many units as possible for temporary heat.
- C. At the conclusion of the temporary heating period, the complete system shall be thoroughly cleaned.
- D. General Contractor will be required to assume full responsibility for the care and operation of the new equipment during its temporary use and to return the equipment to the Mechanical Contractor in perfect order, normal wear and tear excepted.
- E. Water, fuel and electric power required to operate the heating system for temporary heat shall be provided by the General Contractor.

3.07 CLEANING

Prior to acceptance of the buildings, thoroughly clean all exposed portions of the Heating, Ventilating and Air Conditioning installation, including the removal all labels and all traces of foreign substance.

Prior to testing and balancing vacuum and clean inside of all convectors, finned radiators (spackle droppings), unit ventilators, heat recovery units, fans and cabinet unit heaters. Clean the interiors of ductwork (where accessible) as outlined in 3.03, "INSTALLATION OF DUCTWORK AND EQUIPMENT"; paragraph "B", "Protection and Cleaning".

3.08 INSTRUCTIONS

On completion of the job, the Mechanical Contractor shall provide a competent technician to thoroughly instruct the Owner's Representative in the care and operation of the system. The total period of instruction shall not exceed four (4) hours. (Temperature control system instruction shall be in addition to this instruction period). The time of instruction shall be arranged with the Owner.

3.09 REFRIGERANT PIPING (see Part 4, "ALTERNATES")

Refrigerant piping shall be installed and tested in accordance to the conditions set forth herein and as required by the manufacturer of the refrigeration equipment by personnel with not less than 5 years experience in the installation of refrigerant piping.

The installation shall be inspected and certified by the manufacturer of the refrigeration equipment prior to charging with refrigerant.

Refrigerant piping shall be run in a approved manner, providing traps where necessary to maintain gas velocities to return oil to the compressor and to keep systems free of oil slugs at the compressor. Fittings shall be long radius and soldered with Sil-Fos or silver solder. The inside of all refrigerant piping shall be thoroughly cleaned using Virginia Solvent #10 or approved equal; followed by a wiping of compressor oil and then wiped dry with a clean, dry cloth. All refrigerant piping shall then be tested with nitrogen and all joints tapped with a rubber mallet to make sure they are tight. A soap solution shall then be applied to each joint. High side test shall be a minimum of 250 psi while the low side test shall be tested to a minimum of 100 psi. Any equipment that may be damaged by these pressures shall be removed. After pressure test, a freon test shall be applied using Halide torch. The interior of the piping system shall be thoroughly cleaned of all oil, dirt and foreign matter then evacuated and dehydrated. All copper tubing shall be supported by copper coated clevis type hangers, see Paragraph 2.03; "HANGERS AND SUPPORTS". The hangers on the suction piping shall be sized to include the insulation and metal shields 12 inches long shall be placed between hangers and insulation.

3.10 RECYCLING

Discarded materials, both new and removed, shall be recycled whenever practical through metal salvage dealers (ductwork, piping, etc.), paper salvage (cardboard shipping containers, etc.), wood & plastic products, etc. The Mechanical Contractor shall retain the salvage value of discarded materials and may use this value to offset his project bid price if so desired. Toxic materials such as adhesives, coolants, refrigerants, etc. SHALL be disposed of in a manner acceptable to the State of Maine Department of Environmental Protection.

3.11 HAZARDOUS MATERIALS

Mercury, or any other material deemed hazardous by the Federal Environmental Protection Agency or the State of Maine Department of Environmental Protection, shall not be used in any components of the mechanical systems.

PART 4 - ALTERNATES

4.01 GENERAL DESCRIPTION

- A. Alternate No. 2 is an add alternate to provide air conditioning in the Community Areas of Building No. 1 which shall include Unit Ventilator #1, Compressor-Condenser #, required piping and controls.
- B. All provisions of Part 1, "GENERAL" and Part 3, "EXECUTION" shall also apply to this alternate.
- C. There are no other alternates that apply to this section.

4.02 PRODUCTS

- A. Unit Ventilator
 - 1. Furnish and install a hot water coil, valve controlled unit ventilator where shown on the drawings. Unit shall have heating capacity, minimum outdoor air settings, arrangement and standard CFM ratings listed.
 - 2. Provide separate direct expansion cooling coil with capacities indicated on drawings. Coil shall be ARI rated.
 - 3. Unit shall be complete with two or more multi-blade fans, motors having at least two speeds, factory wired disconnect switch, control switch with motor overload protection and outside air and return air dampers. Louvers shall be as specified under SHEETMETAL.
 - 4. Unit shall be designed to admit from 0% to 100% outside air and shall be factory set to introduce minimum outside air indicated on plans. Unit shall be fastened to wall in accordance with manufacturer's instructions and details shown, thus insuring units are set level and plumb. Provide three (3) sets of 1 inch *pleated media* throwaway type filters for each unit as specified under paragraph 2.22, "FILTERS". One set to be provided with each unit from the manufacturer to be used during construction and the second set installed when project is completed. Third set to be turned over to the Owner for future replacement.
 - 5. Unit to be floor mounted and shall be provided with 6 inch deep false back. Outdoor air section shall be completely factory insulated with 2 inches of heavy density board insulation securely fastened to unit with adhesives and/or mechanical fasteners.
 - 6. Unit shall have factory installed winter gasketing on outdoor air damper to provide low leak performance.
 - 7. Unit shall be as manufactured by Trane Co. Units by American Air Filter, Carrier or McQuay will be considered.

B. Air Cooled Compressor/Condensing Unit

1. Provide and install remote compressor/condenser unit for use with unit ventilator as shown on drawings. Capacities shall be as scheduled on drawings. Unit shall be fully charged from the factory with R-22 refrigerant for matched indoor section and up to 15 feet of piping. Unit shall be designed to operate at outdoor ambient temperatures as high as 115°F. Unit shall be of same manufacturer as unit ventilator with cooling capacities matched with the direct expansion evaporator coils in the unit.
2. ARI STANDARD 210/240 rating conditions: Cooling 80°F DB, 67°F WB air entering indoor coil, 95°F DB air entering outdoor coil.
3. ARI STANDARD 270 RATING conditions: (Noise rating numbers are determined with the unit in cooling operation.) Standard Noise Rating number is at 95°F outdoor air.
4. Unit casing shall be constructed of heavy gauge, galvanized steel and painted with weather-resistant, glossy, corrosion resistant powder paint. Cabinet shall have adequate access to refrigerant connections and ease of service.
5. Refrigeration system controls shall include condenser fan and compressor contactor. High and low pressure controls shall be inherent to the compressor. Liquid line dryer shall be standard.
6. Compressor shall include internal over temperature and pressure protector, total dipped hermetic motor. Other features shall include: rotor lock suction and discharge refrigeration connections, centrifugal oil pump and low vibration and noise. Compressor shall carry a 5 year limited warranty.
7. Condenser coil shall be continuously wrapped, corrosion resistant all aluminum with minimum brazed joints. Coil shall be seamless aluminum glued to a continuous aluminum fin and shall be lab tested to withstand 2,000 pounds of pressure per square inch. Coil shall provide low airflow resistance and efficient heat transfer and shall be protected on all four sides by louvered panels and have a 5 year limited warranty.
8. Unit shall have a standard mechanical cooling capability to 55°F. No addition low ambient controls are to be provided.
9. Provide the following accessories:
 - a. Anti-Short Cycle Timer to prevent compressor recycling until 5 minutes have elapsed after satisfying call or power interruptions.
 - b. Evaporator defrost control to cycle the condenser off as indoor coil reaches freeze-up conditions.
 - c. Rubber isolators to isolate condensing unit from transmitting energy into mounting frame or pad.
 - d. Bracket kits to securely mount condensing unit to a frame or pad without removing any panels.

10. Miscellaneous -
Efficiency shall be not less than 13.0 SEER
Unit shall be shipped from the factory with a start kit.
11. Trane Series 2TTB30 for 208 volt, 60 cycle, 1 phase power. Equivalent units by Carrier, Lennox or McQuay will be considered.

C. Refrigerant Piping Insulation

Refrigerant suction piping shall be insulated with 1 inch Self-Seal Armaflex SS or approved equal. Cover exterior insulation with ultraviolet resistant vinyl sheet outdoor PVC jacket. Material shall be 25/50 rated (flame spread rating of 25 or less and smoke developed rating of 50 or less) flexible, closed cell elastomeric thermal insulation.

D. Refrigerant Specialties

1. Sight glass and moisture indicator shall be provided in the liquid line at the evaporator coil and at each compressor-condenser unit.
2. Externally equalized expansion valve shall be installed on each liquid connection to the evaporator coil(s) if not provided by the evaporator manufacturer. Valve size shall be as verified with unit manufacturer based on actual length of piping, quantity of fittings and difference of elevation. Valve shall be manufactured by ALCO or Sporlan and installed in accordance with manufacturer's instructions.
3. A complete charge of R-22 shall be provided for the system.
4. The liquid line shall be provided with removable core type filter-dryer and refrigerant valves as shown on the drawings. Units to be provided with ¼ inch male pipe plug in flange plate for installation of charging valve. Units to be Sporlan series C-R for refrigerant 22 or approved equal.
5. Suction and liquid refrigerant piping shall be provided and installed. The refrigerant piping shall be run in an approved manner providing traps where necessary to maintain the proper gas velocities and to keep the system free of oil.

E. Louvers

See paragraph 2.21, "SHEETMETAL"

F. Controls

See paragraph 2.25, "AUTOMATIC TEMPERATURE CONTROL (ATC)"

END OF SECTION 15600