

**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 no alternates that apply to this section of the project.

1.03 DEFINITIONS

ATC Automatic Temperature Control
CM Construction Manager
EC Electrical Contractor (Division 16)
HC Heating (mechanical) Contractor
PC Plumbing Contractor

1.04 DESCRIPTION OF WORK

A. Work Included

1. Furnish all labor, materials, equipment, transportation and perform all operations required to install a complete heating, ventilating, heat recovery and air conditioning system in the building, in accordance with these specifications and applicable drawings.
2. All temperatures are expressed in degrees Fahrenheit.
3. Perform demolition and removal as required.
4. Work to be performed shall include, but is not limited to, the following:
 - a. Provide and install forced air heat recovery systems in building areas indicated on drawings.
 - b. Provide and install variable refrigerant flow, direct expansion heat pump systems in building areas indicated on drawings.
 - c. Provide and install hot water duct coils and piping systems in building areas indicated on drawings.
 - d. Air handling units
 - e. Electric baseboard heaters and electric towel warmers
 - f. Electric heating coils
 - g. Equipment Supports for Roof-Mounted Heat Pumps
 - h. Insulation
 - i. Fans
 - j. Sheetmetal including Venting System for Fireplaces
 - k. Access doors required in gypsum walls and ceilings,

- l. Automatic Temperature Control (ATC)
 - m. Tests and balance
5. Specifications and accompanying drawings are provided to show general arrangement and extent of work to be performed but do not indicate every detail of pipe, valves, fittings, hangers, ductwork and equipment necessary for complete installation.
 6. 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.
 7. Mechanical contractor shall be responsible for rigging to hoist his own (and his sub-contractors') materials and equipment into place.
 8. 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.
 4. Electrical conduit and wiring, except as noted below
 5. Roofing, 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. Mechanical Electrical Work
1. Provide and erect all motors, temperature controls, limit switches as specified.
 2. Power supply to switches, fused switches, outlets, 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 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. 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. Install all wiring under the 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.

4. 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.

Low voltage control wiring must be plenum rated and adequately supported with no sags or “droops”. Low voltage wiring need not be installed in conduit unless required by local code.

5. Fans

- a. Division 16 to wire to unit mounted disconnect switch with overload protection provided with unit.
- b. Fans shall operate as indicated on "FAN SCHEDULE", drawing M14 and as indicated in "Automatic Temperature Control" section of this specification.

6. Heat Recovery Units

Division 16 shall provide and wire a disconnect switch for each unit then wire to unit power terminals in factory control box. Utilize wiring knockouts if available and thoroughly seal all openings in unit casing (including disconnect mounting screws) water tight. Additionally, Div. 16 to provide 120 volt power to motor operated dampers associated with each unit. Dampers, actuators and control wiring to be provided by ATC Contractor.

8. Outdoor Units

Division 16 shall provide and wire a disconnect switch for each unit.

9. Air Handlers

Division 16 shall provide and wire a disconnect switch for each unit.

10. Electric Duct Heating Coils

Division 16 shall wire to factory disconnect switch provided with each unit.

11. Electric Baseboard Heating Units and Towel Warmers

Division 16 shall wire to power to each unit.

1.05 PERMITS

- A. Unless other arrangements are made with the Construction Manager, 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. Mechanical Contractor shall have prior experience with at least two projects of this nature, size and scope and be capable of producing references indicating as such if requested.
- B. Use sufficient qualified workpersons and competent supervisors in execution of this portion of the work to ensure proper and adequate installation of systems throughout. Technical training and certification of workpersons installing the systems specified, by the systems manufacturer, shall be mandatory prior to commencement of work. Documentation of such certification shall be made available to the Architect upon request within 5 business days.

- C. Work performed shall conform with all Local and State Rules and Regulations, as well as those of the International Building Code and National Fire Protection Association (N.F.P.A.).
- D. Piping design shall conform to ANSI, ASME B31.9 and AWS D10.9 codes.

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*. Submit full details for consideration and obtain written approval of the Architect. Allow sufficient time for the Architect to include any approval to submit substitutions in an addendum so all bidders may be made aware. 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(s) resulting from the substitution of equipment, regardless of acceptance by the Architect or Engineer, shall be paid by this Contractor. Additional costs may include, but not be limited to, electrical and/or structural alterations from the contract documents. Contractor shall be solely responsible to verify that substitutes will fit within the designated spaces provide while permitting adequate clearances for servicing of equipment as required by the manufacturers. Contractor shall, upon request from the Architect or Engineer of record, provide such verification of ample space and clearances in the form of drawings or any other manner requested.

- 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, air handling unit air volumes, etc. Failure to do so may result in the Architect providing the required materials at the Contractor's expense.

Sketches pertaining to changes and amendments during construction (ASI's, RFI's and RFP's for example) shall be contract form documents issued by the Architect and/or Engineer for use during construction and it shall be the Architect's and/or Engineer's discretion to provide sketches or full size drawings. Requests for documentation other than what is provided (full size revised drawings for instance) and deemed suitable for the particular situation shall be paid for by the contractor making the request. The cost(s) shall include, but not limited to, drafting time and reproduction costs.

1.10 ELECTRONIC DRAWINGS AND FILE SHARING

Plans and specifications may be made available in electronic format on request. Plans may be provided in either Adobe (.pdf) or CAD (.dwg or .dxf) formats and will be compressed using WinZip (.zip format). Recipient is responsible to obtain the necessary software to open the files. Note: CAD (.dwg and .dxf) files will be made available to successful bidders only after a contract is awarded.

CAD drawings are produced with AutoCAD and may be provided in the 2004 or 2010 file format. Upon request for CAD files a release form will be provided which must be signed and returned to the Engineer prior to transmission of electronic files. Physical mailing address, telephone numbers and e-mail address for this office are indicated on each drawing. A signed release will not be required for Adobe based files.

All contract documents are copyrighted material. No portion of materials may be reproduced or duplicated except as indicated in the release form. Where release forms are not required (Adobe based files), materials may be printed for use by the intended recipient only and may not be reproduced or copied in any other manner or for any purpose other than for use pertaining to the construction of this project unless written permission is obtained.

1.11 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 shop drawings for review. Unless prior arrangements are made with the Architect all shop drawings must be submitted to the Construction Manager who in turn will forward them to the Architect. The quantity of copies shall be as outlined in Division 01. If shop drawings are rejected or returned for re-submittal, Mechanical Contractor shall provide said re-submittals within 14 calendar days of receipt of original submittals with engineer's comments. If original or re-submitted shop drawings are not submitted within the allotted time frames indicated the engineer reserves the right to require only the

equipment primarily specified to 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 Contractor. Mechanical Contractor's and vendor's name, address, telephone & fax numbers and e-mail addresses must be provided with every shop drawing submission. Capacities indicated are minimums.

- B. Shop drawings shall be properly identified and shall describe in detail the material and equipment to be provided, including all dimensional data, performance data clearly indicated, fan curves, pump curves, computer selection print-outs, etc. Capacities indicated are minimums. Incomplete or illegible submittals will be refused.
- C. 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.
- 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 expense. If the materials are not removed (or replaced) or if the project is delayed as a result of the contractor's actions, 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. Submittals not separated from plumbing shop drawings will be refused for re-submittal.
- F. Electronic submission of shop drawings is required. Paper copies will not be reviewed with exception to original copies of color selection samples where required (B&W or grayscale scanned copies of color samples are not acceptable). Electronic files should be accessible and in an open format, meaning files must not be locked and comments may be added without altering the original content, or have interactive fields intended specifically for commenting.
- G. Review must be obtained on the following items:
 - 1. Ductwork and Accessories
 - a. Registers, diffusers, 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. Side takeoff fittings
 - h. Flexible duct
 - i. Backdraft dampers
 - j. Manual dampers
 - k. Louvers and brick vents - provide original color samples

1. Fire place venting system
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 pump system including air handlers, outdoor units, branch selectors and all accessories.
 - c. Heat recovery units and accessories - provide computer selection printouts.
 - d. Boiler unit and accessories, confirmation of start-up and State Inspection
 - e. Duct heating coils
 - f. Fans and accessories
 - g. Heat recovery units and accessories - provide computer selection printouts.
 - h. Electric heating units
3. Piping and Accessories
 - a. Water piping, valves, unions and flanges
 - b. Flow check valves
 - c. Pipe and valve markers
 - d. Pipe hangers and insulated pipe supports
 - e. Relief valves
 - f. Refrigerant piping and accessories
 - g. Duct heating coils
 - h. Circulating Pumps
4. Insulation
 - a. Duct
 - b. Equipment
 - c. Pipe
5. Automatic Temperature Control (ATC) System

1.12 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.

1.13 AS-BUILT DRAWINGS

Keep in good condition at the job, apart from all other prints used in actual construction, one complete set of all drawings furnished for this job. On this set of drawings, 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 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 the responsibility of the Mechanical Contractor*. Copies of the mechanical CAD drawings (minus professional engineering stamps) will be made available at no cost to the Mechanical Contractor of record if desired. Drawings shall be dated accordingly and clearly identified as “AS-BUILT”. See par. 1.10, “ELECTRONIC DRAWINGS AND FILE SHARING” for additional information.

1.14 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.)

1.15 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.

1.16 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.

1.17 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, however any answers and/or advice is non-binding unless incorporated into the contract documents in the form of addenda, change order, etc. Inquires requiring an answer prior to opening of bids 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).
- E. Should unforeseen job conditions require re-arrangement of piping and/or ductwork resulting in deviation from the intent of the contract documents or potentially compromising the integrity of the mechanical systems, the Architect shall be notified immediately prior to commencement of work. Failure to do so will result in the contractor being responsible to correct any work installed that is contrary to the contract documents at his own expense.

1.18 CHANGE ORDERS

- A. No change shall be made from the work, equipment, or materials under this section except as directed in writing by Engineer.
- 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.

1.19 COORDINATION

- A. Contractor shall be responsible to coordinate his work with that of other trades to adjust to field conditions prior to commencing work. It is also this contractor's responsibility to coordinate locations of his own piping and ductwork to ensure the two do not conflict. 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.

1.20 REQUESTS FOR INFORMATION

Requests for Information (RFI) or other correspondences which are submitted electronically must be in an open format, meaning files must not be locked and comments may be added without altering the original content, or have interactive fields intended specifically for commenting. Locked files will not be accepted.

1.21 WORKPLACE SAFETY

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

PART 2 - PRODUCTS

2.01 PIPING

A. General

Provide and erect in accordance with best practice of trade all hot water supply and return, pump discharge, 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. | Hot water heating mains | Type "L" Copper |
| 2. | Heating water branches, above grade, 200°F. maximum. | PEX crosslinked flexible tubing, ASTM F876 and F877. |
| 3. | Cold water, drains from relief valves and automatic vents. | Type "L" hard drawn copper tubing |
| 4. | Condensate drains | 40 PVC with glued socket joints. |
| 5. | Refrigerant | Type "K" hard drawn copper tubing.
And ACR refrigerant tubing |

C. Pipe Fittings:

- | | | |
|----|--------------------------|---|
| 1. | Screwed | 125# cast iron screwed pattern 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.

8. Dielectric fitting Steel or copper pipe to ASTM A-53, zinc electroplated body with non-corrosive thermoplastic lining, thread connections. Victaulic Style 47-TT or approved equal.

H. Use dielectric fittings when connecting dissimilar metals.

2.02 HOT WATER SPECIALTIES

A. Automatic (Preset) Balancing Valves

1. All finned radiation, convectors, cabinet unit heaters, unit heaters 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 ball valve, flow control cartridge assembly, two (2) pressure/temperature plugs and inlet 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

- d. spring range.
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 250°F
- 5. 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.
- 6. Units shall be Flow Design “AutoFlow” or approved equal.
 - a. Model ACM for ½ inch and ¾ inch sizes.
 - b. Model AC for 1 inch to 2 inch sizes.
 - c. Model WS 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.

E. Drains

Each downfeed radiator, convactor, cabinet unit heater and unit heater shall be provided with either a drain coupling or a drain valve between the shut-off valves and heating equipment at the lowest point in the piping. See details on sheet M5. 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.

F. 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 Taco 409 brass vent with ¾ inch I.D. flexible tube drain. Units by Anderson, Armstrong (No. 1-AV) or Sarco will also be considered. Pet cocks 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 on piping 2 inches and 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. Vent elbows may be used on individual heating units, see details on sheet M6.

G. Expansion Tank

Furnish and install a vertical pressurized replaceable bladder type water expansion tank pre-charged to pressure shown on the 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. Tanks 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. Units by Bell & Gossett or Wood will be considered. Capacities shall be as shown on drawings.

H. Backflow Preventer

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

I. 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.

K. Air Scoop

Furnish and install in-line air scoop; Taco product No. 434 or 435, Bell & Gossett Model IAS or approved equal.

2.03 REFRIGERANT SPECIALTIES

- A. Sight glass and moisture indicator shall be provided in the liquid line at the evaporator coil and at each compressor-condenser unit if not provided by the equipment manufacturer.
- B. 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.
- C. A complete charge of R-410A shall be provided for the system.
- D. 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 for refrigerant R-401A

or approved equal.

- E. 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.

2.04 HEAT PUMP SYSTEMS (OU-1-4 & AH -1-30)

CONTROL SYSTEM NOTE – supply with the equipment TG-2000 Integrated System Software. Include manufacturer representative time to facilitate the installation with the control company and train the owner on the operation of the system.

- 1) **Tenant Billing**
- 2) **Control of multiple G-50A controllers**
- 3) **Web monitoring license (3-year)**
- 4) **Web scheduling license (3-year)**
- 5) **Tenant billing license (3-year)**
- 6) **BACnet capable**
- 7) **Supply all needed Outdoor Unit Watt-Hour meters.**
- 8) **Supply all needed RS-232C RS-485, converters**
- 9) **Billing output to Excel-based HVAC Energy Bill per tenant.**

EQUIPMENT OPTIONS NOTE – supply with the equipment the following:

- 1) **2” MERV 13 filter box for AH-1 through AH-27**
- 2) **External heater adaptor relay for AH-1 through AH-26**
- 3) **Refrigerant shut-off valves for all BCC connections.**

A. General

Provide and install variable refrigerant flow, split system, central air conditioning and heat pump systems with heat recovery capability where indicated on drawings. Capacities shall be as scheduled on sheet M12. Systems shall be two pipe, each with a single branch circuit controller.

Systems may be installed only by factory approved personnel. Submit a copy of the VRF system installation course completion certificate with the VRF system.

Systems and equipment described herein are based on a Mitsubishi City-Multi system consisting of PEFY series indoor (air handling) units, PURY outdoor (Compressor/Condenser) units, CMB-PxxxNU-GA Branch Circuit Controllers and M-NET DDC (Direct Digital Controls). Equivalent equipment meeting the specified features and performance requirements of this equipment will be considered (LG AND DAIKIN). If an alternate equipment is selected by the owner and engineer the alternate equipment manufacturer is required to provide refrigerant piping sizing and diagrams for their equipment.

Outdoor (Compressor/Condenser) units shall be a vertical discharge, 208/230 volt, three phase.

- B. Units shall be listed by Electrical Laboratories (ETL) and bear the ETL label. All wiring shall be in accordance with the National Electrical Code (N.E.C.). Units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).

A full charge of R-410A for the condensing units only shall be provided at the factory.

Provide a full diagrammatic drawing of the systems showing all components (including equipment tags), refrigerant piping (including lengths and sizes) and control wiring with the shop drawings.

- C. Outdoor Units (OU-1,2,3,4)

The outdoor units shall be intended specifically for use with other system components. Each shall have a powder coated finish and be completely factory assembled, piped and wired. Units shall be run tested at the factory.

- E. Branch Circuit Controllers (BCC-1,2,3,4)

A single branch circuit controller shall be provided with each system and be a product of the same manufacturer as the air handlers and outdoor units. Controllers shall be sized to accommodate all of the air handling units and operate with R410A refrigerant. Unit shall be provided from the factory with a condensate lift pump (field installed). Controllers shall have not less than two additional ports for connection to future air handlers. Note: Systems utilizing more than one controller will not be accepted.

- F. Air Handling (AH-1-30) Units

1. Units shall be model PURY, indoor fan coils for ducted applications and shall have a modulating linear expansion device. Units shall support individual control using M-NET DDC controllers and shall feature external static pressure settings up to 0.60 in. WG. AH-28,29&30 to be ceiling recessed mounted non-ducted.
2. Units shall be factory assembled, wired and run tested. Contained within each unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. Units shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Air handling units and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
3. Fans
 - a. The indoor unit fan shall be an assembly with one or two Sirocco fan(s) direct driven by a single direct current brushless motor.
 - b. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
4. Coil

- a. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
- b. The tubing shall have inner grooves for high efficiency heat exchange.
- c. All tube joints shall be brazed with phos-copper or silver alloy.
- d. The coils shall be pressure tested at the factory.
- e. A condensate pan and drain shall be provided under the coil.
- f. Units shall include a condensate lift mechanism that will be able to raise drain water 27 inches above the condensate pan.
- g. Both refrigerant lines to the air handlers shall be insulated.

5. Electrical

- a. Unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
- b. System shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz).

6. Controls

- a. Air handling units shall respond to their own electronic wall mounted thermostats. Fans shall operate continuously.
- b. In the air conditioning mode the air handler controls shall signal the outdoor unit to activate on demand for cooling. The controls shall disable the heating coil control valves (provided and installed by ATC Contractor) associated with each thermostat to close.
- c. In the heating mode the system will attempt to heat the building in the heat pump mode and all coil control valves shall be remain closed. Should the room temperature fall 3oF. below the setpoint the system shall enable auxiliary heat in the form of duct heating coils with modulating valves (coil controls by ATC contractor). The coil valves shall modulate in response to a call for heat.
- d. Thermostats shall be the Mitsubishi Simple MA and the central controller shall be the Mitsubishi AG150 with surface mounting kit. Provide the CN24 relay kit for each Air Handler with a duct heating coil to enable the coil zone valves (provided by ATC Contractor) when necessary. When the heat pump is not capable of providing adequate heat due to low outdoor ambient, the outdoor unit shall shut off and the auxiliary controls shall modulate the two heating coils as needed to provide heat. Also provide DIDO to operate the heat recovery ventilators for scheduling purposes.

F. Warranty

All units shall be covered by the manufacturer's limited warranty for a period of one (1) year from date of installation. In addition the compressors shall have a manufacturer's limited warranty for a period of six (6) years from date of installation.

If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer. This warranty shall not include labor.

2.05 ELECTRIC BASEBOARD AND TOWEL WARMER HEATING UNITS

- A. Provide and install electric baseboard heating units where shown on drawings
- B. EB-1 and EB-2 units to be Runtal Electric Baseboard Model EB3. Color to be selected by Architect from the Standard Runtal colors
- C. TW-1 To be Runtal Omnipanel Towel Warmers. Color to selected by Architect. Units to be hard wired and include High/Low/ Off controls.
- D. CEB-1&2 to be Markel EE Architectural Style Electric Baseboard Heater. Color of White or Brown to be selected by Architect

2.06 ELECTRIC DUCT HEATING COILS

- A. General

Furnish and install duct mounted electric resistance type heating coils where shown on drawings. Capacities and voltage shall be as indicated on Duct Heating Coil Schedule, Sheet M14. Coils shall be designed for slip-in installation.
- B. Heaters shall be UL listed under reference E23192 and E53412. Devices shall be suitable for zero clearance to combustible surfaces and for use with heat pump systems. Units shall also incorporate all necessary provisions for installation in full accordance with the National Electric Code.
- C. Heater frame shall be heavy gauge corrosion resistant steel. Heating elements shall be constructed of 80% nickel and 20% chromium and supported by ceramic bushings mounted in corrosion resistant steel brackets. Heating elements shall be open coil type.
- D. Each heater shall include the following:
 - 1. Integral dustproof control cabinet.
 - 2. Staged electric controls.
 - 3. Manual and automatic reset thermal cutouts.
 - 4. Factory controls wired to clearly marked terminal blocks for field connections.
 - 5. Control transformers.
 - 6. Door interlocking disconnect switch.
 - 7. Contactors (de-energizing).
 - 8. Air proving switch.
 - 9. Quiet disconnecting contactors.
 - 10. One fuse block per heat stage.
- E. Units shall be physically installed in ductwork by the Sheet Metal Contractor with power wiring by Div. 16. Control wiring between heat pump system and coil controls by ATC. Division 16 may be requested to review submittals for NFPA, UL and code compliances.
- F. Indeeco model QUA or approved equal.

2.07 CIRCULATING PUMPS

A. Circulating Pumps

1. Furnish and install hot water circulating pumps of the type, size and capacity shown on drawings.
2. Pumps to be TACO 007 or to be the same manufacture as the heat exchanger circulating pump being provided and installed by Division 15400.

2.08 HEAT RECOVERY UNITS

- A. Provide and install an air to air heat recovery unit 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. Unit 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 opposite sides of the unit casings.
- C. Standard casing panels shall be 20 gauge galvanized steel, lined with not less than 1 inch thick fiberglass insulation with Foil-Scrim-Kraft facing. Housing shall be supported by a formed structural base forming a pan. Lifting holes shall be provided at the unit base. 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, internally insulated access doors. Doors 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. Weather hoods shall be supplied for outdoor air intake and exhaust. Units shall include balancing dampers for the exhaust and intake airstreams.
- 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.

For belt driven fans V-belt drives shall be sized for a minimum 150% of driven horsepower. Sheaves shall be adjustable on fans with motors less than 10 HP to allow independent balancing of exhaust and supply airflows. Pulleys shall be of the fully machined cast type, keyed and securely attached to the fan wheel and motor shafts.

Speed controllers on direct-drive fans shall allow independent balancing of exhaust and supply airflows.

Ground and polished steel fan shafts shall be mounted in permanently lubricated, sealed ball bearing pillow blocks. Bearings shall be selected for a minimum (L10) life in excess

of 100,000 hours at maximum cataloged operating speeds.

Motors shall be standard NEMA frame, energy efficient, complying with EPACT standards, for single speed ODP enclosures. Motors shall be permanently lubricated, heavy-duty type, matched to the fan load and furnished at the specified voltage and phase with thermal overload protection. Where 3-phase is indicated motors shall be VFD rated.

Fans and motors shall be mounted to a unit base with neoprene isolators as standard. Belt drive motors shall be factory mounted to an adjustable motor plate having two heavy-duty adjusting bolts for alignment and belt tension.

- G. The rotor (energy wheel) shall be made of either a light weight polymer media in a stainless steel rotor or an aluminum media, coated to prohibit corrosion in a galvanized steel rotor. All surfaces shall be permanently bonded with a desiccant for both sensible and latent recovery and be designed to insure a laminar flow. Wheels with sprayed on desiccant coatings are not acceptable. The energy recovery wheel shall transfer moisture entirely in the vapor phase. Efficiencies shall match performance as scheduled, transfer ratings must be ARI certified to standard 1060 and bear the ARI certification symbol for ARI Air-to-Air Energy Recovery Equipment Certification Program based on ARI 1060. Ratings “in accordance with 1060” without certification are not acceptable. The media shall be cleanable with low temperature steam, hot water or light detergent, without degrading the latent recovery. 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.
- H. The rotor cassette shall be easily removable from the unit to facilitate rigging (if necessary) and ease of service. The wheel cassette design shall use pillow block bearings for long life. For rotors thicker than 3” an adjustable purge sector shall be included in the cassette.
- I. Filters shall be not less than 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.
- J. Unit 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. In addition, this controller shall be equipped with an outdoor air temperature and discharge temperature sensors such that the energy recovery wheel can be modulated via a (VFD) during moderate temperature periods if desired.
- K. Unit shall require a single point 60-cycle power connection. See equipment schedule on sheet M14 for voltage and phase requirements. The electrical panel shall consist of individual motor contactors, short circuit and overload protection, disconnect switch (for pre-heaters) and control power transformer. The NEMA 4 electrical panel shall be mounted on the unit exterior for ease of access or be a factory integral panel to the unit. Unit shall be ETL listed and labeled.
- L. 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.

- M. Provide a lockable control panel for each unit mounted in Storage 33 (but not in a tenant storage enclosure). Panels shall contain:
 - 1. A contactor to permit start/stop operation with a signal from the building ATC system
 - 2. Rotation detection
 - 3. On-Off-Auto switch
 - 4. Wheel Frost Protection
- N. Provide factory authorized start-up and Owner training by a factory authorized representative.
- O. Submittals must include performance data which incorporates total unit energy consumption (fan power, wheel operation, energy recovery, etc.) vs. energy savings.
- P. Units shall be provided with factory insulated curbs not less than 16 inches high. Contractor shall fill the curbs with fiberglass batt insulation for added thermal and sound protection.
- Q. Units shall be Semco FV series for vertical ducting. Equivalent units meeting the requirements of this specification by Greenheck will be considered.

2.09 FANS

A. General

- 1. Fans with capacity and types shown on the drawings shall be provided and installed. In order to establish a standard, fan model numbers indicated below are based on Greenheck (unless noted otherwise) Equivalent units by Acme, Cook and Ilg 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
- 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 AMCA ratings and are the

maximum allowable. HVI sound ratings are not acceptable.

B. Types

1. KHE-1 and DE-1&2 shall be Greenheck CUE099-VG fans with Varigreen ECM motors.

Provide with the following

- Greenvent System to control fan speed by pressure reading in the ductwork,.
- 14" high roof curbs
- Backdraft Dampers
-

2. EF-1 to be a sidewall direct drive exhaust fan – Greenheck SEI-20

Provide with the following

- OSHA guard
- Wall Sleeve
- Motorized damper and Louver
-

2.10 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, duct lining, setting of control dampers, grilles, registers, diffusers, 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 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
43 --> 60	20
61 --> inf.	18

Medium pressure ducts with air velocities greater than 1,200 FPM:

<u>Dimensions of Longest Side</u> (inches)	<u>Minimum Sheet</u> <u>Metal Gauge</u>
Up thru 10	26
11 --> 12	24
13 --> 18	22
19 --> 22	20
23 --> 30	18
30 B> Inf.	16

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. Clothes dryer ducts shall be use radius, non-

segmented elbows.

8. Furnish and install flexible connections on all air handlers. 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 by this section. Sealant material shall be 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. Diffusers, Grilles and Registers

1. 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 (if substituting, certified sound criteria shall be included with submittals indicating CFM and NC levels of each register and grille). Krueger, Metalaire, and Titus only will also be considered for review.
 - a. Exhaust Registers: 530D with opposed blade damper and 1/2 inch, 45° front blade spacing, front blades set horizontal.
 - d. Return Grilles: X530 with 1/2" inch, 45° front blade spacing, front blades set horizontal.
2. Diffusers shall be installed at air supply openings where shown. Units to be aluminum, except as noted, and provided with a brushed aluminum finish. The following list is based on model numbers of Price to establish a standard of quality (if substituting, certified sound criteria shall be included with submittals indicating CFM and NC levels of each diffuser). Krueger, Metalaire, and Titus only will also be considered for review.

:Price Model LBP Linear Bar Diffuser. Surface mount with CRD-60 Radiation Damper and 5020 cable control damper with adjustment through the grille. 30% blade deflections

D. Louvers

1. All exterior louvers shall be extruded aluminum construction with interior bird screens and anodized finish in color to be selected by Architect. Provide not less than 2 original color chip cards (clearly identified as to what they reference) to Architect for review (photocopies not acceptable). Frames and blades shall have not less than 55% minimum free area and no less than 0.081 inches thick. All louvers shall comply with Section 08400 of this specification. 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. All 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.
3. Frames of all louvers to be box type for mounting in masonry. Provide factory mounting flanges on head and side jambs with extended sill for units mounted in frame walls.
4. Louvers in doors shall be provided as a part of the door by the Construction Manager.

E. Duct Sleeves

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

F. Sealing of Ducts

All interior ductwork (except clothes dryer ducts) 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 is prohibited except on clothes dryer ducts only, use Venture model 3520CW duct tape or approved equal. Ensure duct exterior is thoroughly cleaned prior to installing the tape. Use pop rivets in lieu of screws to fasten dryer duct fittings together.

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.

G. 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 for rectangular duct and Model ADR for round duct or approved equal by Elmdor.

H. 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.

I. 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.

J. 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, 12 inches in height and less; Model IBD20, style "B".

- b. Wall and floor types, greater than 12 inches in height; Model IBD20, style “A”.
 - c. Wall type behind grilles; Model IBDT, Style G
- 3. Provide factory mounted fusible links designed to melt at 165°F. and close the damper.
 - 4. Installation shall be in accordance with damper manufacturer's instructions.

K. Flexible Duct

Provide and install insulated flexible duct where shown on drawings. Ducts 20 inches in diameter and smaller shall be a double lamination of polyester encapsulating a steel wire helix forming an air-tight inner core. The core shall be wrapped in a blanket of fiberglass insulation (R 4.2) and sheathed in a rugged and durable reinforced metallized polyester jacket. Duct shall be class 1, U.L. 181 compliant and rated for not less than 2 inches w.g. positive working pressure. Duct internal diameter shall be same size as diffuser served. Atco UPC 030 or approved equal.

L. Side Takeoff Fittings (for flexible duct)

Provide and install at all flexible duct branches to diffusers, a bellmouth side takeoff fitting similar with a manual damper and locking hand quadrant. Fittings shall be pre-manufactured with bell end shall have a 1½ inch radius and employ a self-adhesive gasket seal and be pre-drilled for attachment screws. Fittings shall be anchored to ductwork with *not less than* three (3) screws. Final diameter shall be same size as diffuser served. Units shall be no thinner than 22 gauge, G-90 galvanized steel. Buckley Bellmouth HD-BM, HD-BMD or approved equal by Flexmaster or United Enertech.

M. Turning Vanes

- 1. Provide and install at all square duct elbows 18 inches and larger, and where shown on drawings, fixed double wall airfoil type turning vanes. Turning vanes shall be constructed as outlined in the latest SMACNA HVAC Duct Construction Standards guidebook, Figure 2-3.
- 2. Provide and install at all square duct elbows less than 18 inches in width, and where shown on drawings, fixed single wall turning vanes. Turning vanes shall be constructed as outlined in the latest SMACNA HVAC Duct Construction Standards guidebook, Figure 2-3.

N. Dryer Box

Provide and install, at each clothes dryer, a fully recessed dryer vent box. Units to be upflow configuration, 3½ inches in depth and have a 3.1/8 inch by 4.7/8 oval top duct connection. A 4 inch diameter flexible dryer hose shall connect to interior port of the box and the box shall provide a place for the dryer hose to be stored when the dryer is pushed back to the wall.

In-O-Vate Technologies (<http://www.dryerbox.com>) Model 350 or approved equal.

O. Fireplace Venting System.

- A. Supply and install the fireplace venting system. System to be DuraVent Direct-Vent Pro or equal. Verify chimney system will be compatible with the owner selected fireplaces. Fireplaces will be supplied and installed by others.
- B. Venting system (all by same manufacturer) to include:
 - a. 4"x 6-7/8" coaxial twist lock construction for venting and combustion air.
 - b. High wind terminations for all vents.
 - c. Tall cone flashings and storm collars
 - d. Insulation shield (required on all floors)
 - e. Fire stops at all penetrations of the floor and the sheetrock.
- C. Terminate venting 4" to 12" below the ceiling of each condominium for future connection (by others) of the venting system.

2.11 FILTERS

All air handling units, filtered return grilles and cabinet unit heaters with filter banks, and separate filter boxes 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.

Filters shall be Farr 30/30, Air Guard DP-40 or approved equal, 1 inch thick.

2.12 WALL AND CEILING ACCESS DOORS

Provide and install access doors in walls and ceilings where indicated to facilitate access to dampers, valves, duct access doors, etc. where indicated. Provide unit pricing with the bid for access panels.

Panels shall be installed in accordance with manufacturer's installation instructions. Panels must be anchored to a rigid backer behind gypsum wall board such as framing or a rigid angle behind the gypsum

Doors for use in rated walls (1 hour or more) shall be Williams Brothers WB FR 800 standard fire-rated access door or approved equal. All others shall be Williams Brothers WB GP 100 series premium access door or approved equal.

2.14 EQUIPMENT IDENTIFICATION

Tag each new fan, circulating pump, air handler, outdoor unit, heat recovery unit, branch selector unit, boiler, air handling unit, unit heater and cabinet unit heater 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, outdoor units, heat recovery units, branch selector 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. Mount nameplates inside control access covers for cabinet unit heaters.

Identify all heating hot water supply and return, drain and refrigerant 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. Markers shall be no less than 10 feet apart where piping is concealed and not less than 20 feet apart where exposed. Identification shall read "Heating Water Supply", "Heating Water Return", "Drain", "Refrigerant Suction" and "Refrigerant Liquid" 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.

2.13 INSULATION AND CONDENSATE PROTECTION

A. General

1. Insulation shall be provided for all hot water supply and return piping, refrigerant piping, outside air intakes, exhaust and relief ducts (where specified) and other insulation where shown on drawings.
2. All insulation products shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less per ASTM E 84, UL 723 and NFPA 255.

B. Refrigerant Piping

1. All refrigerant piping shall be insulated with flexible, closed cell elastomeric thermal insulation. Material shall be 25/50 rated (flame spread rating of 25 or less and smoke developed rating of 50 or less) when tested in accordance with ASTM E84, latest revision. Thickness shall be 3 inches on refrigerant piping and ½ inch on PEX tubing.
2. Exterior piping and fittings shall have the insulation covered with ultraviolet resistant vinyl outdoor PVC jacket, JohnsManville Zeston 300 or approved equal.
3. Materials shall have a maximum thermal conductivity of 0.27 Btu-in./h-ft²-°F at a 75°F mean temperature when tested in accordance with ASTM C177 or ASTM C 518, latest revisions.
4. Materials shall have a maximum water vapor transmission of 0.08 perm inches when tested in accordance with ASTM E 96, Procedure A, latest revision.
5. Adhesive shall be the insulation manufacturer's recommended contact adhesive: Armaflex 520, Armaflex 520 BLV.

6. Accessories such as adhesives, mastics and cements shall be provided by the insulation manufacturer and have the same properties as listed above and shall not detract from any of the system ratings as specified above.

C. Duct and Equipment Insulation

1. Duct insulation shall be a ¾ pound density, all-service fiberglass duct wrap with factory applied foil faced FRK vapor barrier facing meeting the requirements of ASTM C 1136, Type II. Insulation material shall meet the requirements of NFPA 90A, NFPA 90B, ASTM C 1290 and ASTM C 553. Operating temperature range shall be from 40°F. to 250°F. Maximum “k” factor of 0.30 at 75°F. mean temperature difference. Owens Corning Type 75, Johns Manville Microlite XG or approved equal.
2. Insulate the following ducts with 1½ inches installed thickness fiberglass duct wrap:
 - a. Concealed air handling unit supply air ducts.
 - b. Supply air duct from the energy recovery unit
3. Insulate the following ducts with 1-1/2 inches installed thickness 3M-615+ Fire Barrier Wrap
 - a. Clothes dryer exhaust ducts from the shaft to the exhaust fans on the roof.
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. Installation

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

2.14 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 vendors (listed alphabetically):
 - a. T.A.C.
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. ATC Contractor must be capable of providing, installing and servicing the control system in its entirety. Sub contracting of parts or partial sections of the ATC system is not permitted. Exception: Sub contracting of ATC wiring is permissible but the ATC contractor shall be ultimately responsible and liable for proper installation as outlined in Divisions 15 and 16 of this specification.
 - 4. The control systems shall be provided and installed by trained control mechanics, regularly employed by the approved vendors, in installation and calibration of ATC equipment. No other vendor will be accepted.
 - 5. Shop drawings of entire control system shall be submitted for approval before work is started.
 - 6. Provide ATC technician to test the complete ATC systems sequences for specified cycles of operation with the Testing and Balancing Contractor.
 - 7. 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 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. Heat pump systems including supplemental heating
- 2. Line voltage thermostats for electric heat
- 3. Fans operated by pressure control system.
- 4. Control valves for hot water duct heating coils
- 4. Carbon Monoxide and Hydrogen sensing and control system in Garage.
- 5. Smoke Relief damper on elevator shaft.
- 6. Coordination with Heat Pump Tenant Billing Software supplied by equipment manufacturer.

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 ATC 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.
 - (5) Physically install duct smoke detectors (supplied by Division 16).
 - c. The Construction Manager 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) Wire power to all motor operated dampers.
 - (2) Provide and wire duct smoke detectors.

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 1.03, 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. Temperature Control Contractor shall be responsible for coordinating installation of his wiring conduits with Division 16, "ELECTRICAL".

E. Submittal Brochure

The following shall be submitted for approval:

1. Control drawings with detailed wiring diagrams, including bill of material and description of operation for all systems.
2. Valve and damper schedules showing size, configuration, capacity and location of all equipment.
3. 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. ATC 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.

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. Thermostats

1. Heat pump system: Thermostats shall be supplied with the heat pump system and installed by ATC.
2. Electric heat thermostats: These shall be of line voltage, heavy duty all metal type and provided with clear plastic locking tamper proof covers (where covers are shown on plans).
3. Thermostats shall be mounted according to ADA requirements (<http://www.access-board.gov/adaag/html/adaag.htm#4.27>).
4. Provide clear plastic heavy duty locking guards over thermostats in public areas.

J. Miscellaneous Devices

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

K. 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 ATC Contractor shall include motor operated dampers installed where indicated.
5. Dampers shall be Ruskin Model CD60, Air Balance Model AC-516, Arrow, or approved equal.

N. Description of Operation

1. Energy recovery unit
Unit to have it's own internal controls – no occupied/unoccupied schedule
3. Fans shall operate continuously.
Install and test pressure controls for DE-1&2 and KEH-1. Set speed control on fans to maintain a -0.1" negative duct pressure.
5. Electric baseboard heat EB-1&2 and CEB-1&2
Supply line voltage thermostats for installation by electrician.
6. Heat Pump System
Heat pump system shall be supplied with all control devices by the system

manufacturer. Devices and programming of systems shall be performed by factory authorized personnel trained in the installation of the system. See Par. 2.07, "HEAT PUMP SYSTEMS". Provide the necessary control wiring and installation.

Provide man-hours to help set up Tenant Billing Software with the assistance of the Heat Pump manufacturer. Provide an allowance of 16 hours for this assistance.

7. Electric Duct Heating Coils

Coils to come from the manufacturer with relays to activate or deactivate coils. Heat pump system control installer shall wire from each air handler control to its associated booster coil. Should the outdoor temperature be too cold to effectively heat the building the duct heating coils shall be activated to supplement as needed by the space thermostats.

8. Hot Water Duct Heating Coils

Heat pump system control installer shall wire from each air handler control to its associated hot water duct heater coil. When the auxiliary heat signal from the air handler is activated then open the duct heating coil control valve.. Also, activate the two pumps at the hot water heater heat exchanger.

9. Carbon Monoxide and Hydrogen System

- a. Supply and install a Carbon Monoxide and Hydrogen detection and exhaust system as shown on drawings.
- b. System shall consist of a Macurco Control Panel to control up to 12 CO and/or nitrogen detectors.
 - i. Externally visible LCD display.
 - ii. Lockable NEMA 1 enclosure
 - iii. Fail Safe operation can be eliminated
- c. Provide and install one Macurco Carbon Monoxide and Hydrogen Detector as shown on drawings.
 - i. Output; Fan Relay, Alarm Relay and 4-20mA current Loop.
 - ii. Factory calibrated
- d. Upon detection of 25 ppm CO activate EF-1 and open all associated intake and exhaust dampers.
- e. Upon detection of 25 ppm N2 activate EF-1 and all associated intake and exhaust dampers.

8. Smoke Relief for elevator shaft

On a signal from the building fire alarm system open relief damper. Damper operator to be poser closed and spring open Activation by any of the elevator lobby smoke detectors.

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 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 and refrigerant 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. All refrigerant mains shall be run level.
7. All condensate drain piping shall be pitched downward in the direction of flow by not less than 1/8 inch per foot of run.
8. Where preset balancing valves are used, it is critical that there not be two valves installed in series anywhere throughout the piping system.

9. Provide drains with hose threads and metal caps at all low points in the hydronic piping system.
10. 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.
11. Runouts to hot water radiation shall be size indicated on plans and shall come off the main downward (downfeed units) or off the side (upfeed units) with no less than three (3) 90 degree elbows provided on runout from main to drop or rise to radiation to absorb movement.
12. Install brass fittings at all points of dissimilar piping connections.
13. Install a sufficient number of unions or flanges to facilitate assembly and disassembly of hydronic piping and removal of equipment.
14. 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.
15. Inspect each piece of pipe, tubing, fittings, and equipment for defects and obstructions; promptly remove all defective materials from the job site.
16. 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.
17. All risers and offsets shall be substantially supported.
18. Make all changes in pipe size with reducing fittings.
19. All low points in water piping shall be provided with an accessible plug tee or drain valve.
21. All high points in water piping shall be provided with an accessible automatic vent.
22. Maximum spacing of hangers for steel 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"

23. Maximum spacing of hangers for copper piping shall be as follows:

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

24. 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.
25. 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.

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 soldering areas at all times. Take additional precautionary measures when soldering close to wood structures to protect the wood from igniting.

3.04 INSTALLATION OF DUCTWORK AND EQUIPMENT

A. General

1. Size and general arrangements as well as methods of connecting all diffusers, 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. Do not use segmented elbows or screws to connect fittings on clothes dryer ducts. Use smooth, long radius elbows and pop rivets instead.
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. 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. All heat recovery unit ductwork mains on the second floor (from the heat recovery units to and including the main drops to the lower level) 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.

3.05 TESTING, ADJUSTING AND BALANCING (TAB)

A. General

1. TAB contractor shall be a subcontractor to the Mechanical Contractor.
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.
4. TAB Contractor shall submit field reports to Construction Manager. 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. 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. 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, diffuser terminal unit 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. Adjust all balancing valves so that each heating/cooling coil is furnished with design fluid flow within 5% of the specified quantities. Mark all set points.
9. Take and record flow readings of preset balancing valves.
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.

12. 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) Provide a static pressure profile of all AHU's components in the two extreme operating modes; minimum outdoor air and economizer cycle.
- 7) Filter status report

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. See par. 1.10, "ELECTRONIC DRAWINGS AND FILE SHARING" for additional information.

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

3.06 CLOSING IN UNINSPECTED WORK

A. General

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

- B. Contractor is required to provide not less than 48 hours advance notice to the Architect of intent to cover non-inspected work to permit time for scheduling inspections.

C. Noncompliance

Should any work be covered up or enclosed prior to all required inspections and approvals, the Architect reserves the right to order the uninspected work to be uncovered

for inspection at the Contractor's expense. After the work 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.

3.07 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. Construction Manager 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 Construction Manager.

3.08 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 air handling units, fans and cabinet unit heaters. Clean the interiors of ductwork as outlined in 3.04, "INSTALLATION OF DUCTWORK AND EQUIPMENT"; paragraph "B", "Protection and Cleaning".

3.09 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 twenty-four (24) hours. (Temperature control system instruction shall be in addition to this instruction period). The time of instruction shall be arranged with the Owner.

3.10 REFRIGERANT PIPING

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.

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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 and brazed. 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.

3.11 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.

3.12 HAZARDOUS MATERIALS

Mercury, asbestos 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.

END OF SECTION 15600