SECTION 23 00 00
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 DESCRIPTION OF WORK

A. Work Included

1. Furnish all labor, materials, equipment, transportation and perform all operations required to install a complete air conditioning and ventilating system where show, 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 direct expansion air conditioning system in building areas indicated on drawings.
   b. Refrigerant piping and fittings
   c. Air handling units
   d. Outdoor units
   e. Insulation
   f. Sheetmetal
   g. Automatic Temperature Control (ATC)
   h. Tests and balance

5. Specifications and accompanying drawings do not indicate every detail of pipe, valves, fittings, hangers, ductwork and equipment necessary for complete installation; but are provided to show general arrangement and extent of work to be performed.

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. Work Not Included in this Section

1. Cutting and patching
2. Electrical conduit and wiring, except as noted below

3. Roofing, curbs, curb openings and framing of openings.
4. Setting of sleeves in masonry work (sleeves provided by Mechanical Contractor)
5 All finish work

1.03 PERMITS

A. This Contractor shall be responsible for providing and filing all Plans, Specifications and other documents, pay all requisite fees and secure all permits, inspections and approvals necessary for the legal installation and operation of the systems and/or equipment furnished under this Section of the Specifications.

B. The Contractor shall frame under glass/ clear plastic all permits, secured by him, adjacent to the respective system and/or equipment and required to be displayed by Code, law or ordinance. Those permits secured but not required to be displayed shall be laminated in plastic and included in the Owner's maintenance manual.

1.04 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.

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.

1.05 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.

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 Owner 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.).

1.06 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 not mentioned in this specification shall be made in writing via letter or e-mail to the Owner or Engineer up to four working days prior to opening of bids to permit sufficient time to notify all bidders via addenda. Any requests made after the final addenda prior to bid opening will not be considered. Contractor must certify within his submittals that any equipment or materials requested 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 while providing adequate clearances for servicing of equipment as required by the manufacturers and will not interfere with other trades. Engineer shall not be responsible to provide drawings for substituted materials unless the substitution is agreed upon prior to opening of bids.

B. The phrase "or approved equal" shall be defined to mean the Owner or Engineer shall make final determination whether or not substitute materials are an equal to that which is specified. 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.

C. Approval by Engineer 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 Owner's decision on acceptability of substitute materials shall be final. Engineer's decision on acceptability of substitute materials shall be final.

D. 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.

E. Any additional cost(s) resulting from the substitution of equipment, regardless of acceptance by the Owner or Engineer, shall be the responsibility of this Contractor. Additional costs may include, but not be limited to, electrical and/or structural alterations from the contract documents.

1.07 SHOP DRAWINGS & SUBMITTALS

A. As soon as possible after award of contract (*but not longer than 21 calendar days*), <u>before any material or equipment is purchased</u>, Mechanical Contractor shall submit shop drawings for review. Unless prior arrangements are made with the Owner all shop drawings must be submitted to the General Contractor who in turn will forward them to the Owner. 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 all substitutions included in the late shop drawings will, at the Owner’s discretion, be invalid and the equipment primarily specified must be provided. Any costs resulting from delays in the project schedule due to failure to submit shop drawings related to this section in a timely manner shall be the responsibility of the Mechanical Contractor. Mechanical Contractor’s and vendor’s name, address, telephone number and e-mail addresses shall be provided with every shop drawing submission. Capacities indicated are minimums. Equipment submitted with capacities below specified parameters will

be refused.

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. Equipment submitted with capacities below specified parameters 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 Owner, 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 Owner reserves the right to order the withholding of payment until the situation is resolved in a manner satisfactory to the Owner.

E. Shop drawings are required to be submitted electronically (paper copies will not be accepted). Resolution on files in .pdf format shall be a minimum of 300 dpi and a maximum of 600 dpi. Electronic files must 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. Locked files will not be reviewed. Exception: Color samples, where required, must be provided to the Owner in the form of original paper copies. Electronic color samples are not acceptable due to differences in monitor color rendition. Faxed copies of color samples will be refused.

F. Review must be obtained on the following items:

1. Registers, diffusers, and grilles
2. Duct access doors
3. Volume control dampers (manual and automatic)
4. Duct sealant
5. Flexible duct
6. Air filters
7. Air handlers
8. Outdoor units
9. Refrigerant and drain piping and accessories

1.08 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 Owner at no additional cost to the Owner.

1.09 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 special 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 drawings must be kept up to date by recording all changes within one week of the time that the changes are authorized. At the completion of the work, this set of drawings shall be delivered to the Owner for the Owner electronically in the form of CAD drawings or Adobe .pdf with markups in red. If a complete record of changes is not made and electronic 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 Adobe or CAD drawings (minus professional engineering stamps) may 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”.

1.10 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. These may be incorporated in Maintenance Manuals, if binders are of adequate size. Also, include (2) CD’s with all electronic shop drawings and catalog cuts.

1.11 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 Owner, the necessary changes eliminating the noise or vibration shall be made by this Mechanical Contractor at no extra cost to the Owner.

1.12 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.

1.13 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 Ownerural, 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 drawings, or between drawings and this specification notify the Owner immediately so a clarification may be issued by addenda.

C. Questions to the Owner 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. Inquiries 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 Owner 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 Owner 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.

1.14 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.

1.15 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 Owner 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 Owner 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 Owner 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.

1.16 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 new refrigerant and drain 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.	Condensate drains	Schedule 40 PVC with solvent joints
2.	Refrigerant with flared fittings	Type "K" hard drawn copper tubing

2.02 PIPE HANGERS AND SUPPORTS

A. General

1. All interior hangers and supports shall be specially manufactured for that purpose and shall be the pattern, design and capacity required for the location of use.

2. Piping specified shall not be supported from piping of other trades.

3. Hangers on drain piping shall be sized for the piping only (not including insulation). Hangers on refrigerant piping shall be sized to include the insulation and include thermal hanger shields (insulated pipe supports).

   Hangers for refrigerant piping shall be steel, band type. Carpenter & Paterson, Inc., Fig. 1A or approved equal.

   Hangers for PVC piping shall be steel, band type; plastic coated. Carpenter & Paterson, Inc., Fig. 1A PVC or approved equal. Riser clamps shall be Carpenter & Patterson, Inc. Fig. 126 PVC.

4. Thermal hanger shields shall be Carpenter & Paterson, Inc., Fig. 265P or approved equal.

B. Hanger Rods

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

Pipe Size	Rod Size
½" to 2"	3/8"

2. Provide toggle bolts for fastening to concrete blocks and compound anchor shields for bolts for fastening to poured concrete.

3. Provide lag points with rod couplings or side beam connectors with drive screws for fastening to wood.

4. All nuts for hanger rod to be stainless steel.

C. Supports

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

2.03 AIR CONDITIONING SYSTEMS

A. General

Provide and install variable refrigerant flow, split system, air conditioning systems where indicated on drawings. Capacities shall be as scheduled on sheet M1.

Systems may be installed only by factory approved personnel. Installing contractor must include a copy of the VRF system installation course completion certificate with the VRF system submittals. Certificate shall include names of installers.

Systems and equipment described herein are based on a Mitsubishi City-Multi system to establish a standard. Equivalent equipment by Daikin, LG and others meeting the specified features and performance characteristics of the specified equipment will be considered. If substituting, schematic diagrams showing piping, pipe sizes, air handlers, outdoor units, electrical and controls must be submitted with shop drawings or the substitution will be refused. Diagrams generated with the manufacturer's selection software is permissible.

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 schematic drawing of each system showing all components (including equipment tags), refrigerant piping (including lengths and sizes) and control wiring with the shop drawings.

C. Outdoor (Compressor/Condenser) Units

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

1. Seacoast protection
2. Wind baffles for low ambient operation
3. Disconnect switch

Systems shall consist of PUZ outdoor (Compressor/Condenser) units and M-NET DDC (Direct Digital Controls). Outdoor units shall be a horizontal air discharge, 208/230 volt, single phase.

D. Air Handling (AH) Units

1. Units shall be models PLA and PEAD, high-performance indoor fan coils for ducted or ductless applications and shall have a modulating linear expansion device. Units shall support individual control using M-NET DDC controllers. Ducted units shall feature external static pressure settings up 0.50 in. WG. All units shall include a condensate lift mechanism that will be able to raise drain water 27 inches above the condensate pan.

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 fans 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. Coils

   a. The indoor coils 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. Both refrigerant lines to the air handlers shall be insulated.

5. Electrical

   a. Electrical power for air handlers and circuit controllers 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 unit 1 shall respond to an electronic return air sensor. Fan shall operate continuously.
   b. Air handling unit 2 shall respond to an electronic wall mounted thermostat. Fan shall operate continuously.
   c. In the air conditioning mode the air handler controls shall signal the respective outdoor unit to activate on demand for cooling.

d. Thermostats shall be Mitsubishi Simple MA.

e. Each system shall include PAC-725AD (LON compatible) wiring harness to permit connection to the existing building automation system for monitoring purposes only.

E. 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.

2.04 SHEETMETAL

A. General

The work under this section includes all the required sheetmetal and duct work, extensions for grilles, manual dampers, deflectors, grilles, registers and flexible connections 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:

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

3. Methods of fabrication and installation shall be in strict accordance with guidelines set forth in the latest SMACNA Guide and Data Book for Low and Medium Pressure Duct Construction unless otherwise shown on drawings. Cross break all ducts with largest dimension being 18 inches and larger. Beaded ducts are not acceptable except for ductwork less

than 18 inches in either direction.

4. All dampers and deflectors shall be a minimum of #22 gauge and stiffened as required. Splitter dampers shall not be acceptable.

5. All joints in ducts shall be made air tight, and all branches and turns shall be made with long radius elbows and fittings. Long radius elbows are defined as having a centerline radius of 1½ 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^{o} or rounded are not acceptable.

6. All ducts shall be installed with necessary offsets, changes in cross sections, risers, and drops which may be required. They shall be constructed with approved joints and be supported in an approved manner.

7. Round ductwork shall be constructed in accordance with the latest SMACNA HVAC Duct Construction Standards for round and oval duct construction. Ductwork larger than 8 inches in diameter shall employ spiral seams. All turns shall be made with smooth (not segmented), long radius elbows and fittings. All seams shall be type RL-5, grooved seam pipe lock or better. *Lap seams are not permissible*. Gauge thicknesses shall be as outlined in SMACNA for galvanized steel round duct gauge selections for maximum 2 inches w.g. static pressure. Ductwork shall be supported with full wrap-around band and single hanger strap as indicated in Figure 4-4 of the 1985 edition of the SMACNA HVAC Duct Construction Standards handbook.

8. Furnish and install flexible connections on air handlers (where indicated). 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 Owner.

10. Requirements set forth in applicable codes (see part one) shall supersede SMACNA standards.

C. Registers and Grilles

Registers and grilles shall be installed at air supply, return and transfer 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 Titus to establish a standard of quality. Certified sound criteria shall be included with submittals indicating CFM and NC levels of each register and grille. Units by Anemostat, Krueger, Metalaire and Price will also be considered for review.

a. Supply Registers: Double deflection; 300FL with opposed blade damper and ¾ inch front blade spacing; front blades set horizontal.
b. Transfer Grille: 350FL with ¾ inch, 45° front blade spacing, front blades set horizontal.
c. Filtered Return Grilles: Model 350FLF1 with hinged core, ¾ inch front blade spacing, front blades set horizontal. Provide filters with grilles as outlined in paragraph 2.05, “FILTERS”.

D. Sealing of Ducts

All new ductwork shall be sealed with low VOC water based duct mastic, either "MP" (Multi-Purpose), Carlisle 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 exclusively.

E. 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.

F. 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.

2.05 FILTERS

Filtered return grilles 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 Owner 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.

2.06 EQUIPMENT IDENTIFICATION

Tag each new air handling unit and outdoor unit 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. Locate nameplate on AH-2 so as not to be visible from the room. Nameplates shall be 4 inches by 1½ inches, Setonply Style No. M1774.

Identify all new refrigerant and drain 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. Markings and colors shall be per the following chart:

Marking	Background Color	Lettering Color
Refrigerant Liquid	Green	White
Refrigerant Suction	Green	White
Drain	Green	White

2.07 INSULATION AND CONDENSATE PROTECTION

A. General

1. Insulation shall be provided for all new refrigerant piping and ducts associated with AH-2.

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 (not pre-insulated by equipment manufacturer) 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 1½ inches.

2. Piping and fittings exposed to the elements shall have the insulation covered with ultraviolet resistant vinyl outdoor PVC jacket, JohnsManville Zeston 300 or approved equal.

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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 perminches 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 have the same properties as listed above and shall not detract from any of the system ratings as specified above.

C. Duct 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^{o}F. to 250^{o}F. Maximum “k” factor of 0.30 at 75^{o}F. mean temperature difference. Owens Corning Type 75, Johns Manville Microlite XG or approved equal.

2. Insulate the supply and return air ducts connected to AH-1 with 1½ inches installed thickness fiberglass duct wrap.

3. 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.

2.08 AUTOMATIC TEMPERATURE CONTROL (ATC)

A. General

1. Furnish and install a complete system of electric/electronic temperature controls.

2. The control system shall be an extension of the existing DDC system by T.A.C. Maine Controls, 400 Presumpscot Street, Portland, Maine 04103 (207) 774-0220

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 23 and 26 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 control 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 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 relocating controls for existing VAV unit shown to be relocated on the plan and removal of controls from an existing VAV unit shown to be removed.

System shall also include interfacing with the internal controls for AH-1/OU-1 for monitoring purposes only. AH-1/OU-1 and AH-2/OU-2 shall be provided from the factory with internal controls. Wiring between air handlers, outdoor units and thermostats by ATC contractor. Wiring for interface between AH-1/CU-1 and building controls shall be by ATC contractor.

C. 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 26, "ELECTRICAL".

2. ATC Contractor shall be responsible for coordinating installation of his wiring conduits with Division 26, "ELECTRICAL".

D. 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.

E. Instruction and Adjustment

Upon completion of the project, after the ATC systems have been commissioned and are functioning as intended, the ATC 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.

3. A competent technician shall be provided to thoroughly instruct the Owner's Representative(s) in the care and operation of the ATC system. The total period of instruction shall not exceed twenty-four (24) hours. This instruction shall be in addition to instructions for equipment and systems not included in the ATC portion of this project. See par. 3.09, “INSTRUCTIONS”. Date and time of instruction shall be arranged with the Owner.

4. 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.

F. 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 Owner agrees Owner has begun to receive beneficial use of the system.

G. 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.

H. Description of Operation

1. New air conditioning unit systems shall operate from internal controls provided with the equipment. ATC Contractor shall interface AH-1 with the existing Building Automation System for the purpose of monitoring only.

2. Existing VAV Unit Control

An existing VAV unit shall be relocated by the Mechanical Contractor as shown on plans. ATC Contractor shall modify the controls to have the primary air damper close fully under normal conditions. The existing DDC thermostat for the unit shall be used to open the damper 100% should temperature rise 3^{o}F above the setpoint of the thermostat for AH-1. The purpose is to use the VAV unit as an emergency backup should AH-1/OU-1 fail. Coordinate the two temperature settings to avoid overlap.

3. Systems shall be on occupied settings at all times.

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 Owner.

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. 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.

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. All joints in refrigerant tubing shall be brazed.

C. Fire Safety

When soldering and welding within 10 feet of combustible materials, fire extinguishing equipment shall be kept within 25 feet of the soldering and welding areas at all times. Contractor shall take additional measures when soldering and welding close to wood structures to protect from ignition.

3.03 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 and equipment 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.

3.05 TESTING, ADJUSTING AND BALANCING (TAB)

A. General

1. TAB contractor shall be a subcontractor to the Mechanical Contractor.

2. The TAB Contractor must provide, for review, contact information and copies of qualifications and certifications through the shop drawing review process. The following is a list of acceptable TAB contractors.

a. Central Air Balance
b. Maine Air Balance
c. Tab-Tech International
d. Tekon-Technical Consultants
e. Yankee Balancing

No others will be accepted unless pre-approved prior to opening of bids.

3. TAB contractor shall perform functional performance test of all Division 15 equipment and entire ATC system for specified operation and control sequences.

4. The mechanical contractor shall startup all Division 23 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. Volume dampers are in place and open.
   h. Air outlets are installed and connected.

5. TAB Contractor shall submit field reports to Mechanical Contractor who shall, in turn, submit them to the General Contractor for review by the Engineer. Report defects and deficiencies noted during performance of services which prevent system testing and balance.

6. TAB contractor shall submit all verification and functional performance checklists/results, signed by indicated personnel, organized by system and sub-system.

7. TAB contractor shall submit other reports described below.

B. Work Included

1. Test, adjust and balance all new air 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. 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 ATC Contractor to adjust set points of various devices to balance system(s) and test control sequences of operation. 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.

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 new air 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 air discharge patterns of all new supply air registers for optimal air diffusion.

10. 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 Owner/Engineer may request a re-check or re-adjustment of any part of the work.

11. Reports shall be compiled on a spreadsheet such as Excel, Quattro-Pro, Lotus, etc. and shall clearly indicate the following *minimum* information:

    a. System/unit name
    b. Static pressures; suction, discharge and total
    c. Total system flow rate
    d. Individual terminal flow rates (Terminal readings must show location, make, model and size of register, grille or diffuser).
    e. Filter status report

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

3.06 CLOSING IN UNINSPECTED WORK & ROUTINE INSPECTIONS

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 Owner of intent to cover non-inspected work to permit time for scheduling inspections.

C. Contractor is required notify the Owner when the project is close to completion and ready for review by the design team. Notification shall be not less than 48 hours to permit time for scheduling. At the completion of the project, Contractor is required to provide, in writing, confirmation that any comments or issues brought up during construction and review have been addressed and corrective measures have been taken as required.

D. Noncompliance

Should any work be covered up or enclosed prior to all required inspections and approvals, the Owner 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 Owner and at no additional cost to the Owner.

3.07 CLEANING

Prior to acceptance of the buildings, thoroughly clean all exposed portions of the Heating, Ventilating and Air Conditioning installation, including the removal all labels and all traces of foreign substance. Prior to testing and balancing vacuum and clean inside of all convectors, finned radiators (spackle droppings), unit ventilators, air handling units, VAV units, fans and cabinet unit heaters.

3.08 INSTRUCTIONS

On completion of the job, the Mechanical Contractor shall provide a competent technician to thoroughly instruct the Owner's Representative in the care and operation of the system. The total period of instruction shall not exceed one (1) hour.

3.09 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.

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 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.

3.10 REMOVAL OF EXISTING PIPING AND EQUIPMENT

A. All piping and equipment indicated on the drawings for removal shall be done so by the Mechanical Contractor.

B. All materials removed shall remain the property of the Owner until such time the Owner has reviewed the removed materials and either taken or designated items which he may wish to retain. The remainder shall become the property of this Mechanical Contractor and be removed from the premises immediately.

C. Any damages done to removed materials prior to release by the Owner shall be corrected by the Mechanical Contractor at no additional expense to the Owner. Any materials removed prior to release by the Owner shall be replaced by the Mechanical Contractor at no additional expense to the Owner.

END OF SECTION 23 00 00