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## **SECTION 23 00 07**

### **SUMMARY OF WORK**

#### **PART 1 GENERAL**

##### **1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract apply to this Section.

##### **1.02 PROJECT/WORK IDENTIFICATION**

- A. General: The project name is Forestbrook Middle School HVAC Renovations as shown on Contract Documents prepared by McKnight Smith Ward Griffin Engineers, Inc.
- B. Summary, Prime Contract Work: Briefly, the work, as defined in greater detail by other provisions of the Contract Documents, can be summarized as follows:
  - 1. Remove existing split system makeup air units, duct furnaces and condensing units and install new packaged makeup units with gas heat.
  - 2. Connect to existing ductwork.
  - 3. Install new propane piping system.
  - 4. Update existing CMI controls for noted mechanical system renovations.

##### **1.03 PROJECT COORDINATION**

- A. General: The Contract includes coordination of the entire work of the project, including preparation of general coordination drawings, diagrams and schedules and control of site utilization from the beginning of construction activity through project close-out and warranty periods. The HVAC Contractor shall act as the Prime Contractor for coordination of the project schedule. The intent of the paragraph is to Require that the contract be administered as a single prime contract, preferably (logically) with the HVAC Contractor as the Prime. It is not the intent of this paragraph to eliminate the opportunity for other contractors to serve as Prime. Note that the submission of a Bid as Prime Contractor will attest that that subcontractors with proper licensing necessary to secure all required permits are included as a part of the proposal.

##### **1.04 ALTERNATE BID DESCRIPTION:**

- A. Base Bid: The base bid shall include all work illustrated on the drawings and described within the specifications unless otherwise noted.

- B. Alternate 1: State the amount to deduct from the base bid price to use an approved substitution for the makeup air units.
- C. Alternate 2: State the amount to add to the base bid price to provide 5 year parts and labor warranty for the make up air units.
- D. Alternate 3: State the amount to add to the base bid price to provide factory training on the makeup air unit components and operations. For the purposes of pricing training shall consist of a one day session, 8 hours long and shall include all necessary training materials.
- E. Alternate 4. State the amount to deduct from the bid to omit installation of MAU-9 and MAU-10.

**PART 2      PRODUCTS (not used)**

**PART 3      EXECUTION (not used)**

**END OF SECTION**

## **SECTION 23 05 00**

### **MECHANICAL GENERAL PROVISIONS**

#### **PART 1 GENERAL**

##### **1.01 SCOPE**

- A. Applicable requirements of the General Conditions, Supplementary General Conditions, and Special Conditions bound at the front of these specifications shall govern work under this heading.
- B. The Contractor shall coordinate the work and equipment of this Division with the work and equipment specified elsewhere in order to assure a complete and satisfactory installation. Work such as excavation, backfill, concrete, flashing, wiring, etc., which is required by the work of this section shall be performed in accordance with the requirements of the applicable section of the specifications.
- C. It is the intention of these specifications and drawings to call for finished work, tested and ready for operation. Whenever the word "provide" is used, it shall mean "furnish and install complete and ready for use".
- D. Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the work, the same as if herein specified or shown.
- E. This Contractor is referred to the General and Special Conditions of the Contract which shall form a part and be included in this section of the specification and shall be binding on this Contractor.
- F. Some items of equipment are specified in the singular; however, the Contractor shall provide and install the number of items or equipment as indicated on the drawings, and as required for complete systems.

##### **1.02 DEFINITION**

- A. The word "Contractor" as used in this section of the specification refers to the HVAC Contractor unless specifically noted otherwise. The word "provide" means furnish, fabricated, complete, install, erect, including labor and incidental materials necessary to complete in place and ready for operation or use the item referred to or described herein and/or shown or referred to on the Contract Drawings.

##### **1.03 CONTRACTOR'S QUALIFICATIONS**

- A. It is assumed that the Contractor has had sufficient general knowledge and experience to anticipate the needs of a construction of this nature. The

Contractor shall furnish all items required to complete the construction in accordance with reasonable interpretation of the intent of the Drawings and Specifications. Any minor items required by code, law or regulations shall be provided whether or not specified or specifically shown where it is a part of a major item of equipment, or of the control system specified or shown on the plans.

## **PART 2 PRODUCTS**

### **2.01 MATERIALS AND WORKMANSHIP**

- A. All materials and apparatus required for the work, except as specifically specified otherwise, shall be new, of first-class quality, and shall be furnished, delivered, erected, connected and finished in every detail, and shall be so selected and arranged as to fit properly into the building spaces. Where no specific kind or quality of material is given, a first-class standard article as approved by the Architect shall be furnished.
- B. The Contractor shall furnish the services of an experienced superintendent, who shall be constantly in charge of the installation of the work, together with all skilled workmen, fitters, metal workers, welders, helpers and labor required to unload, transfer, erect, connect-up, adjust, start, operate and test each system.
- C. Unless otherwise specifically indicated on the plans or specifications, all equipment and material shall be installed with the approval of the Architect in accordance with the recommendations of the manufacturer. This shall include the performance of such tests as the manufacturer recommends.
- D. All work must be done by first-class and experienced mechanics properly supervised and it is understood that the Architect has the right to stop any work that is not being properly done and has the right to demand that any workman deemed incompetent by the Architect be removed from the job and a competent workman substituted therefore.

### **2.02 EQUIPMENT APPLICATION AND PERFORMANCE**

- A. The Contractor and/or Equipment Supplier shall be responsible to see that equipment supplied is correct for the intended application and will perform within the limits of capacity, noise, life expectancy, pressure drop and space limitations intended for that equipment as shown on the plans or described in the specifications. The shop drawings shall show the capacity and operating characteristics of the equipment.

### **2.03 EQUIPMENT DEVIATIONS**

- A. Where the Contractor proposes to use an item of equipment other than that specified or detailed on the drawings, which requires any redesign of the structure, partitions, foundations, piping, wiring or any other part of the mechanical, electrical, or architectural layout, all such redesign, and all new drawings and detailing required therefore, shall be prepared by the Sub-

contractor at his own expense and submitted for approval by the Architect.

- B. Where such approved deviation requires a different quantity and arrangement of ductwork, piping, wiring, conduit, and equipment from that specified or indicated on the drawings, the Contractor shall furnish and install any such ductwork, piping, structural supports, insulation, controllers, motors, starters, electrical wiring and conduit, and any other additional equipment required by the system, at no additional cost to the Owner.

#### 2.04 MOTORS

- A. Motors shall be built in accordance with the latest standards of NEMA and as specified. Motors shall be tested in accordance with standards of A.S.A. C40 and conform thereto for installation resistance and dielectric strength. Each motor shall be provided with conduit terminal box, adequate starting and protective equipment as specified or required. The capacity shall be sufficient to operate associate driven devices under all conditions of operation and load and without overload, and at least shall be the horsepower indicated or specified. Each motor shall be selected for quiet operation. Motors 1 HP or more shall have a minimum acceptable nominal full load efficiency not less than that shown in Table 10.8 of ASHRAE Standard 90.1 – 2007 Edition.

#### 2.05 DRIVES

- A. Machinery drives shall be provided for all power driven equipment specified in this section.
- B. Drives shall be V-belt and shall be selected to overcome the starting inertia of the equipment without slippage, but in no case shall be less than 150% of the full motor load. Drives 1/2 HP and smaller may be provided with single belts. Drives 3/4 HP and larger shall be provided with the number of belts necessary to transmit the required power with 95% minimum efficiency.
- C. Where adjustable type sheaves are indicated they shall be selected such that the schedule speed of the driven equipment is at the midpoint in the adjustment range of the sheave.
- D. Where fixed type sheaves are indicated the Contractor shall include in his price changing sheave sizes once during the balancing period to achieve proper air quantities.
- E. Sheaves shall be machined cast iron of the same manufacturer as the belt provided. Shop drawings shall be submitted of each drive which shall include actual transmission capacity of each drive.

#### 2.06 FOUNDATIONS, SUPPORTS, PIERS, ATTACHMENTS

- A. This Contractor shall furnish and install all necessary foundations, supports, pads, bases and piers required for all air conditioning equipment, pip-

ing, pumps, tanks, compressors, and for all other equipment furnished under this contract, and shall submit drawings to the Architect for approval before purchase, fabrication or construction of same.

- B. For all makeup air units located on grade, furnish and install concrete pads minimum 4 inches thick or as shown. All pads shall be extended six (6) inches beyond machine base in all directions with top edge hampered. Insert six (6) inch long, 1/2" round steel dowel rods at 12" on center into floors to anchor pads. Shop drawings for all foundations and pads shall be submitted to the Architect for approval before same are constructed.
- C. Construction of foundations, supports, pads, bases, and piers where mounted on the floor, shall be of the same materials and same quality of finish as the adjacent and surrounding flooring material.
- D. All equipment, unless otherwise shown, shall be securely attached to the building structure in an approved manner. Attachments shall be of a strong and durable nature and any attachments that are, in the opinion of the Architect, not strong enough shall be replaced as directed.

## 2.07 VIBRATION ISOLATION

- A. All work shall operate under all conditions of loads without any sound or vibration which is objectionable in the opinion of the Architect. If requested, the Contractor shall record sound power level readings in all areas adjacent to mechanical rooms, over, under or beside, after all equipment is fully operational and all wall and ceiling systems are completed. Sound level readings shall not exceed NC levels as recommended in Table 1, Chapter 48 of 2011 ASHRAE Applications Handbook.
- B. The readings are to be tabulated in the Maintenance and Operating Instruction Booklets.
- C. Sound or vibration conditions in excess of listed quantities shall be corrected in an approved manner by the Contractor at his expense.
- D. Unless otherwise noted mechanical equipment over one horsepower shall be isolated from the structure with resilient vibration and noise isolators supplied by one manufacturer to the Mechanical Contractor. Where isolator type and required deflection are not shown, equipment shall be isolated in accordance with the 2011 ASHRAE Applications Handbook, Chapter 48, Table 47. Submittals shall include complete design for the equipment bases, a tabulation of the design data for the isolators, including lateral stiffness, O.D.; free operating and solid height of the spring isolators, free and operating height of the neoprene or fiberglass isolators. Selection of isolators for proper loading to obtain desired efficiency shall be the responsibility of the manufacturer of isolating units to suit the equipment being supplied on the job and shall be fully guaranteed by this supplier. All vibration isolation equipment complete with thorough selection data shall be submitted. Units shall be Vibration Eliminator Company, Mason, Peabody, or approved equal.

- E. Flexible duct connections shall be provided at inlet and outlet of all fans or cabinets containing fans and shall be constructed such as to allow a minimum movement of 2 inches in any direction and will not restrict normal movement of any equipment.

#### 2.08 DIELECTRIC CONNECTIONS

- A. Dielectric connections shall be used at any points within the piping systems where dissimilar metals meet. Careful attention shall be given to support brackets and hangers to select proper materials to avoid dissimilar metal contact at these points.

#### 2.09 DRAINS AND VENTS

- A. In addition to the drains and vents indicated on the plans and piping details, the Contractor shall install additional drains and vents as required to remove all water and air from the piping systems.

#### 2.10 MOTOR STARTERS AND DISCONNECTS

- A. Individual motor controllers complete with auxiliary contacts, control transformers, push buttons, selector switches and remote push button stations not specifically specified to be furnished with the equipment shall be provided under this section. Motor controllers shall comply with NEMA Standards and be complete with proper size heaters and auxiliary contacts and shall be in NEMA enclosures as required. Unless otherwise noted, push button stations shall be oil-tight heavy duty type. Controllers shall be manual, magnetic, or combination type with disconnect switch or circuit breaker as indicated on the drawings or where required by the NEC. Controllers shall include motor over current protection in each phase conductor. Each motor controller shall be provided with phenolic nameplate, black with 1/4" high letters and white border, indicating equipment served, attached using counter sunk screws.
- B. The Electrical Contractor shall furnish and install all disconnecting switches unless otherwise indicated or specified. Where disconnecting switches are indicated to be furnished under this Section, they shall be General Electric, Type TH in NEMA 1 enclosures, with voltage and amperage rating appropriate to the application. Unless otherwise noted, fuses shall be Buss "Fusetrons", or approved equal. Unfused motor disconnecting switches shall be Type TH in NEMA 1 or 4 applicable enclosures. Similar and equivalent equipment as manufactured by I.T.E., Square D, or Westinghouse is equally acceptable. Switches used as service switches shall bear such U.L. Label and nameplate on switch shall so indicate.

#### 2.11 PAINTING

- A. Paint material shall be selected from the products listed below and, insofar as practical, products of only one manufacturer shall be used. Contractor shall submit to the Architect the listed manufacturer he proposes to use in



the work. Should the Contractor desire to use products of a manufacturer not listed below, or products made by a listed manufacturer but not scheduled herein, Contractor shall submit complete technical information on the proposed products to the Architect for approval. Only products approved by the Architect shall be used. Paint and Primers to adhere to requirement in Section 018114.

1. Rust Inhibitive Primer
  - a. Devco: Bar-Ox Quick Dry Metal Primer, Red.
  - b. Duron: Deluxe Red Primer.
  - c. Glidden: Rustmaster Tank and Structure Primer.
  - d. Pittsburgh: Inhibitive Red Primer.
2. Galvanized Metal Primer
  - a. Devco: Mirrolac Galvanized Metal Primer.
  - b. Duron: Duron Deluxe Galvanized Metal Primer
  - c. Glidden: Rustmaster Galvanized Iron Metal Primer.
  - d. Pittsburgh: Speedhigh Galvanized Steel Primer.

### **PART 3 EXECUTION**

#### **3.01 DUTIES OF CONTRACTOR**

- A. Contractor shall furnish and install all materials called for in these Specifications and accompanying drawings, and must furnish the apparatus complete in every respect. Anything called for in the specifications and not shown on the drawings or shown on the drawings and not called for in the specifications must be furnished by the Contractor.
- B. Contractor is responsible for familiarizing himself with the details of the construction of the building. Work under these specifications installed improperly or which requires changing due to improper reading or interpretation of building plans shall be corrected and changed as directed by the Architect without additional cost to the Owner.
- C. The Contractor shall follow drawings in laying out work and check drawings of other trades to verify spaces in which work will be installed. Maintain maximum headroom and space conditions at all points. Where headroom or space conditions appear inadequate, Architect shall be notified before proceeding with installation.
- D. The plans are diagrammatic and are not intended to show each and every fitting, valve, pipe, pipe hanger, or a complete detail of all the work to be done; but are for the purpose of illustrating the type of system, showing pipe sizes, etc., and special conditions considered necessary for the experienced mechanic to take off his materials and lay out his work. This Contractor shall be responsible for taking such measurements as may be necessary at the job and adapting his work to local conditions.
- E. Conditions sometimes occur which require certain changes in drawings and specifications. In the event that such changes in drawings and specifications are necessary, the same are to be made by the Contractor without expense to the Owner, providing such changes do not require furnishing

more materials, or performing more labor than the true intent of the drawings and specifications demands. It is understood that while the drawings are to be followed as closely as circumstances will permit, the Contractor is held responsible for the installation of the system according to the true intent and meaning of the drawings. Anything not entirely clear in the drawings and specification will be fully explained if application is made to the Architect. Should, however, conditions arise where in the judgment of the Contractor certain changes will be advisable, the Contractor will communicate with the Architect and secure his approval of these changes before going ahead with the work.

- F. The right to make any responsible change in location of apparatus, equipment, routing of piping up to the time of roughing in, is reserved by the Architect without involving any additional expense to the Owner.
- G. It shall be the duty of prospective Contractors to visit the job site and familiarize themselves with job conditions. No extras will be allowed because of additional work necessitated by, or changes in plans required because of evident job conditions, that are not indicated on the drawings.
- H. Contractor shall determine the schedule of work as lay down by the General Contractor and must schedule his work to maintain the building construction schedule so as not to interfere with or hold up any other Contractors.
- I. Contractor shall leave the premises in a clean and orderly manner upon completion of the work, and shall remove from the premises all debris that has accumulated during the progress of the work.

### 3.02 CODES, RULES, PERMITS AND FEES

- A. The Contractor shall give all necessary notices, obtain all permits and pay all sales taxes, fees and other costs, including utility connections or extensions, in connection with his work; file all necessary plans prepare all documents and obtain all necessary approvals of all authorities having jurisdiction. Obtain all required certificates of inspection for his work and deliver same to the Architect before request for acceptance and final payment of the work.
- B. The Contractor shall include in his work, without extra cost to the Owner, any labor, materials, service, apparatus, drawings, in order to comply with all applicable laws, ordinances, rules and regulations, whether or not shown on drawings and/or specified.
- C. All materials furnished and all work installed shall comply with the National Fire Codes of the National Fire Protection Association, and with the requirements of all governmental departments having jurisdiction.
- D. All materials and equipment for the electrical portion of the mechanical system shall bear the approval label, and shall be listed by the Underwriters' Laboratories, Inc.

- E. All work shall be done in accordance with the North Carolina State Building Code, and requirements of governmental agencies having jurisdiction.

### 3.03 COOPERATION WITH OTHER TRADES

- A. This Contractor shall give full cooperation to other trades and shall furnish any information necessary to permit the work of all trades to be installed satisfactorily and with the least possible interference or delay.
- B. Where the work of the Contractor will be installed in close proximity to, or may interfere with the work of other trades, he shall assist in working out space conditions to make a satisfactory adjustment. If so directed by the Architect, the Contractor shall prepare composite working drawings and sections at a suitable scale not less than  $3/8" = 1'-0"$ , clearly showing how his work is to be installed in relation to the work of other trades. If the Contractor installs his work before coordination with other trades, or so as to cause any interference with work of other trades, he shall make the necessary changes in his work to correct the condition without extra charge.
- C. The Contractor shall furnish to other trades, as required, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

### 3.04 RECORD DRAWINGS

- A. The Contractor shall furnish drawings showing dimensioned location and depths of all exterior piping and structures, and shall indicate any and all changes in location of piping, ductwork, equipment or valves from that shown on the Contract Drawings. The drawings shall consist of clean, legible sepia prints of the Contract Drawings, available from the Architect on which the Contractor shall mark all notes, dimensions, sizes and information required. The sepias shall be kept for this purpose only. Before final inspection the Contractor shall submit to the Architect eight (8) sets of black line prints of the sepias.

### 3.05 SURVEYS AND MEASUREMENTS

- A. This Contractor shall base all measurements, both horizontal and vertical, from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at the site and check the correctness of same as related to the work.
- B. Should the Contractor discover any discrepancy between actual measurements and those indicated, which prevents following good practice or the intent of the drawings and specifications, he shall notify the Architect through the General Contractor, and shall not proceed with his work until he has received instructions from the Architect.

### 3.06 SAFETY REQUIREMENTS

- A. All systems shall be installed so as to be safe operating and all moving parts shall be covered where subject to human contact. All rough edges of equipment and materials shall be made smooth.
- B. All safety controls shall be checked under the supervision of the Architect's representative and eight (8) copies of test data showing setting and performance of safety controls shall be submitted to the Architect.

### 3.07 SHOP DRAWINGS

- A. Contractor shall submit within ten (10) days after award of contract eight (8) copies of a complete list of all manufacturers to be used on the job. No substitutions will be allowed after this date except in extenuating circumstances as determined by the Architect.
- B. Submission of a manufacturer's name or equipment number on this list shall not be considered as equipment approved by the Architect.
- C. The Contractor shall submit for approval eight (8) sets of detailed shop drawings of all equipment and all material required to complete the project, and no materials or equipment may be delivered to the job site or installed until the Contractor has in his possession the approved shop drawings for the particular material or equipment. The shop drawings shall be complete as described herein. The Contractor shall furnish the number of copies required by the General and Special Conditions of the Contract, but in no case less than eight (8) copies.
- D. Prior to delivery of any material to the job site, and sufficiently in advance of requirements to allow the Architect ample time for checking, submit for approval detailed, dimensioned drawings or cuts, showing construction, size, arrangement, operating clearances, performance, characteristics and capacity. Each item of equipment proposed shall be standard catalog product of an established manufacturer and of equal quality, finish, performance, and durability to that specified.
- E. Samples, drawings, specifications, catalogs, submitted for approval, shall be properly labeled indicating specific service for which material or equipment is to be used, Section and Article number of specification governing, Contractor's Name and Name of Job.
- F. Catalogs, pamphlets, or other documents submitted to describe items on which approval is being requested, shall be specific and identification in catalog, pamphlet, etc. of item submitted shall be clearly marked. Data of a general nature will not be accepted. Data shall include eight (8) copies of computation sheets indicating how unit capacity was determined where ratings are at other than standard conditions. No payment for any equipment or labor will be allowed until all major pieces of equipment specified have been submitted to the Architect for approval.
- G. The Contractor, as part of the shop drawing submitted, shall submit shop drawing of all ductwork in the mechanical rooms, the risers including take-

offs to the floors with their associated dampers, and ells with unequal legs showing turning vanes.

- H. Static pressure drops across fittings, dampers, heaters, attenuators, etc. shall not exceed minimum ASHRAE Standards when not specified.
- I. The submittal of shop drawings shall be with the Contractor stamp affixed; this shall assure the Engineer that they are being submitted in accordance with Sub-Paragraph 4.13.4 in AIA Document A201 and/or Paragraph 6.26, in NSPE Document 1910-8. This stamp indicates that the Contractor, by approving and submitting shop drawings, represents that he has determined and verified all field measurements and quantities, field construction criteria, material, catalog material, and similar data that he has reviewed and coordinated information in the shop drawings with the requirements of the work and the Contract Documents. It, also, indicates that any deviation from the Contract Documents has been shown on the submittal and clearly defines the deviations from the specifications.
- J. Approval rendered on shop drawings shall not be considered as a guarantee of quantities, measurements, or building conditions. Where drawings are approved, said approval does not mean that drawings have been checked in detail: said approval does not in any way relieve the Contractor from his responsibilities or necessity of furnishing material or performing work as required by the contract drawings and specifications.
- K. Failure of the Contractor to submit shop drawings in ample time for checking shall not entitle him to an extension of Contract time, and no claim for extension by reason of default will be allowed.
- L. All shop drawings and submittals are to be in the office of the Architect within 30 days after the Contracts have been awarded. Contractor shall be financially responsible for any price increase of shop drawing items from the time these drawings are issued until they are returned to the Contractor for purchase of items.
- M. Contractor shall keep on the job at all times copies of all approved shop drawings.

### 3.08 OBSERVATION

- A. The project will be observed periodically as construction progresses. The Contractor will be responsible for notifying the Architect at least 72 hours in advance when any work to be covered up is ready for inspection. No work will be covered up until after observation has been completed on such items as piping and insulation, etc.

### 3.09 ACCESSIBILITY

- A. Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate clearance in double partitions and hung ceilings for the proper installation of his work. He shall cooperate with the General

Contractor and all other Contractors whose work is in the same space, and shall advise the General Contractor of his requirements. Such spaces and clearances shall; however, be kept to the minimum size required.

- B. The Contractor shall locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment shall include but not be limited to valves, traps, cleanouts, motors, controllers, switch-gear, and drain points. If required for better accessibility, furnish access doors for this purpose. Minor deviations from drawings may be made to allow for better accessibility and any change shall be submitted for approval.
- C. The Contractor shall provide the General Contractor with exact locations of access panels for each concealed valve, control damper or other device requiring service. Access panels shall be provided and installed by the General Contractor and as specified in the Architectural sections of the specifications. Locations of these panels shall be submitted in sufficient time to be installed in the normal course of work.

### 3.10 CUTTING AND PATCHING

- A. This Contractor shall provide all cutting and patching necessary to install the work specified in this section.
- B. No structural members shall be cut without the approval of the Architect and all such cutting shall be done in a manner directed by him.
- C. This Contractor shall arrange for proper openings in building to admit his equipment. If it becomes necessary to cut any portion of building to admit his equipment, portions cut must be restored to their former condition by this Contractor through agreeable arrangement with the General Contractor.
- D. The General Contractor will provide all openings or chases in masonry or concrete; however, it is this Contractor's responsibility to advise exact dimensions, shape and locations of openings required in sufficient time for the General Contractor to make the necessary provisions. This Contractor shall be responsible for correct size and location of each opening for his equipment even though these openings are provided by the General Contractor.

### 3.11 SLEEVES AND PLATES

- A. This Contractor shall provide and locate all sleeves and inserts required before the floors and walls are built, or shall be responsible for the cost of cutting and patching required where sleeves and inserts were not installed, or where incorrectly located. This Contractor shall do all drilling required for the installation of his hangers.
- B. Sleeves shall be provided for all mechanical piping passing through concrete floor slabs and concrete, masonry, tile and gypsum wall construction. Sleeves shall not be provided for piping running imbedded in concrete or in

insulating concrete slabs on grade.

- C. Where sleeves are placed in exterior walls below grade, the space between the pipe or conduit and the sleeves shall be packed with oakum and lead and made completely watertight.
- D. Where pipe motion due to expansion and contraction will occur, make sleeves of sufficient diameter to permit free movement of pipe. Where sleeves pass insulated pipes, the sleeves shall be large enough to pass the pipe and insulation. Check floor and wall construction finishes to determine proper length of sleeves for various locations; make actual lengths to suit the following:
  - 1. Terminate sleeves flush with walls, partitions and ceiling.
  - 2. In areas where pipes are concealed, as in chases, terminate sleeves flush with floor or as shown on the plans.
  - 3. In all areas where pipes are exposed, extend sleeves 1/4 inch above finished floor, except in rooms having floor drains, where sleeves shall be extended 3/4 inches above floor.
- E. Sleeves shall be constructed of schedule 40 black steel pipe unless otherwise indicated on the drawings. Sleeves through concrete beams shall be constructed as indicated on the drawings.
- F. Fasten sleeves securely in floor, walls, so that they will not become displaced when concrete is poured or when other construction is built around them. Take precautions to prevent concrete, plaster, or other materials being forced into the space between pipe and sleeve during construction.
- G. Where piping penetrates fire rated floors or walls, penetrations shall be sealed with a U.L. approved fire stopping system. System shall be as manufactured and detailed by 3M Company or approved equal.
- H. Escutcheon plates shall be provided for all exposed pipes and all exposed conduit passing through walls, floors and ceilings. Plates shall be nickel plated, of the split ring type, of size to match the pipe or conduit. Where plates are provided for pipes passing through sleeves which extend above the floor surface, provide deep recessed plates to conceal the pipe sleeves.

### 3.12 UTILITIES

- A. This Contractor shall bear the cost of utilities required to perform the work under this Contract. Where services such as electricity, hoist, etc. are provided by the General Contractor, he shall be responsible directly to the General Contractor for his portion of the utilities as may be agreed upon.

### 3.13 SCAFFOLDING, RIGGING, HOISTING

- A. This Contractor shall furnish all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises of any equipment and apparatus furnished. Remove same from premises when no longer required.

### 3.14 ELECTRICAL CONNECTIONS

- A. The Electrical Contractor shall furnish and install all wiring except: (1) temperature control wiring; (2) equipment control wiring and (3) interlock wiring. The Electrical Contractor shall receive from the Mechanical Contractor and mount all individually mounted motor starters and provide all power wiring to the motor terminals unless otherwise indicated. The Electrical Contractor will provide branch circuit protection and disconnects unless otherwise indicated or specified. The Mechanical Contractor shall provide all other control and protective devices, and perform all control and interlock wiring required for the operation of the equipment. Power wiring, from nearest panel, for control components (dampers, panels, etc.) shall be provided by the Mechanical Contractor unless specifically called for by Division 26.
- B. After all circuits are energized and complete, the Electrical Contractor shall be responsible for all power wiring, and all control wiring shall be the responsibility of this Contractor. Motors and equipment shall be provided for current characteristics as shown on the drawings.
- C. It shall be the responsibility of this Contractor to check with the Electrical Contractor on service outlets provided for this Contractor, to determine that the switches and wiring provided are of adequate size to meet Code requirements for this Contractor's equipment. Any discrepancy shall be brought to the attention of the Architect before work is installed. Otherwise, any cost for changes shall be at the expense of this Contractor, and in any case electrical cost increase due to equipment substitution of different electrical characteristics shall be this Contractor's expense.

### 3.15 PIPE WORK

- A. All pipe work shown on the drawings and/or specifications or implied herein and required for a complete and operating system shall be done by experienced mechanics in a neat and workmanlike manner and subject to the approval of the Architect.
- B. Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings and accessories which may be required and it shall be the responsibility of the Contractor to furnish and install all materials and equipment required for the operating systems.
- C. The piping shall be installed as shown on the plans with strict conformity to the sizes listed and due provisions for expansion and contraction.
- D. Unless otherwise noted on the plans, all piping shall be installed inside the insulated envelope of the building.

### 3.16 LUBRICATION

- A. All bearing, except those specifically requiring oil lubrication, shall be pressure lubricated. All lubrication points shall be readily accessible, away from



locations dangerous to workmen. In areas where lubrication points are not readily accessible Contractor shall provide extended lubrication tubes to positions where lubrication can be easily accomplished. Pressure grease lubrication fittings shall be "Zerk-Hydraulic" type as made by the Stewart-Warner Corporation, or approved equal, for each type of grease required.

- B. The Contractor shall furnish lubrication charts or schedules for each piece of equipment or machinery. The charts or schedules shall designate each point of lubrication. Eight (8) copies of charts and schedules shall be submitted to the Architect prior to final inspection and approved copies of each schedule and chart shall be framed by the Contractor in metal frames with glass front and installed in the Equipment Room.

### 3.17 PROTECTION

- A. The Contractor shall protect all work and material from damage, and shall be liable for all damage during construction.
- B. The Contractor shall be responsible for work and equipment until all construction is finally inspected, tested and accepted. He shall protect work against theft, injury or damage; and shall carefully store material and equipment received on site which is not immediately installed. He shall close open ends of work including pipe, duct, or equipment with temporary covers or plugs during storage and construction to prevent entry of obstructing materials or dust and debris.
- C. Provide a protective covering of not less than 0.004" thick vinyl sheeting (or a similar approved material) to be used in covering all items of equipment, immediately after the equipment has been set in place, (or if in a place of storage within the building under construction) to prevent the accumulation of dirt, sand, cement, plaster, paint or other foreign materials from collecting on the equipment and/or fouling working parts.

### 3.18 CLEANING

- A. Clean from all exposed insulation and metal surfaces grease, debris or other foreign material.
- B. Chrome plated fittings, fixtures, piping and trim shall be polished upon completion.

### 3.19 LABELS, TAGS, COLOR CODING AND INSTRUCTIONS

- A. Post in the Equipment Room framed under glass the following:
  1. Lubrication instructions listing all equipment which requires lubrication, the type of lubricant to be used and the frequency of lubrication.
  2. Photostatic copy of wiring diagram of temperature controls.
  3. Step-by-step operating instruction for each piece of equipment with control sequence description.

- B. A tabulation shall be made of each panel number and circuit number serving each air conditioning unit, fan or other device with electrical service. This list shall be prepared and be ready to turn over to inspectors prior to calling for final inspection.
- C. Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.
- D. Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI A13.1 for piping and similar applications shall be used. Stencils shall not be less than 1-1/4" high letters for ductwork and not less than 3/4" high letters for access door signs and similar operational instructions. Stencil paint shall be standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.
- E. Engraved Plastic-Laminate Signs
  - 1. Provide engraving stock melamine plastic laminate, in the sizes and thickness indicated, engraved with engraver's standard letter style of the sizes and wording indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
  - 2. Thickness: 1/16" for units up to 20 square inches or 8" length; 1/8" for larger units.
  - 3. Fasteners: Self-tapping stainless steel screws.
- F. Installation Requirements
  - 1. Coordinate new labeling with existing labeling through Project Manager. Where identification is to be applied to surfaces that require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, identification shall be installed after completion of covering and painting. Identification is to be installed prior to installation of acoustical ceilings and similar removable concealment.
- G. Mechanical Equipment Identification: Provide for engraved plastic laminate sign on or near each major item of mechanical equipment and each operational device. Provide signs for the following general categories of equipment and operational devices:
  - 1. Main control and operating valves, including safety devices.
  - 2. Meters, gauges, thermometers and similar units.
  - 3. Pumps, compressors, and similar motor-driven units.
  - 4. Heat exchangers, coils, heat recovery units and similar equipment.
  - 5. Fans, blowers, primary balancing dampers and VAV boxes.
  - 6. HVAC central-station and zone-type units.
  - 7. Tanks and pressure vessels.
  - 8. VFD's and transmitters and Control Boxes.
  - 9. Other items as specified by Project Manager.

### 3.20 EQUIPMENT SERVICEABILITY

- A. All equipment shall be serviceable. All equipment shall be installed so that it can be removed. All equipment in or connected to piping systems shall have valves to isolate this equipment from the piping system. This includes, but not necessarily limited to control valves, water heaters, sensors, switches, pumps, traps and strainers. Unions (screwed or flanged) shall be provided so that all equipment is removable.
- B. Equipment installed in walls, ceilings or floors shall be accessible for service or removal without cutting walls, etc.
- C. Equipment requiring periodic service shall be installed to allow clearance for service and have removable panels, access doors, etc. through which the service is to be performed.
- D. Elevated equipment shall have service platforms.

### 3.21 ACCEPTANCE OF EQUIPMENT

- A. In the event that the Architect considers it impractical, because of unsuitable test conditions, or some other factors, to execute simultaneous final acceptance of all equipment portions of the installation may be certified by the Architect for final acceptance when that portion of the system is complete and ready for operation.
- B. Contractor shall make all necessary tests, trial operation balancing and balance tests, etc., as may be required as directed by the engineer to prove that all work under these plans and specification is in complete serviceable condition and will function as intended.
- C. Upon completion of all work the system shall be tested to determine if any excess noise or vibration is apparent during operation of the system. If any such objections are detected in the system or noisy equipment found, the Contractor shall be responsible for correcting same. Ducts, plenums and casings shall be cleaned of all debris and blown free of all particles of rubbish and dust before installing outlet faces. Equipment shall be wiped clean with all traces of oil, dust, dirt and paint spots removed. Temporary filters shall be provided for all fans that are operated during construction and after all construction dirt has been removed from the building, new filters shall be installed. Bearings shall be lubricated as recommended by the equipment manufacturer. All control valves and equipments shall be adjusted to setting indicated. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

### 3.22 GUARANTEE

- A. The Contractor shall guarantee the complete mechanical system against defect due to faulty materials, faulty workmanship or failure due to negligence of the Contractor. This guarantee will exclude normal wear and tear, maintenance lubrication, replacement of expendable components, or abuse. The guarantee period shall begin on the date of the final ac-

ceptance and shall continue for a period of 12 months during which time the Contractor shall make good such defective workmanship and materials and any damage resulting there from, within a reasonable time of notice given by the Owner.

- B. The period of Guarantee for equipment driven by electrical motors, etc., shall be 12 months from the date of acceptance. Refrigeration compressors shall have a five (5) year warranty.

### 3.23 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. Submit 3 sets of complete operating and maintenance instructions.
- B. Bind each set in plain black vinyl-covered, hard back, 3-ring binder. Individual paper shall be Boorum and Pease Reinforced Ring Book Sheet, No. S-212-101 or equivalent.
- C. Organize material in the following format:
  - 1. Section I
    - a. Name of Project
    - b. Address
    - c. Owner's Name
    - d. Mechanical Contractor's Name and Address
    - e. Control Subcontractor's Name and Address
    - f. Warranty Dates
  - 2. Section II
    - a. Major Equipment List (name, manufacturer, serial no., H.P. and voltage) (include all equipment with motors)
    - b. Control Sequence Description
    - c. Routine Maintenance Instructions in Step-by-Step form
    - d. Lubrication Charts and Schedules
    - e. Valve Schedules
    - f. Test and Balance Reports
    - g. Sound Power Level Readings (Where Required)
  - 3. Section III
    - a. Operating and Maintenance Instructions by Manufacturer
    - b. Shop Drawings (Major Requirement)
    - c. Wiring Diagrams
    - d. Control Drawings

### 3.24 PAINTING

- A. Painting shall be performed as detailed in Division 09.
- B. All surfaces to receive paint shall be dry and clean.
- C. Before priming, all surfaces shall be thoroughly cleaned of all dirt, oil, grease, rust, scale and other foreign matter. Cleaning shall be done with sandpaper, steel scraper, or wire brush where appropriate and necessary. Metallic surfaces which have been soldered shall be cleaned with benzol and all other metal surfaces washed with benzine.

- D. Mixing shall be in galvanized iron pans. Paint shall be mixed in full compliance with manufacturer's directions. Thinning shall be done only in full compliance with manufacturer's directions.
- E. Workmanship shall be highest quality, free from brush marks, laps, streaks, sags, unfinished patches, or other blemishes. Edges where paint joins other material or colors shall be sharp and clean without overlapping. Paint shall be brushed or sprayed on in strict compliance with manufacturer's directions and shall work evenly and be allowed to dry at least 48 hours before subsequent coating. Paint shall not be applied in damp or rainy weather or until surface has thoroughly dried. Contractor shall furnish and lay drop-cloths in all areas where painting is done as necessary to protect work of other trades. Varnish and enamel shall not be applied when temperature in the area is less than 60 degrees Fahrenheit nor paint when under 50 degrees Fahrenheit. Prior to final acceptance, Contractor shall touch up or restore any damaged finish. All insulation materials shall be provided with a paint suitable jacket.
- F. The following materials and equipment require painting as noted:
  - 1. All concealed piping, sheet metal, hangers and accessories except galvanized sheet metal or piping:
    - a. One coat rust-inhibitive primer except where exterior insulation is provided.
  - 2. All exposed, exterior and interior, piping, sheet metal, hangers and accessories, air handling units, pumps, etc. except galvanized sheet metal or piping:
    - a. One coat rust-inhibitive primer except where exterior insulation is provided.
  - 3. All concealed galvanized sheet metal, piping and accessories.
    - a. One coat galvanized metal primer on threaded portions of piping and any damaged galvanized surfaces.
  - 4. All exposed, exterior and interior galvanized sheet metal, piping and accessories.
    - a. One coat galvanized metal primer except where exterior insulation is provided.
  - 5. All exposed, exterior and interior, insulation equipment.
    - a. Two coats exterior glass enamel over paint suitable insulation jacket.
- G. All gas piping in shall be painted Light Yellow and identified by stenciling with letters minimum 1/2" high in a contrasting color. Stenciling shall occur at each change of direction and every 20 feet. Arrows should be placed adjacent to letters signifying direction of flow.

**END OF SECTION**

## SECTION 23 05 48

### VIBRATION AND SEISMIC CONTROL

#### PART 1 GENERAL

##### 1.01 GENERAL

- A. All vibration isolation and seismic control materials specified herein shall be provided by a single manufacturer to assure single responsibility for their proper performance. Installation of all vibration and seismic control materials specified herein shall be accomplished following the manufacturer's written instructions.
- B. The Contractor shall furnish a complete set of shop drawings and other necessary information, of all mechanical equipment to receive vibration isolation and seismic devices, to the vibration isolation and seismic control materials manufacturer. The information to be furnished shall include operating weight of the equipment to be isolated, distribution of weight to support points and dynamic characteristics along with any internal isolation systems to be analyzed. The Contractor shall also furnish a complete layout of piping and ductwork to be isolated, including vertical risers, showing size or weight and support points of the piping and ductwork system, to the vibration isolation and seismic control materials manufacturer, for selection and layout of mountings.
- C. The vibration and seismic control materials manufacturer shall use the above listed information to design a complete system of vibration and seismic mounts in accordance with the contract documents along with the 2000 International Building Code Section 1607, SMACNA "Seismic Restraint Manual", and ASHRAE 1995, Chapters 43 and 50. The vibration and seismic control materials Contractor shall analyze all "multiple degree of freedom" systems, and provide properly designed isolation systems avoiding all resonance frequencies. To accomplish this, the vibration and seismic control materials supplier shall employ an Engineer registered in the State of South Carolina to design all isolation and restraint systems and prepare a complete set of calculations and shop drawing submittals with his professional Engineer's seal certifying that the design meets all requirements of these contract documents. A seismic design "errors and omissions" insurance certificate must accompany submittals from the vibration and seismic Engineer. Manufacturer's product liability insurance certificates are not acceptable.
- D. The vibration and seismic control Engineer or his designated representative shall inspect the project upon completion of the applicable work and provide written certification that the installation is in compliance with the approved shop drawing submittals. This certification shall also bear the professional Engineer's seal and shall become part of the

contract closeout documents. All seals shall be signed and dated appropriately.

- E. Vibration and seismic control systems shall be provided by Vibration Mounting and Controls, Mason Industries, Consolidated Kinetics, or prior approved equal.

## **PART 2 PRODUCTS AND EXECUTION**

### **2.01 VIBRATION ISOLATION**

- A. All mechanical equipment shall receive external vibration isolation. Internal component isolation of equipment shall not be considered equivalent, but shall be considered when analyzing systems with multiple degrees of freedom.
- B. Vibration isolators shall be selected based upon known operating weight distributions and dynamic characteristics of the isolated equipment, with the quantity and location as required by the component drawing. Isolator type shall be tabulated for each isolated piece of equipment. Complete calculations of vibration analysis shall be included with submittals, including but not limited to fundamental and harmonic frequencies.
- C. Isolators shall have either known non-deflected heights of spring element or calibration markings so that, after adjustment, when carrying their load, the deflection under load can be verified to determine if the load is within the proper range of tile isolator and if the correct degree of vibration isolation is being provided.
- D. Isolators shall function in the linear portion of the load versus deflection curve. Theoretical vertical natural frequency shall not differ from the design objectives by more than  $\pm 10\%$ .
- E. Spring mounts shall have seismic housings as required by Paragraph 2.02.
- F. Isolation of equipment shall be as follows:
  - 1. Suspended equipment shall be isolated from the building structure by means of noise and vibration isolators. Units shall be supported with spring and neoprene type isolators, springs to be as described above. Isolators shall be VMC Series RSH.
  - 2. Roof mounted equipment shall be isolated from the building structure by means of a structural aluminum or hot dipped galvanized structural steel isolation curb. The structural spring isolation curbs shall bear directly on the roof support structure and be flashed and waterproofed into the roofs membrane waterproofing system. Roof curbs shall be designed to match pitch of roof. Equipment manufacturers or field fabricated curbs shall not be used. The curb shall consist of a rigid lower section containing properly spaced pockets with fully adjustable spring isolators. All springs shall be color coded for proper identification

and spring pocket shall allow for easy removal or replacement of any spring without disturbance of the supported equipment. Pockets shall have removable waterproof covers to allow for spring adjustment. Spring pockets shall contain combination vertical and horizontal restraint in conjunction with a 1/4 inch thick neoprene rubber bushing which will resist wind and seismic forces. All springs shall be installed in series with a 1/4 inch thick neoprene acoustical cup or pad. Curbs supplied shall be factory acoustically lined with 1 inch 3 PCF duct liner. An air tight neoprene seal shall be incorporated into the curb design to prevent air leakage or infiltration. Air seal must not be exposed so that it could be damaged or that in the event of the air seal failure, water could leak into the curb's interior. Wood nailer and flashing shall be provided and curbs shall be manufactured to NRCA standards. Curbs shall include a means of incorporating a sound banier package, consisting of two layers of waterproof gypsum board furnished and installed by the Mechanical Contractor. Individual pier supported curbs are not acceptable. Roof equipment supports to be VMC type P or R.

3. Mechanical equipment as noted shall be mounted on a rigid structural steel base. The equipment including the base shall be mounted on or suspended from vibration isolators as applicable. Base shall be VMC Type WFB.
4. Floor mounted equipment as noted shall be provided with a noise and vibration isolated structural steel concrete slab inertia base mounted on isolators. Spring mounts shall be recessed at comers. Inertia base shall be VMC Type MPF or WPF as applicable.

## 2.02 SEISMIC CONTROL

- A. All mechanical equipment, piping, ductwork, etc. shall be provided with seismic restraints in accordance with the 2000 International Building Code, 2000 International Mechanical Code, and SMACNA Seismic Restraint Manual, Latest Edition requirements, as a minimum.
  1. All equipment isolated or not, shall be bolted to the structure to allow for seismic acceleration with no failure or displacement. All connections shall be positive bolted type; no friction clamps of any kind are allowed.
  2. Provide cable and connection sets for suspended equipment at each of four comers secured to the building structure.
  3. Provide seismic roof curb systems fastened to roof structure for roof top equipment.
  4. Floor mounted equipment shall be provided with seismically housed springs or springs with seismic snubbers as determined by the equipment to be isolated.

**END OF SECTION**



## **SECTION 23 05 93**

### **TESTING, ADJUSTING, AND BALANCING**

#### **PART 1 GENERAL**

##### **1.01 SCOPE**

- A. The provisions of Section 23 05 00 apply to all the work in this Section.
- B. Work shall be performed by an independent balancing company certified by AABC or NEBB. Technicians shall be competent in the trade of testing and balancing environmental systems and shall be done in an organized manner utilizing appropriate test and balance forms.
- C. The test and balance contractor shall be a sub-contractor to the HVAC contractor.
- D. The test and balance report shall be submitted prior to the final inspection.
- E. Balancing of chilled water and hot water pumps installed in Phase 1 area that provide water to phase 2 are included in this scope of work.

##### **1.02 SUBMITTALS**

- A. Submit the following in accordance with Section 23 05 00.
  - 1. Manufacturer's cut sheets for all equipment to be used.
  - 2. Sample balancing charts and forms.
  - 3. Completed final balancing data.

#### **PART 2 PRODUCTS**

##### **2.01 INSTRUMENTATION**

- A. Instruments for use in the test and balancing procedures shall be of first quality and be accurately calibrated at the time of use. The following list is provided to indicate the instruments expected, however, other instruments as necessary to properly perform the work will be provided and subject to approval of the Architect.
  - 1. Inclined manometer calibrated in no less than .006-inch divisions.
  - 2. Combination inclined and vertical manometer (0 to 10 inch is generally the most useful).
  - 3. Pitot Tubes. (Usually 18 and 48 inch tube covers most balance requirements).
  - 4. Tachometer. This instrument should be of the high quality self-timing type.

5. Clamp-on ampere meter with voltage scales.
6. Deflecting vane anemometer.
7. Rotating vane anemometer.
8. Thermal type (hot wire) anemometer.
9. Hook gage.
10. Dial and glass stem thermometers.
11. Sling psychrometer.

- B. The accuracy of calibration of the field instruments used is of the utmost importance. All field instruments used in the balance should have been calibrated at least within the previous three months. Naturally, any suspect instruments should be checked more frequently.

### **PART 3 EXECUTION**

#### **3.01 SYSTEM START-UP**

- A. Starting date for mechanical system shall be scheduled well in advance of expected completion date and shall be established a minimum of two weeks prior to acceptance date. The system shall be in full operation with all equipment functional prior to acceptance date.
- B. Performance readings shall be taken and recorded on all air and water distribution devices and the system shall be balanced out prior to acceptance. Balancing of the system shall be accomplished with duct dampers and only minor adjustments made with grille dampers. Record and submit results in table form along side of scheduled quantities.
- C. All controls shall be calibrated by qualified personnel prior to acceptance date. Thermostats shall be in close calibration with one another and shall operate their respective units without interference from adjacent units.
- D. All units shall be checked out thoroughly and the following information recorded on each machine which shall include, but not be limited to information listed below. Check sheets shall be included in Operating and Maintenance instructional Manual.
- E. Contractor shall have in his possession a copy of a letter from the responsible Control Representative stating that the controls have been installed according to the plans; that the control sequence has been checked and that all controls have been calibrated.
- F. Replace fan sheaves as necessary to produce design air volume.

#### **3.02 SPECIAL REQUIREMENTS**

- A. Provide TAB result to ATC contractor for use in control logic.

**END OF SECTION**

## **SECTION 23 07 00**

### **INSULATION**

#### **PART 1 GENERAL**

##### **1.01 DESCRIPTION**

- A. This section of specifications and related drawings describe requirements pertaining to insulation.
- B. Provide all insulation in conjunction with equipment and ductwork furnished under this division.

##### **1.02 QUALITY ASSURANCE**

- A. Products of the manufacturers listed under MATERIALS will be acceptable for use for the specific functions noted. Adhesives, sealers, vapor barriers, and coatings shall be compatible with the materials to which they are applied, and shall not corrode, soften or otherwise attack such material in either the wet or dry state.
- B. Materials shall be applied subject to their temperature limits. Any methods of application of insulating materials or finishes not specified in detail herein shall be in accordance with the particular manufacturer's published recommendations.
- C. Insulation shall be applied by experienced workers regularly employed for this type of work.

##### **1.03 SUBMITTALS**

- A. Submit the following.
  - 1. Catalog cuts.
  - 2. Materials ratings.
  - 3. Insulation instructions.

##### **1.04 RATING**

- A. Insulation and accessories such as adhesives, mastics, cements, tape and jackets, unless noted otherwise, shall have a flame spread rating of not more than 25 and a smoke developed rating of not more than 50. Materials that are factory applied shall be tested individually. No fugitive or corrosive treatments shall be employed to impart flame resistance.
- B. Flame spread and smoke developed ratings shall be determined by Method of Test of Surface Burning Characteristics of Building Materials, NFPA No. 255, ASTM E-84, UL 723.

- C. Products of their shipping cartons shall bear a label indicating that flame and smoke ratings do not exceed above requirements.
- D. Treatment of jackets or facings to impart flame and smoke safety shall be permanent. The use of water-soluble treatment is prohibited.
- E. Certify in writing, prior to installation, that products to be used will meet RATING criteria.

## **PART 2 PRODUCTS**

### **2.01 DUCT INSULATION**

- A. Materials. Insulation shall be Owens-Corning as specified hereinafter or products of Certain-Teed/St. Gobain, Armstrong or Manville. Adhesives shall be as manufactured by 3-M Foster or insulation manufacturer. Insulation shall have composite (insulation, jacket and adhesive) fire and smoke hazard rating as tested by ASTM E-84, not exceeding Flame Spread -25 and Smoke Developed -50.

## **PART 3 EXECUTION**

### **3.01 DUCT INSULATION**

- A. All vapor barriers and joints shall be sealed to prevent condensation. Clean and dry all ductwork before installing insulation. All weld joints shall be wire brushed and give one (1) coat of red lead before insulating. Staples will not be permitted in insulation.
- B. Lined Duct:
  - 1. Ductwork as indicated below shall be lined with Owens-Corning Aeroflex Vapor-Seal Duct Insulation, 1-1/2 pcf, 1" thick, or equal by Certain-Teed/St. Gobain or Johns Mansville.
    - a. Return - From unit connection to a point 10 feet from unit.
    - b. Medium Pressure Supply - From fan discharge to point 10 feet from unit.
    - c. Where specifically noted on plans.
    - d. Ductwork shall be lined in only those sections of ductwork listed in parts (a) through (c) above.
  - 2. Duct liner and adhesive shall meet requirements of NFPA 90A and shall have UL fire hazard classification not to exceed the following: flame spread -25; fuel contributed -50; smoke generated -50. There will be no erosion of duct liner material at velocities up to 4000 fpm. Duct liner shall be applied to the sheet metal with 100% coverage of adhesive. The duct liner shall be cut to assure corner joints with no gaps. On horizontal runs, tops of ducts over 12" in width and sides of 16" in height shall be additionally secured with mechanical fasteners. On spans over 30" fasteners are to be placed at midpoints. On vertical runs, fasteners shall be placed on a maximum of 15" centers on all width dimensions over 12". Fas-

teners shall be flush with the liner surface. All exposed edges and leading edges of all transverse and longitudinal joints of the liner shall be coated with a fire resistant adhesive. The exposed mechanical fasteners shall be coated with a fire resistant adhesive. The upstream end must be continuously adhered to for a 6" width.

C. **Wrapped Duct:**

1. All ducts shall be insulated by wrapping with fiberglass with vapor barrier jacket with joints overlapped a minimum of two inches. Insulation shall be adhered to duct with non-combustible insulation bonding adhesive applied in 4" strips, 8" on center. All joints shall be secured with flare door staples on 3" centers through all laps over duct tape.
  - a. Supply – 2" thick, 1.5# density

D. **Ducts Installed In Unconditioned Spaces:**

1. All supply, return and outside air ducts that are to be installed outside the insulated perimeter of the building shall be wrapped with a layer of duct wrap as specified above if lined. If unlined, ducts shall be insulated by wrapping with 2" thick, minimum installed "R" value = 8.0, fiberglass with vapor barrier jacket with joints overlapped a minimum of two inches. Insulation shall be adhered to duct with non-combustible insulation bonding adhesive applied in 4" strips, 8" on center. All joints shall be secured with flare door staples on 3" centers through all laps over duct tape.
2. Ductwork exposed to weather shall be insulated in addition to insulation specified above, as follows: Seal all joints with hard cast sealer, apply 2" thick polystyrene insulation (1" if duct is lined), cover with two (2) individual layers of glassfab and white mastic. Paint to match background color.

**END OF SECTION**

## **SECTION 23 09 00**

### **BUILDING AUTOMATION AND CONTROL SYSTEM**

#### **PART 1 GENERAL**

##### **1.01 SCOPE**

- A. The provisions of Section 23 05 00 apply to the work of this section.
- B. This specification section is included for information purposes only. The owner shall perform the Building Automation System (BAS) and temperature controls portion of this project under a separate contract. For coordination contact Control Management, Inc. (803) 765-9070.
- C. This specification defines the minimum equipment and performance requirements for a direct digital control building control system.
- D. Acceptable manufacturers are as follows:
  - 1. Siemens – Landis Division
- E. The scope of work is extension of an existing building automation system as required for connection to new equipment.

##### **1.02 SUBMITTALS/DRAWINGS**

- A. The Control System Contractor shall submit prior to installation a set of installation drawings and control strategies for review by the consultant and/or owner's representative. These drawings shall include the physical location of building control system equipment and system architecture. The complete sequence of operation of the control system shall be provided.
- B. Upon System completion of the installation and final system adjustment, the Control Contractor shall provide a full set of as-built drawings of the installation and the control strategies. In addition, the Control Contractor shall provide a thumb drive containing the as-built control drawings in AutoCad format
- C. Framed control diagrams shall be mounted on the wall inside the appropriate mechanical room.

##### **1.03 GUARANTEE**

- A. The entire control system shall be installed by the control system contractor and guaranteed free of defects and shall include required servicing and

maintenance for one year after final acceptance.

#### 1.04 CONTROL AND INTERLOCK WIRING

- A. All electrical work required under this section of specifications shall comply with the latest National Electrical Code. Control system power supply shall be served by a separate breaker and fused in control center for secondary protection.
- B. The mechanical contractor shall furnish and turn over to the electrical contractor, motor starters for mounting and power connections through starter to motor. Disconnect switches, when required, shall be furnished by electrical contractor.
- C. All control wiring shall be run in rigid conduit below grade or, on outdoor installation. Galvanized EMT may be run in dry wall construction, above ceilings, or in equipment rooms where permitted by electrical specifications.
- D. Control wiring shall be color-coded #16 TFF or TFFN wire with 600 volt insulation. Run all wiring between terminal points without changing color. Color code of control wiring shall be as indicated on control wiring diagram. Multi-conductor thermostat cable will not be acceptable.

#### 1.05 TRAINING/OWNER'S INSTRUCTION

- A. The Control System Contractor shall provide two copies of an operator's manual describing all operating and routine maintenance service procedures to be used with the system. The Control System Contractor shall instruct the Owner's designated representatives in these procedures during the start-up and test period. The duration of the instruction period shall be no less than 8 hours. These instructions are to be conducted during normal working hours. The instructions shall consist of both hands-on and classroom training at the jobsite.

#### 1.06 SYSTEM ARCHITECTURE

- A. The building control system shall consist of a modular building controller (MBC), and its network of independent Mechanical Equipment Controllers (MEC), and terminal equipment controllers (TEC). The new MBC and network of Mechanical Equipment Controllers, and Terminal Equipment Controllers shall be connected to the District's existing operator workstation computer through the school district wide area network, (Ethernet).

#### 1.07 OPERATOR INTERFACE

- A. The building control system shall permit full operator communication including: obtaining information about the performance of his system; allowing the operator to change the system operation; and diagnosing

system malfunctions. Operator communication shall be through the use of any one of the owner operator terminals.

- B. The network shall be addressable as a whole and shall not require referencing a particular control unit for the commanding or monitoring of points on the network.
- C. Dynamic color graphic software shall be provided for the central operator's computer. Graphics shall be drawn and installed by this contractor.
- D. All color graphic software shall display and update current control point data automatically.
- E. The following graphics shall be generated and installed under this contract:
  - 1. Each Packaged Roof Top Unit
  - 2. Each Outside Air Unit
  - 3. Each VRF System
  - 3. Each Fan controlled by BAS.
  - 4. Building layout with unit locations and temperatures displayed
- F. The software shall provide, as a minimum, the following functionality:
  - 1. Graphical viewing and control of environment
  - 2. Scheduling and override of building operations
  - 3. Collection and analysis of historical data
  - 4. Definition and construction of dynamic color graphics
  - 5. Editing, programming, storage and downloading of controller databases

#### 1.08 TELECOMMUNICATIONS CAPABILITIES

- A. A telecommunications interface shall provide direct connection of the Modular Building Controller (MBC) and its building network to public and private phone lines. This device shall be microprocessor based and will be capable of both automatic answer and automatic dial methods of call handling. Additionally, manual call initiation shall be done via a man-machine interface command.
- B. The telecommunications interface shall also have automatic answer capabilities to allow it to be accessed from a remote control computer or terminal with modem. The interface unit shall be able to allow the person calling access to any information on the network, provided that the standard log-on security screening is met.

## **PART 2 PRODUCTS**

### 2.01 MODULAR BUILDING CONTROLLER (MBC)

- A. The stand-alone Modular Building Controller(s) shall be microprocessor-



based with a minimum word size of 16 bits. They shall also be multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules. Controller size shall be sufficient to fully meet the requirements of this specification and the attached point list.

- B. Each MBC Controller shall have sufficient memory, a minimum of 1 megabyte, to support its own operating system and databases, including:
  - 1. Control processes
  - 2. Energy management applications
  - 3. Alarm management applications including custom alarm messages for each level alarm or each point in the system.
  - 4. Historical/trend data for points specified
  - 5. Maintenance support applications
  - 6. Custom processes
  - 7. Operator I/O
  - 8. Dial-up communications
  - 9. Manual override monitoring
  
- C. Each Modular Building Controller shall support the following point types:
  - 1. Monitoring of the following types of inputs, without the addition of equipment outside the MBC Controller cabinet:
    - a. Analog inputs
      - 1) 4-20 mA
      - 2) 0-10 Vdc
      - 3) Thermistors
      - 4) 1000 ohm RTDs
    - b. Digital inputs
      - 1) Dry contact closure
      - 2) Pulse Accumulator
      - 3) Voltage Sensing
  - 2. Direct control of electronic actuators and control devices. Each MBC Controller shall be capable of providing the following control outputs without the addition of equipment outside the MBC Controller cabinet:
    - a. Digital outputs (contact closure)
      - 1) Contact closure (motor starters, sizes 1-4)
    - b. Analog outputs
      - 1) 0-20 psi
      - 2) 4-20 mA
      - 3) 0-10 Vdc
  
- D. MBC Controllers shall provide at least two RS-232C serial data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals. MBC Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers or terminals.

- E. The operator shall have the ability to manually override automatic or centrally executed commands at the MBC Controller via local, point discrete, on-board hand/off/auto operator override switches for digital control type points and gradual switches for analog control type points. These override switches shall be operable whether the panel processor is operational or not.
  - 1. Switches shall be mounted either within the MBC Controllers key-accessed enclosure.
  - 2. MBC Controllers shall monitor the status of all overrides and inform the operator that automatic control has been inhibited. MBC Controllers shall also collect override activity information for reports.
- F. MBC Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Graduated intensity LEDs or analog indication of value shall also be provided for each analog output. Status indication shall be visible without opening the panel door.
- G. Each MBC Controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components. The DDC Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.
- H. Isolation shall be provided at all peer-to-peer network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standards 587-1980.
- I. In the event of the loss of normal power, there shall be an orderly shutdown of all MBC Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.
  - 1. Upon restoration of normal power, the MBC Controller shall automatically resume full operation without manual intervention.
  - 2. Should MBC Controller memory be lost for any reason, the user shall have the capability of reloading the MBC Controller via the local RS-232C port, via telephone line dial-in or from the existing network workstation PC.

## 2.02 MBC CONTROLLER RESIDENT SOFTWARE FEATURES

- A. All necessary software to form a complete operating system as described in this specification shall be provided.
- B. The software programs specified in this Section shall be provided as an integral part of MBC Controllers and shall not be dependent upon any

higher level computer for execution.

- C. Control Software Description:
1. The MBC Controllers shall have the ability to perform the following pre-tested control algorithms:
    - a. Two-position control
    - b. Proportional control
    - c. Proportional plus integral control
    - d. Proportional, integral, plus derivative control
  2. Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.
  3. The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.
  4. Upon the resumption of normal power, each MBC Controller shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling and turn equipment on or off as necessary to resume normal operations.
- D. MBC Controllers shall have the ability to perform any or all the following energy management routines:
1. Time-of-day scheduling
  2. Calendar-based scheduling
  3. Holiday scheduling
  4. Temporary schedule overrides
  5. Start-Stop Time Optimization
  6. Automatic Daylight Savings Time Switchover
  7. Night setback control
  8. Peak demand limiting
  9. Temperature-compensated duty cycling
  10. Heating/cooling interlock
- E. All programs shall be executed automatically without the need for operator intervention and shall be flexible enough to allow user customization. Programs shall be applied to building equipment as described in the Sequence of Operations.
- F. MBC Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
1. It shall be possible to use any of the following in a custom process:
    - a. Any system measured point data or status
    - b. Any calculated data
    - c. Any results from other processes
    - d. User-defined constants
    - e. Arithmetic functions (+, -, \*, /, square root, exp, etc.)

- f. Boolean logic operators (and/or, exclusive or, etc.)
- g. On-delay/off-delay/one-shot timers
- 2. Custom processes may be triggered based on any combination of the following:
  - a. Time interval
  - b. Time-of-day
  - c. Date
  - d. Other processes
  - e. Time programming
  - f. Events (e.g., point alarms)

### 2.03 APPLICATION SPECIFIC CONTROLLERS

- A. Provide application specific controllers (ASCs) as required for each mechanical system or piece of equipment. Each ASC shall be a microprocessor-based direct digital control unit and shall be capable of operating either as a standalone controller or on a multi-drop communications network originating at the MBC. Provide each ASC with sufficient memory to operate in a truly independent manner; that is, each ASC shall support its own inputs and outputs, operating system, database and programs necessary to perform control sequences and energy management routines.
- B. Provide the following types of ASCs as a minimum:
  - 1. Unitary controllers
  - 2. Terminal equipment controllers

### 2.04 TERMINAL EQUIPMENT CONTROLLERS

- A. Terminal equipment controllers shall be provided for each piece of equipment as specified. The BMCS shall support specific controllers for the following types of equipment as a minimum:
  - 1. Roof Top Units
- B. Controllers shall include all point inputs and outputs necessary to perform the specified control sequences.
- C. Each controller performing space temperature control shall be provided with a matching room temperature sensor. The sensor may be either RTD or thermistor type.
  - 1. Each room temperature sensor shall include a terminal jack integral to the sensor assembly. The terminal jack shall be used to connect a portable laptop or similar operator's terminal to control and monitor all hardware and software points associated with the controller.
  - 2. Each room sensor shall also include the following auxiliary devices:
    - a. Setpoint Adjustment Dial
    - b. Temperature Indicator
    - c. Override Switch

3. The setpoint adjustment dial shall allow for modification of the temperature by the occupant. Setpoint adjustment may be locked out, overridden or limited as to time or temperature through software by an authorized operator at the central workstation, MBC or via the portable programming tool.
  4. The temperature indicator shall be a LCD thermometer and shall be visible without removing the sensor cover.
  5. The override switch shall initiate override of the night setback mode to normal (day) operation when activated by the occupant. The override function may be locked out, overridden or limited as to the time through software by an authorized operator at the central workstation, MBC or via the portable programming tool.
- D. Each controller shall have connection provisions for a portable laptop or similar operator's terminal. This connection shall be possible at both the controller and at the matching room temperature sensor as previously specified. The terminal may be used for readout of system variables, override control, adjustment of control parameters, air balancing, servicing and troubleshooting. The terminal shall provide the user with the following functionality as a minimum:
1. Display system status (heating, cooling, etc.)
  2. Display all point values and setpoints
  3. Set and change all setpoints
  4. Set and change heating/cooling deadbands
  5. Set and change PID loop gains
  6. Set and change system mode (occupied/unoccupied)
  7. Set and change system mode times
  8. Override all setpoints
  9. Override all digital and analog outputs
  10. Command all digital and analog outputs
  11. Select application mode
  12. Assign controller address
- E. All communication and displays via the portable terminal shall be in full English language with accompanying English and SI (International System of Units) engineering units for all displayed data. Selection between English and SI units shall be accomplished via a single keystroke on the portable terminal.
- F. In addition to local interface capabilities, all functionality as specified above may be performed both from the central operator's workstation and from any MBC on the communications network via the same portable terminal. From a terminal connected to any MBC it shall be possible to issue global commands to groups of controllers. Provide the following global commanding capabilities for all controllers as a minimum:
1. Heating/Cooling setpoint changes
  2. Stage Off/On heating
  3. Fan on/off control

## 2.05 DAMPER OPERATORS

- A. All damper operators shall be electric and shall be two-position or proportional as indicated. They shall be furnished in sufficient numbers and with sufficient power to insure satisfactory operation of the damper to provide tight close off. They shall be spring return type to return the damper to the normal positions indicated. Mark full open and full closed positions of all dampers. Marks shall be made with Bakelite nameplates, attached to ductwork.

## **PART 3 EXECUTION**

### 3.01 PROJECT MANAGEMENT

- A. Provide a designated project manager who will be responsible for the following:
  - 1. Construct and maintain project schedule.
  - 2. On-site coordination with all applicable trades and subcontractors.
  - 3. Authorized to accept and execute orders or instructions from owner/architect.
  - 4. Attend project meetings as necessary to avoid conflicts and delays.
  - 5. Make necessary field decisions relating to this scope of work.
  - 6. Coordination/Single point of contact.
- B. The contractor shall collaborate with the owner directly to determine the owner's preference for naming conventions, etc. before entering the data in to the system.

### 3.02 START-UP AND COMMISSIONING

- A. When installation of the system is complete, calibrate equipment and verify transmission media operation before the system is placed on-line. All testing, calibrating, adjusting and final field tests shall be completed by the manufacturer. Verify that all systems are operable from local controls in the specified failure mode upon panel failure or loss of power.
- B. Provide any recommendation for system modification in writing to owner. Do not make any system modification, including operating parameters and control settings, without prior approval of owner.

### 3.03 TRAINING

- A. The manufacturer shall provide factory trained instructor to give full instruction to designated personnel in the operation of the system installed. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. The manufacturer shall provide all students with a student binder containing product specific training modules for the system installed. All training shall be held during normal

working hours of 8:00 am to 4:30 PM weekdays.

- B. Provide 16 hours of training for Owner's designated operating personnel. Training shall include:
1. Explanation of drawings, operations and maintenance manuals.
  2. Walk-through of the job to locate control components.
  3. Operator workstation and peripherals.
  4. DDC controller and ASC operation/function.
  5. Operator control functions including graphic generation and field panel programming.
  6. Explanation of adjustment, calibration and replacement procedures.
- C. Since the Owner may require personnel to have more comprehensive understanding of the hardware and software, additional training must be available from the Manufacturer. If such training is required by the Owner, it will be contracted at a later date.

### 3.04 SEQUENCE OF OPERATION

- A. Make Up Air Units
1. The DDC air handling unit controller shall be provided by Control Management to the Make Up Air Unit manufacturer for factory mounting and wiring. The manufacturer shall provide Control Management a written sequence of operation and required points list prior to bid for coordination.
  2. When enabled for operation, The MEC will start the supply and exhaust fans. After flow has been proven by the fan current switches, the MEC will stage the cooling if the outdoor temperature is above 55 degrees, and any of the following conditions are present:
    - average room temperature is greater than 75 degrees
    - the room dewpoint is greater than 58 degrees
    - the return relative humidity is greater than 55%RH
  3. When cooling is required, the coil leaving air setpoint is calculated by subtracting the return air %RH from 98 (i.e.:  $CSP = 98 - XX\%RH$ ). The four stages of cooling are staged on based on a 0 – 100% cooling load loop as follows:
    - stage 1 on at 70% and off at 5%
    - stage 2 on at 80% and off at 15%
    - stage 3 on at 90 % and off at 25 %
    - stage 4 on at 100% and off at 35%
  4. In addition, there is an on delay for each stage of 2 minutes. When stage 1 is energized, all condenser fans are energized. When the ventilation air unit is enabled in the occupied mode, the MEC will modulate the outdoor/return/relief air dampers to maintain the CO2 levels of the return air to an adjustable setpoint. The MEC will also monitor a room CO2 sensor. When the ventilation air unit is in the unoccupied mode the dampers will spring return to the normal (closed) position. In the unoccupied mode, the MAU will be

disabled unless the room %RH rises above an adjustable setpoint.

### 3.05 MAINTENANCE AND OPERATING TRAINING

- A. Manufacturer's representative to provide training to maintenance staff on manufacturers' recommended cleaning procedures, in addition to maintenance instructions provided in close out documents.

**END OF SECTION**



## **SECTION 23 11 20**

### **GAS PIPING**

#### **PART 1 GENERAL**

##### **1.01 SCOPE**

- A. The provisions of Section 230500 apply to all the work in this Section.
- B. Contractor shall furnish and install all gas piping as shown on the plans complete in all respects. Gas piping shall be connected to existing propane tank farm and extended from the connection point to the equipment connections.
- C. Installation shall be in accordance with ALL state, local and national codes including NFPA Pamphlet No. 54 and NBFU Pamphlet No. 58.

#### **PART 2 PRODUCTS**

##### **2.01 GAS PIPING**

- A. All piping shall be steel ANSI/ASTM A53 "welded and seamless steel pipe".

##### **2.02 GAS PIPE FITTINGS**

- A. Fittings shall be steel or malleable iron. Pipe joints may be screwed or welded. Fittings shall be suitable for the appropriate working pressure.

#### **PART 3 EXECUTION**

##### **3.01 GAS PIPING**

- A. Gas piping shall be extended from the tank farm as shown.
- B. All gas piping shall be tested with air at 150 psig minimum. All joints shall be checked to determine if any leaks occur, using soap solution. Any joint or fitting found defective shall be removed and replaced. No caulking or other artificial means will be used to make repairs.
- C. Ground plug shutoff cocks shall be installed at each equipment service stub. Piping shall be installed with valves, drip pockets, stop cocks, and other accessories that may be required to give proper service.

**END OF SECTION**

## **SECTION 23 31 13**

### **METAL DUCTS**

#### **PART 1 GENERAL**

##### 1.01 SCOPE

- A. Furnish and install all sheet metal work shown or called for including ductwork and connections to fans and equipment.
- B. Ductwork shall be provided and installed as shown on the drawings. All details of ductwork are not indicated, and necessary bends, offsets and transformation must be furnished whether shown or not.

##### 1.02 SUBMITTALS

- A. Submit the following:
  - 1. Manufacturer's cuts.
  - 2. Certified capacity ratings.
  - 3. Installation instructions.

#### **PART 2 PRODUCTS**

##### 2.01 GENERAL

- A. All ductwork, plenums and casings shall be constructed of sheet metal, as herein specified. All sheet metal construction shall conform to the pressure classification shown on the contract drawings, or herein specified and shall be in accordance with the construction and installation details in Chapter 16 of the 1992 ASHRAE Systems and Equipment Handbook or the appropriate SMACNA Standards.
- B. Duct sizes on drawings represent gross sheet metal dimensions. Allowance has been made, where applicable, for duct liner.

##### 2.02 LOW PRESSURE DUCTWORK

- A. Low pressure ductwork shall be constructed of zinc coated sheet steel and shall conform to the 1st Edition of SMACNA HVAC Duct Construction Standards -Metal and Flexible, 1985, as follows:
  - 1. Rectangular Duct
    - a. 1" w.g. pressure class - Table 1-4.
  - 2. Round Duct
    - a. 2" w.g. pressure class - Table 3-2.

## **PART 3 EXECUTION**

### **3.01 DUCTWORK**

- A. All ductwork shall be provided in a neat workmanlike manner. The ducts shall be properly braced and reinforced. All slip joints shall be made in the direction of flow. All ducts shall be true to the dimension indicated and shall be straight and smooth on the inside with neatly finished airtight joints. The ducts shall be securely anchored into the building construction in an approved manner and shall be completely free from vibration under all conditions of operation. All supply, return fresh-air and exhaust systems shall be completely balanced.
- B. No duct transformation shall be of a ratio less than four to one and where possible, shall be of a ratio of six to one. No less than three vertical splitters shall be provided where these ratios cannot be met. No elbow shall have a throat center line radius of less than one and one-half times the duct width at the turn. All turns of less than this amount in rectangular duct shall be provided with duct turning vanes of standard design. Splitters or multi-blade volume dampers, where indicated, shall be provided in all branch.
- C. All ductwork must be sealed in accordance with Seal Class C as defined in SMACNA HVAC Duct Construction Standards - Metal and Flexible, 1985.
- D. All joints and seams in ductwork exposed to weather shall be sealed watertight with a suitable non-aging sealer.

### **3.02 DUCT HANGERS AND SUPPORTS**

- A. Duct hangers and supports shall conform to those shown in Tables 4-1 and 4-2 of SMACNA HVAC Ductwork 1985, 1st Edition.

### **3.03 CLEANING DUCT SYSTEMS**

- A. Before fan systems are put in operation, vacuum clean inside of air units, plenums and apparatus housing. Filters are to be installed before moving air through duct systems.

**END OF SECTION**

## **SECTION 23 74 13**

### **MAKEUP AIR UNITS**

#### **PART 1 GENERAL**

##### **1.01 SUBMITTALS**

- A. Submit unit performance data including: capacity, nominal and operating performance.
- B. Submit Mechanical Specifications for unit and accessories describing construction, components and options.
- C. Submit drawings indicating overall dimensions as well as installation, operation and services clearances. Indicate lift points and recommendations and center of gravity. Indicate unit shipping, installation and operating weights including dimensions.
- D. Submit data on electrical requirements and connection points. Include recommended wire and fuse sizes or MCA, sequence of operation, safety and start-up instructions.
- E. Drawings submitted for approval shall be accompanied by a copy of the purchase agreement between the Contractor and an authorized service representative of the manufacturer for check, test and start up and first year service.

##### **1.02 DELIVERY, STORAGE and HANDLING**

- A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- B. Protect units from physical damage. Leave factory shipping covers in place until installation.
- C. Units to be secured via base rail tie-down locations.

##### **1.03 WARRANTY**

- A. Provide one year parts and labor warranty for entire unit. In addition, provide 5 year compressor parts warranty.

#### **PART 2 PRODUCTS**

##### **2.01 SUMMARY**

- A. The contractor shall furnish and install packaged outdoor air unit(s) as

shown and scheduled on the contract documents. The unit(s) shall be installed in accordance with this specification and perform at the specified conditions as scheduled.

B. Acceptable Manufacturers

1. Manufacturers: This specification is based on an Energy Recovery Unit as manufactured by Trane. Cost associated with dimensional, performance, warranty, or other deviations from the specified equipment, including engineering costs to evaluate such deviations, shall be paid for by the contractor. Subject to compliance with requirements, acceptable manufacturers are: Trane, Carrier, JCI or Daikin

## 2.02 GENERAL UNIT DESCRIPTION

- A. Unit(s) furnished and installed shall be packaged outdoor air unit(s) as scheduled on contract documents and described in these specifications. Unit(s) shall be designed for dehumidification, cooling and/or heating of 100% Outdoor Air. For dehumidification and cooling modes the evaporator temperature shall be monitored, reported at unit controller. Compressor controls shall modulate capacity to maintain evaporator leaving set point. Hot Gas Bypass shall not be used to control compressor capacity. Compressor Hot Gas Reheat (HGRH) shall be factory installed. To prevent rehydration of evaporator condensate the reheat coil face shall be located a minimum of 6" downstream from the leaving face of the evaporator coil. Heating system shall include modulating controls. Compressor on-off only or primary heating on-off only controls shall not be acceptable control strategies.
- B. Unit(s) shall have labels, decals, and/or tags to aid in the service of the unit and indicate caution areas.
- C. Unit discharge airflow configuration shall be as shown on the plans.

## 2.03 CABINET

- A. Cabinet panels: 2" double-wall foamed panel construction throughout the indoor section of unit to provide nonporous, cleanable interior stainless steel surfaces. All interior seams exposed to airflow shall be sealed.
- B. Insulation: 2" polyisocyanurate foam metal encapsulated with no exposed edges. Initial R value of 6.6 per inch of thickness.
- C. Cabinet base shall be double wall construction designed to prevent trapping or ponding of water within the unit base. Cabinet base pan shall be insulated with 2" thick polyisocyanurate foam. Foam insulation shall be fully enclosed with galvanized steel insulation cover. Insulation shall not be applied to underside of unit base.
- D. Cabinet Base Rails: Side and end base rails shall include openings for forklift and tie-down access. To protect unit base from fork damage side

rails shall include removable heavy gauge fork pockets.

- E. Shipping anchors attach to and/or through unit base rails. Straps over unit shall not be used to secure unit for shipping.
- F. Exterior Corrosion Protection: Exterior cabinet panels shall be a base coat of G-90 galvanized steel with exterior surfaces cleaned, phosphatized and finished with a weather-resistant baked enamel finish. Unit's surface shall be in compliance with ASTM B45 salt spray testing at a minimum of 672 hour duration.
- G. Interior Corrosion Protection: Interior surfaces shall be a stainless steel. Cabinet shall include interior liner constructed of Type 304 stainless steel with sealed seams. All Unit Coils shall be coated. See coil coating requirements below.
- H. Cabinet construction shall provide hinged panels providing easy access for all parts requiring routine service.
- I. Cabinet top cover shall be one piece construction or where seams exist, it shall be double-hemmed and gasket-sealed.
- J. Hinged Access Panels: Water- and air-tight hinged access panels shall provide access to all areas requiring routine service including air filters, heating section, electrical and control cabinet sections, ERV and power exhaust fan section, supply air fan section, evaporator and reheat coil sections. Insulated doors shall be constructed to allow the hinges to be reversed in the field.
  - 1. Hold-open devices shall be factory installed on all hinged access doors. Chains shall not be used as hold-open devices.
  - 2. Latches with locking hasp or tool operated closure devices shall be factory installed on all hinged access panels.
- K. Drain Pan material shall be Type 430 Stainless steel drain and constructed to sloped in two directions to ensure positive drainage with corners exposed to standing water and drain fittings welded liquid tight to prevent leaks. Pan shall have a minimum depth of 2". Base of drain pan shall be insulated with 1" thick foam insulation.
- L. Provide openings either on side of unit or thru the base for power, control and gas connections.
- M. Unit shall be equipped with a 6" filter rack upstream of the evaporator. Frame shall be field-adjustable to match any filter combination specified in the following section.

#### 2.04 SUPPLY/RETURN - FANS AND MOTORS

- A. Supply and Exhaust Fans shall be high efficiency backward curved impeller.

- B. All Fan motors shall be an (ECM) electronic commutated motor with integrated power electronics for variable motor speed.
- C. Outdoor fans shall be direct drive with premium efficiency motors, statically and dynamically balanced, draw through in the vertical discharge position.
- D. Provide shafts constructed of solid hot rolled steel, ground and polished, with key-way, and protectively coated with lubricating oil.

#### 2.05 AIR FILTERS

- A. Evaporator Inlet shall include a full compliment of pleated media air filters. Filters shall be deep MERV 13

#### 2.06 DAMPERS

- A. Unit shall include a motor operated outdoor air damper constructed of galvanized steel.
- B. Damper blades shall be air foil design with rubber edge seals designed not to exceed a 4 CFM/SQ FT leakage rate exceeding ASHRAE 90.1 damper leakage requirements.
- C. Damper actuator shall be factory mounted and wired sealed spring return and either two-position or fully modulating.
- D. Return Air damper shall be of same material, construction and leakage rate as outdoor air damper. Return air damper actuator shall be factory mounted and wired sealed spring fully modulating and operate based on outdoor air damper feedback signal to properly regulate RA airflow.

#### 2.07 DEHUMIDIFICATION/COOLING

- A. Compressors
  1. All unit compressors shall be direct-drive, digital scroll type compressors.
  2. Motor shall be suction gas-cooled and shall have a voltage utilization range of plus or minus 10 percent of unit nameplate voltage.
  3. Internal overloads shall be provided with the scroll compressors.
  4. Each compressor shall have a crankcase heater to minimize the amount of liquid refrigerant present in the oil sump during off cycles.
  5. Each compressor shall be mounted on rubber vibration isolators, to reduce the transmission of noise.
  6. Provide each unit with two hermetically sealed independent refrigerant circuits factory-supplied completely piped with liquid line filter-drier, liquid line charging port, suction and liquid line pressure ports, sight glass, and thermal expansion valve.
  7. Provide each circuit with automatic reset high and low pressure

and high temperature switches for safety control.

B. Coils

1. Evaporator, Condenser and Hot Gas Reheat coils shall be constructed with copper tubes mechanically bonded to configured aluminum plate fins.
2. Coils shall be factory leak tested in accordance ANSI/ASHRAE 15-1992 at a minimum pressure of 500 PSIG.
3. The condenser coil shall have a fin designed for ease of cleaning.
4. Evaporator coil shall include (six / four) rows of cooling interlaced for superior sensible and latent cooling with a maximum of 12 FPI for ease of cleaning.
5. Reheat coil shall be fully integrated into the supply airstream and be capable of delivering design supply air temperature.
6. To prevent re-hydration of condensate from evaporator coil, the evaporator coil face and the hot gas reheat coil face shall be separated by a minimum of six inches.
7. Coil Coating for condenser, evaporator, HGRH coils: Coil will have a flexible epoxy polymer e-coat uniformly applied to all coil surface areas with no material bridging between fins. The coating process will ensure complete coil encapsulation and a uniform dry film thickness from 0.6 – 1.2 mills on all surface areas including fin edges and meet 5b rating cross hatched adhesion per ASTM B3359- 93. Corrosion durability will be confirmed through testing with no less than 5,000 hours salt spray resistance per ASTM B117-90 using scribed aluminum test school coupons.
8. The unit(s) must comply per above - spray coatings not acceptable
9. Condenser coil hail guards shall be factory installed.

C. Condenser Section

1. Outdoor Fans: Shall be direct drive vertical discharge design with low-noise corrosion resistant glass reinforced polypropylene props, powder coated wire discharge guards and electro-plated motor mounting brackets.
2. Fans shall be statically and dynamically balanced.

D. Compressor Capacity Control – DIGITAL SCROLL COMPRESSORS

1. (Mechanical Control: Unit shall be equipped with Refrigerant Capacity Control (RCC) to modulate compressor capacity during Dehumidification or Cooling modes to maintain evaporator Dehumidification or Cooling setpoint and prevent evaporator frosting or freezing. Hot gas by pass shall not be an acceptable compressor capacity control strategy. The RCC setpoint is factory set, and field adjustable, to maintain desired suction pressure and compressor discharge pressure.

## 2.08 HEATING

A. Modulating Electric Resistance Heating System



1. Completely assembled and factory installed electric heating system shall be fully modulating, SCR controlled and listed for use in roof top handler. The heating section will include open coil heating elements, automatic and manual cut-outs, low voltage controls, air proving switch, maximum 48 amps per circuit and fusing for heaters over 48 amps. Electric heater shall be located:
  - a. In the Primary heating position located downstream of the indoor fan assembly.
  - b. In the Secondary heating position located upstream of the unit return air section and will be staged and of fin tubular type.
2. Heater shall be UL or CSA listed and approved and provide single point power connection.

## 2.09 ELECTRICAL RATINGS AND CONNECTIONS

- A. All high voltage power components such as fuses, switches and contactors shall include a service personnel protection barrier or shall be a listed as touch-safe design.
- B. Field wiring access to be provided thru unit base into isolated enclosure with removable cover.
- C. Power wiring to be single point connection.
- D. Wiring internal to the unit shall be colored and numbered for identification.
- E. Unit shall be factory wired to field wiring terminal block mounted in isolated enclosure.
- F. Factory wired main power disconnect and overcurrent device shall be rated for total unit connected power
- G. SCCR rating shall be a minimum of 65kA
- H. Factory wired Voltage/Phase monitor shall be included as standard. In the event of any of the following, the units will be shut down and a fault code will be stored in the monitor for the most recent 25 faults. Upon correction of the fault condition the unit will reset and restart automatically.
  1. Phase Unbalance Protection: Factory set 2%
  2. Over/Under/Brown Out Voltage Protection: +/-10% of nameplate voltage
  3. Phase Loss/Reversal
- I. Factory to mount and wire 120 volt convenience outlet. Field wiring of convenience outlet not acceptable.
- J. All low voltage field wiring connections shall be made at factory installed low voltage terminal strip.

## 2.10 UNIT CONTROLS

- A. Main Unit Controller (MCM) shall be provided by CMI. (There shall be no control interface devices, no integration, no BacNet, and no controllers provided by the VAU manufacturer.) VAU manufacturer shall provide and factory install the following control end devices and wire all to a terminal strip, with no controller and no interface:
  
- B. Space must be provided downstream of the unit's cooling coil for placement of the averaging temperature sensor, such that the unit can be controlled to the coil's leaving air set point, continuously. Controlling the unit indirectly via suction temp or any other indirect control algorithm is not acceptable.
  - 1. Primary control shall be Discharge Air Control via cooling coil leaving air temperature sensor.
  
- C. Factory Mounted and Wired Control Devices:
  - 1. Unit Manufacturer shall provide, factory install, and wire the following control points to terminal strip for CMI (Controls interface shall not be permitted):
    - a. Outdoor Air Temperature Sensor
    - b. Outdoor Air Humidity Sensor
    - c. Outdoor Air Flow Measuring Station
    - d. Outdoor Air Modulating Damper and Actuator
    - e. Return Air/Mixed Air Modulating Damper and Actuator
    - f. Return Air Temperature Sensor
    - g. Return Air Humidity Sensor
    - h. Return Air Duct Pressure Sensor
    - i. Filter Differential Pressure Switch – Status
    - j. Exhaust Fan Piezometer Air Flow Station
    - k. Exhaust Fan ECM Variable Speed Fan Control
    - l. Exhaust Damper and Actuator
    - m. Exhaust Damper End Switch
    - n. Exhaust Air Temperature Sensor
    - o. 0-10 vDc Input for Single/Dual Digital Compressor Capacity Modulation
    - p. Evaporator Leaving Air Temperature Sensor
    - q. 0-10 vDc Input for Hot Gas Reheat Modulation
    - r. Supply Fan Status
    - s. Supply Fan Piezometer Air Flow Measuring Station
    - t. Supply Fan ECM Variable Speed Fan Control
    - u. Unit Leaving Air Temperature Sensor for Discharge Air Temperature.
  - 2. CMI shall furnish Space Temperature, Space Humidity and Co2 sensor(s) for field installation and connection to the CMI provided controller.
  - 3. Discharge Air Sensor: Provided with Unit, field installed by CMI.
  
- D. System controls shall include:
  - 1. Anti-cycle timing.
  - 2. Minimum compressor run/off-times.

2.11 POWER EXHAUST

- A. Provide a factory installed power exhaust assembly that shall be designed to ventilate return air to atmosphere.
- B. Plenum mounted direct drive airfoil design exhaust wheel material shall be heavy gauge aluminum, welded construction and rated for up to Class III speed/pressure performance. Belt-drive and/or forward curve plenums fans shall not be used.
- C. Exhaust to discharge through powered isolation dampers located on each side of unit cabinet.

**PART 3 EXECUTION**

3.01 MANUFACTURER'S FIELD SERVICES

- A. Unit start-up shall be completed by an Employee of the Factory and must be a factory-certified technician.
  - 1. Manufacturer must have twenty factory-authorized and factory-trained technicians within a 50 mile radius of job site.
- B. The contractor shall furnish manufacturer complete submittal wiring diagrams of the package unit as applicable for field maintenance and service.

**END OF SECTION**