DIVISION 23

SECTION 23 05 00: MECHANICAL GENERAL PROVISIONS

23 05 00.01 GENERAL

A. SCOPE

1. 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.

2. 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.

3. 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".

4. 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.

5. 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.

6. 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.

B. DEFINITION

1. 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.

C. CONTRACTOR'S QUALIFICATIONS

1. 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.

23 05 00.2 PRODUCTS

A. MATERIALS AND WORKMANSHIP

1. 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.

2. 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.

3. 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.

4. 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.

B. EQUIPMENT APPLICATION AND PERFORMANCE

1. 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.

C. EQUIPMENT DEVIATIONS

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

2. 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.

D. MOTORS

1. 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.

E. DRIVES

1. Machinery drives shall be provided for all power driven equipment specified in this section.

2. 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.

3. 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.

4. 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.

5. 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.

F. FOUNDATIONS, SUPPORTS, PIERS, ATTACHMENTS

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

2. For pumps, compressors, and other rotating machinery and for all equipment where foundations are indicated, 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 chamfered. Insert six (6) inch long, l/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.

3. 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.

4. 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.

G. VIBRATION ISOLATION

1. 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.

2. The readings are to be tabulated in the Maintenance and Operating Instruction Booklets.

3. Sound or vibration conditions in excess of listed quantities shall be corrected in an approved manner by the Contractor at his expense.

4. 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.

5. 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.

H. DIELECTRIC CONNECTIONS

1. 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.

I. DRAINS AND VENTS

1. 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.

J. MOTOR STARTERS AND DISCONNECTS

1. 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.

2. 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.

K. PAINTING

1. 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.

   a. Rust Inhibitive Primer:

      1) Devoe: Bar-Ox Quick Dry Metal Primer, Red.
      2) Duron: Deluxe Red Primer.
      3) Glidden: Rustmaster Tank and Structure Primer.
      4) Pittsburgh: Inhibitive Red Primer.

   b. Galvanized Metal Primer:

      1) Devoe: Mirrolac Galvanized Metal Primer.
      2) Duron: Duron Deluxe Galvanized Metal Primer
      3) Glidden: Rustmaster Galvanized Iron Metal Primer.
      4) Pittsburgh: Speedhigh Galvanized Steel Primer.

23 05 00.3 EXECUTION

A. DUTIES OF CONTRACTOR

1. 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.

2. 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.

3. 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.

4. 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.

5. 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.

6. 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.

7. 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.

8. 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.

9. 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.

B. CODES, RULES, PERMITS AND FEES

1. 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.

2. 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.

3. 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.

4. 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.

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

C. COOPERATION WITH OTHER TRADES

1. 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.

2. 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.

3. 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.

D. RECORD DRAWINGS

1. 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.

E. SURVEYS AND MEASUREMENTS

1. 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.

2. 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.

F. SAFETY REQUIREMENTS

1. 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.

2. All safety controls shall be checked under the supervision of the Architect's representative and eight (8) copies of test date showing setting and performance of safety controls shall be submitted to the Architect.

G. SHOP DRAWINGS

1. 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.

2. Submission of a manufacturer's name or equipment number on this list shall not be considered as equipment approved by the Architect.

3. 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.

4. 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.

5. 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.

6. 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.

7. The Contractor, as part of the shop drawing submitted, shall submit shop drawing of all ductwork in the mechanical rooms, the risers including takeoffs to the floors with their associated dampers, and ells with unequal legs showing turning vanes.

8. Static pressure drops across fittings, dampers, heaters, attenuators, etc. shall not exceed minimum ASHRAE Standards when not specified.

9. 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.

10. 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.

11. 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.

12. 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.

13. Contractor shall keep on the job at all times copies of all approved shop drawings.

H. OBSERVATION

1. 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.

I. ACCESSIBILITY

1. 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.

2. 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.

3. 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.

J. CONCEALED PIPE

1. In general, all pipes in finished spaces shall be run concealed in floors, walls, partitions and above ceilings.

2. Concealment of pipe and covering of same shall not be done until authorized by the Architect, after proper tests have been made. This applies to all interior work and exterior work.

K. CUTTING AND PATCHING

1. This Contractor shall provide all cutting and patching necessary to install the work specified in this section.

2. 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.

3. 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.

4. 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.

L. SLEEVES AND PLATES

1. 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.

2. 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.

3. 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.

4. 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:

   a. Terminate sleeves flush with walls, partitions and ceiling.
   b. In areas where pipes are concealed, as in chases, terminate sleeves flush with floor or as shown on the plans.
   c. 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.

5. 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.

6. 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.

7. 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.

8. 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.

M. UTILITIES

1. 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.

N. SCAFFOLDING, RIGGING, HOISTING

1. 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.

O. EXCAVATING AND BACKFILLING

1. Each trade shall perform all excavation and backfill required for the installation of its work.

2. Particular care shall be taken not to disturb or damage work of other Contractors.

3. Mass excavation to approximate levels will be carried out under a section of the architectural specifications. The Contractor shall, however, do all trench and pit excavation and backfilling required for work under this section of the specifications, inside and outside the building, including repairing of finished surfaces and all required shoring, bracing, pumping and all protection for safety of persons and property. State and OSHA Safety Codes shall be strictly observed. In addition, it shall be the responsibility of the Contractor to check the indicated elevations of the utilities entering and leaving the building. If such elevations require excavations lower than the footing levels, the Architect shall be notified of such conditions and a redesign shall be made before excavations are commenced. It is also the responsibility of the Contractor to make the excavations at the minimum required depths in order to avoid undercutting the footings.

4. No backfilling shall be done until work involved has been tested and approved by the Architect.

5. Contractor shall schedule excavation work so as not to unduly interfere with work of other trades on the job. Contractor shall be responsible for establishing all lines and grades required for proper location of his work.

6. When rock is encountered in excavation, it shall be paid for as outlined under the architectural section of these specifications.

7. In backfilling pipe trenches, approved fill shall first be compacted firmly and evenly on both sides of pipe in 6" layers to a depth of 12" over the top of the pipe. Remainder of trench shall be backfilled to established grade in 6" layers. Compact between each layer with a high-frequency vibrator tamper such as Dart Soil Compactor (as manufactured by Dart Manufacturing Company, Denver, Colorado). Fill shall be compacted to density specified under Earth Work Section of specifications for specified area through which trench passes. Compact fill to 95% maximum density at optimum moisture content all other areas. Earth bearing pressure as indicated shall be verified by a testing laboratory, which following the criteria specified for foundation wall trench, etc. in the Earth Work Section of the specifications. The reports shall be forwarded to the Architect for approval unless otherwise specified, the cost will be borne by this contractor, before any work is performed. If the earth bearing pressure is less than that required, the Contractor

shall not begin additional work until notified by the Architect to do so. A copy of the report shall be forwarded to the Architect in triplicate.

8. Excess earth shall be distributed on premises as directed by the Architect.

9. Where ditches occur outside the building, the surface shall be finished to match existing surfaces. Any existing work or work of other trades which is damaged or disturbed shall be repaired or replaced, and left in good order.

P. ELECTRICAL CONNECTIONS

1. 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.

2. 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.

3. 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.

Q. PIPE WORK

1. 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.

2. 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.

3. The piping shall be installed as shown on the plans with strict conformity to the sizes listed and due provisions for expansion and contraction.

4. Unless otherwise noted on the plans, all piping shall be installed inside the insulated envelope of the building.

R. LUBRICATION

1. 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.

2. 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.

S. PROTECTION

1. The Contractor shall protect all work and material from damage, and shall be liable for all damage during construction.

2. 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.

3. 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.

T. CLEANING

1. Clean from all exposed insulation and metal surfaces grease, debris or other foreign material.

2. Chrome plated fittings, fixtures, piping and trim shall be polished upon completion.

U. LABELS AND INSTRUCTIONS

1. Label all switches and controls furnished under this Section with engraved bakelite permanent labels to indicate the function of each and the apparatus serviced.

2. Post in the Equipment Room framed under glass the following:

   a. Lubrication instructions listing all equipment which requires lubrication, the type of lubricant to be used and the frequency of lubrication.
   b. Photostatic copy of wiring diagram of temperature controls.

c. Step-by-step operating instruction for each piece of equipment with control sequence description.

3. All units shall be marked with unit numbers in three inch high letters with unit designated numbers.

4. 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.

V. VALVE, MOTOR & DAMPER TAGS AND SCHEDULE

1. Each valve, motor and damper shall be provided with an engraved black finish, phenolic tag indicating service and number. Tag lettering shall be at least 1/4" high etched white letters and beveled white trim. Tags to be attached using brass chains.

2. The Contractor shall submit eight (8) copies of charts indicating valve number, location, service, "normal" position, manufacturer, size and model number to the Architect for approval.

3. Prior to final inspection an approved copy of each chart shall be framed by the Contractor in a metal frame with glass front and installed in the Equipment Room.

W. EQUIPMENT SERVICEABILITY

1. 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.

2. Equipment installed in walls, ceilings or floors shall be accessible for service or removal without cutting walls, etc.

3. 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.

X. ACCEPTANCE OF EQUIPMENT

1. 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.

2. 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. Oil burners, gas burners, and water chillers shall be started by a representative of the equipment manufacturer. All costs of these procedures shall be borne by this Contractor.

3. 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.

Y. GUARANTEE

1. 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 acceptance 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.

2. 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.

Z. OPERATING AND MAINTENANCE INSTRUCTIONS

1. Submit 3 sets of complete operating and maintenance instructions.

2. 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.

3. Organize material in the following format:

   a. Section I:

      1) Name of Project
      2) Address
      3) Owner's Name
      4) General Contractor's Name and Address
      5) Mechanical Contractor's Name and Address
      6) Control Subcontractor's Name and Address
      7) Warranty Dates

   b. Section II:

      1) Major Equipment List (name, manufacturer, serial no., H.P. and voltage) (include all equipment with motors)

2) Control Sequence Description
3) Routine Maintenance Instructions in Step-by-Step form
4) Lubrication Charts and Schedules
5) Valve Schedules
6) Test and Balance Reports
7) Sound Power Level Readings (Where Required)

c. Section III:

1) Operating and Maintenance Instructions by Manufacturer
2) Shop Drawings (Major Requirement)
3) Wiring Diagrams
4) Control Drawings

AA. PAINTING

1. Painting shall be performed as detailed in Division 09.

2. All surfaces to receive paint shall be dry and clean.

3. 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.

4. 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.

5. 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.

6. The following materials and equipment require painting as noted:

a. All concealed piping, sheet metal, hangers and accessories except galvanized sheet metal or piping:

1) One coat rust-inhibitive primer except where exterior insulation is provided.

b. All exposed exterior and interior, piping, sheet metal, hangers and accessories, air handling units, chillers, pumps, etc. except galvanized sheet

metal or piping:

1) One coat rust-inhibitive primer except where exterior insulation is provided.

c. All concealed galvanized sheet metal, piping and accessories.

1) One coat galvanized metal primer on threaded portions of piping and any damaged galvanized surfaces.

d. All exposed exterior and interior galvanized sheet metal, piping and accessories.

1) One coat galvanized metal primer except where exterior insulation is provided.

e. All exposed exterior and interior, insulation equipment.

1) Two coats exterior glass enamel over paint suitable insulation jacket.

7. All piping in Equipment Rooms shall be painted (color shown below) and identified by stenciling with letters minimum 1/2" high in a contrasting color. Piping outside Equipment Rooms shall be stenciled. Stenciling shall occur at each change of direction and every 20 feet. Arrows should be placed adjacent to letters signifying direction of flow.

a. Standard piping color codes:

1) Heating Hot Water - Orange
2) Chilled Water - Blue
3) Drains - Natural with Walls
4) Electrical - Natural with Walls

DIVISION 23

SECTION 23 05 93: TESTING, ADJUSTING, AND BALANCING

23 05 93.01 GENERAL

A. SCOPE

1. The provisions of Section 23 05 00 apply to all the work in this Section.

2. 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.

3. The test and balance contractor shall be a sub-contractor to the HVAC contractor.

4. The test and balance report shall be submitted prior to the final inspection. The TAB sub-contractor shall attend the final to spot check air and water flows. Certificate of occupancy will not be issued until final test and balance report has been approved.

5. Balance systems to within +/- 10% of the specified value.

B. SUBMITTALS

1. Submit the following in accordance with Section 23 05 00:

   a. Manufacturer's cut sheets for all equipment to be used.
   b. Sample balancing charts and forms.
   c. Completed final balancing data.

23 05 93.02 PRODUCTS

A. INSTRUMENTATION

1. 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.

   a. Inclined manometer calibrated in no less that .006-inch divisions.
   b. Combination inclined and vertical manometer (0 to 10 inch is generally the most useful).
   c. Pitot Tubes. (Usually and 18 and 48 inch tube covers most balance requirements.
   d. Tachometer. This instrument should be of the high quality self-timing type.
   e. Clamp-on ampere meter with voltage scales.
   f. Deflecting vane anemometer.
   g. Rotating vane anemometer.
   h. Thermal type (hot wire) anemometer.
   i. Hook gage.

j. Dial and glass stem thermometers.
k. Sling psychrometer.

2. 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.

23 05 93.03 EXECUTION

A. SYSTEM START-UP

1. 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.

2. 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.

3. 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.

4. 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.

a. Pumps (Each):

1) Pump No.
2) Manufacturer and Model
3) Motor Manufacturer, Frame and Nameplate Data
4) Water Flow Rate, GPM
5) Water Pressure Increase (Ft. H20)
6) Motor Amperage
7) Voltage
8) RPM
9) Check Lead-Lag Controls

b. Coils (Each):

1) Unit Number and Location
2) Manufacturer and Model No.
3) Return Air, Supply Air and Outside Air Temperature
4) Discharge Temperature, Cooling or Heating
5) Air Flow CFM, Entering and Leaving Static Pressure
6) Hot Water, Pressure Drop, and EWT, LWT

7) Water Flow

c. Fans and Miscellaneous:

1) Unit No. and Use
2) Manufacturer and Model
3) Motor Nameplate Data
4) Motor Amps and Volts
5) Entering and Leaving Static Pressure
6) Fan RPM
7) Damper Operation

5. 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.

6. Each unit shall be marked with 3" high letters in accordance with mechanical plan designation. Each panel and breaker number for all equipment shall be marked. Each control device shall be labeled.

7. Replace fan sheaves as necessary to produce design air volume.

DIVISION 23

SECTION 23 07 00: INSULATION

23 07 00.01 GENERAL

A. DESCRIPTION

1. This section of specifications and related drawings describe requirements pertaining to insulation.

2. Provide all insulation in conjunction with equipment, piping and ductwork furnished under this division.

3. The provisions of Section 23 05 00 apply to all the work in this section.

B. QUALITY ASSURANCE

1. 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.

2. 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.

3. Insulation shall be applied by experienced workers regularly employed for this type of work.

C. SUBMITTALS Submit the following in accordance with Section 23 05 00:

1. Catalog cuts.

2. Materials ratings.

3. Insulation instructions.

D. RATING

1. 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.

2. 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.

3. Products of their shipping cartons shall bear a label indicating that flame and smoke ratings do not exceed above requirements.

4. Treatment of jackets or facings to impart flame and smoke safety shall be permanent. The use or water-soluble treatment is prohibited.

5. Certify in writing, prior to installation, that products to be used will meet RATING criteria.

23 07 00.02 PRODUCTS

A. PIPE INSULATION

1. Materials shall be heavy density fiberglass with an all-service jacket composed of an outer layer of vinyl, fiberglass scrim cloth, aluminum foil, and kraft paper, in that order, from outside to inside of pipe covering.

   a. Chilled water supply and return piping, including drain lines from chilled water coils or apparatus handling chilled water.
   b. Cold water make up lines and hot water heating supply and return piping.
   c. Refrigerant Suction Piping - flexible foamed elastomeric plastic tubing with a density of 6 lbs./CF, K of 0.27 @ 70 degrees F., self-extinguishing, and a water vapor transmission of less than 0.05 perm in., flame spread rating 25 or less, smoke developed rating of 50 or less (ASTM E84-75).

2. Thicknesses:

   a. Chilled water supply and return piping and condensate drain lines: Pipe size 2-1/2" and larger - 1-1/2", Pipe size 2" and smaller - 1".
   b. Cold water make up lines: All pipe sizes 1".
   c. Hot water heating and dual temperature water supply and return lines - Pipe size 1-1/4" and larger - 1-1/2", Pipe size 1" and smaller - 1".

B. DUCT INSULATION

1. Materials. Insulation shall be Owens-Corning as specified hereinafter or products of Certain-Teed/St. Gobain 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.

23 07 00.03 EXECUTION

A. PIPE INSULATION

1. Application:

   a. Insulation and surfaces to be insulated shall be clean and dry when insulation is installed and during the application of any finish.

2. Refrigerant Piping.

   a. End joint strips and overlap seams shall be adhered with a vapor barrier mastic. Valves, fittings, and flanges shall be insulated with strips of pipe

insulation, and finished with tape and vapor barrier mastic. Seal off vapor barrier to pipe at all fittings, hangers, and every 20 feet on straight runs. Cover exposed exterior refrigerant piping with metal jacket.

3. Fiberglass Insulation:

a. All fiberglass pipe covering shall be furnished with self-seal lap and 3" wide butt joint strips. The release paper is pulled from adhesive edge, pipe covering closed tightly around pipe and self-seal lap rubbed hard in place with the blunt edge of an insulation knife. This procedure applies to longitudinal as well as circumferential joints. Under no circumstances will staples be allowed. Care shall be taken to keep jacket clean, as it is the finish on all exposed work. All adjoining insulation sections shall be firmly butted together before butt joint strip is applied, and all chilled water and cold water service lines shall have vapor seal mastic thoroughly coated to pipe at butt joints every 21' and at all fittings. All insulation outside shall be protected with aluminum weather-proof jacketing with lap-seal, and factory attached moisture barrier. The aluminum shall be .016 gauge (3303-H14 alloy) of embossed pattern. It shall be applied with a 2" circumferential and 1-1/2" longitudinal lap and be secured with aluminum bands 3/8" wide 8" o.c.. All elbows shall be covered with the same .016 aluminum with factory applied moisture barrier. All fittings, valve bodies, unions, and flanges shall be finished as follows:

1) Apply molded or segmental insulation to fittings equal in thickness to the insulation on adjoining pipe and wire in place with 2#14 copper wires.
2) Apply a skim coat of insulating cement to the insulated fitting, if needed, to produce a smooth surface. After cement is dry, apply Owens-Corning Fiberglass Fitting Mastic, Type C, UL labeled.
3) Wrap the fitting with fiberglass reinforcing cloth overlapping the preceding layer by 1 to 2". Also, overlap mastic and cloth by 2" on adjoining sections of pipe insulation.
4) Apply a second coat of mastic over cloth, working it well into mesh of cloth and smooth the surface. Mastic to be applied at the rate of 40 square feet per gallon. All flanges and fittings on hot and cold lines in utility tunnels shall be insulated according to above. Omit insulation on flanges and unions over 60 degrees F. If painting is required, no sizing is necessary. To maintain the non-combustibility of the system only Glidden acrylic latex paint (#5370) is to be used.
5) All piping exposed to view (equipment rooms, etc.) shall be covered with an 8 oz. canvas jacket.

B. DUCT INSULATION

1. 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.

2. Lined Duct:

a. Ductwork as indicated on plans 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. Liner shall be anti microbial.

b. 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 less than 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". Fasteners 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.

3. Wrapped Duct:

a. All supply, return and outside air ducts shall be insulated by wrapping with 2" thick, minimum installed "R" value = 6.0, 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.

DIVISION 23

SECTION 23 09 00: BUILDING AUTOMATION SYSTEM

23 09 00.01 GENERAL

A. RELATED DOCUMENTS

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. RELATED SECTIONS

1. This Section includes the Building Management System (BMS) control equipment for HVAC systems and components, including open protocol control components for split system heat pumps, air handling units, exhaust fans and other components shown on the drawings.

2. Additional related sections and sub-sections can apply.

    a. 23 05 00 Mechanical General Provisions

C. STANDARD TERMS

1. Standard

    a. ASHRAE: American Society Heating, Refrigeration, Air Conditioning Engineers
    b. BACnet: Building Automation Controls Network
    c. BMS: Building Management System
    d. DDC: Direct Digital Control
    e. EIA: Electronic Industries Alliance
    f. GUI: Graphical User Interface
    g. HVAC: Heating, Ventilation, and Air Conditioning
    h. IEEE: Institute Electrical Electronic Engineers
    i. MER: Mechanical Equipment Room
    j. PID: Proportional, Integral, Derivative

2. Communications and protocols

    a. ARP: Address Resolution Protocol
    b. CORBA: Common Object Request Broker Architecture
    c. CSMA/CD: Carrier Sense Multiple Access/Collision Detect
    d. DDE: Dynamic Data Exchange
    e. FTT: Free Topology Transceivers
    f. HTTP: Hyper Text Transfer Protocol

g. IIOP: Internet Inter-ORB Protocol
h. LAN: Local Area Network
i. LON: Echelon Communication – Local Operating Network
j. MS/TP: Master Slave Token Passing
k. ODBC: Open Database Connectivity
l. ORB: Object Request Broker
m. SNVT: Standard Network Variables Types
n. SQL: Structured Query Language
o. UDP: User Datagram Protocol
p. XML: eXtensible Markup Language

3. Controllers

a. ASD: Application Specific Device
b. AAC: Advanced Application Controller
c. ASC: Application Specific Controller.
d. CAC: Custom Application Controller.
e. DCU: Distributed Control Unit
f. LCM: Local Control Module
g. MC: MicroControllers
h. MCI: MicroInterface
i. MN-II: Microzone II direct digital controller
j. MN-FLO: Micronet 2000 Pressure Independent VAV Controller
k. NSC: Network Server Controller
l. PEM: Package Equipment Module
m. PPC: Programmable Process Controller
n. SDCU: Standalone Digital Control Units
o. SLC: Supervisory Logic Controller
p. UEC: Unitary Equipment Controller

4. Tools and Software

a. AMBCx: Automated Monitoring Based Commissioning
b. APEO: Automated Predictive Energy Optimization
c. DR: Demand Response
d. CCDT: Configuration, Commissioning and Diagnostic Tool
e. BPES: BACnet Portable Engineering Station
f. LPES: LON Portable Engineering Station
g. POT: Portable Operator's Terminal

D. QUALIFICATIONS OF BIDDER AND PRE-BID SUBMITTAL

1. All bidders must be building automation contractors in the business of installing direct digital control building automation systems for a minimum of 10 years.

2. The Building Management System contractor shall have a full service facility within 200 miles of the project that is staffed with engineers trained and certified by the manufacturer in the configuration, programming and service of the automation system. The contractor's technicians shall be fully capable of providing instructions and routine emergency maintenance service on all system components.

   a. Any installing contractor, not listed as prequalified in the Approved Manufacturer's section, shall submit credentials as detailed in the Pre-bid Submittal section for the engineer's review 2 weeks prior to bid date. Failure to follow the attached formats shall disqualify potential alternate bidders. Credentials must attest that the contractor meets all requirements of the specification and the Engineers judgment regarding approval to bid as an acceptable installer after reviewing the data will be final.

3. All bidders must be authorized distributors or branch offices of the manufacturers specified.

   a. The automation system shall be an extension of the existing Siemens building automation system. The new equipment shall be fully integrated into the system and graphics updated as required. Any system upgrades required by integrating the new building into the existing system shall be provided.

4. Any installing contractors or manufacturers interested in participating as acceptable bidders for this project that are not pre-qualified shall furnish a detailed technical pre-bid submittal to the consulting engineer. All information must be submitted 2 weeks prior to the published bid date to allow the engineer adequate time to review the bidder's credentials.

5. The Pre-Bid submittal shall contain the following information as a minimum:

   a. A profile of the manufacturer and the local installation and service/organization.
   b. Description of how the system meets and achieves all the specified criteria in terms of configuration, operation, and control.
   c. System Architecture with single line riser diagram showing all major components (digital controllers, routers, hubs, etc.) that will be required for this project.
   d. Procedure for commissioning and time required to startup and commission each of the systems for this project.
   e. Contractors approach for the project planning and management.
   f. Product Data Sheets for all components, DDC panels, and all accessories listed per the appropriate specification sections herein.
   g. Examples of actual graphic screens for other similar projects.
   h. Number and types of DDC panels required for this installation.
   i. Number and types of spare points provided with the proposed system.
   j. Recommended spare parts list for components with list price schedule.
   k. List of 2 similar systems in size, point capacity, total installed value, installed and commissioned by the local office with a list of the installers/manufacturers design team members for each project and the owners contact information.

l. Samples of service offerings and a list of current similar service contracts with contact information.

m. Resumes for the management team and all employees who will be involved with the project design, commissioning, project management, and after installation service. Resumes should include copies of manufacturer's certifications for the proposed product line.

n. Copy of this Control Specification in its entirety with a check mark beside each paragraph to signify that the manufacturer's equipment and software shall fully conform to the specified requirement. If the requirement cannot be met, indicate the reasons/limitations and the alternative proposed.

o. An interview may be conducted and the bidder will be requested to make a formal presentation concerning the proposed system and possibly provide an installed project tour prior to a final decision.

E. SCOPE OF WORK

1. The Contractor shall furnish and install a complete building automation system including all necessary hardware and all operating and applications software necessary to perform the control sequences of operation as called for in this specification. All components of the system – workstations, servers, application controllers, unitary controllers, etc. shall communicate using the BACnet protocol, as defined by ASHRAE Standard 135-2007, or EIA standard 709.1, the LonTalk™ protocol, or Modbus protocol. The only exception will be field controllers within the Schneider I/NET, Continuum, and NETWORK 8000 family. No gateways shall be used for communication to controllers furnished under this section.

2. Except as otherwise noted, the control system shall consist of all necessary Ethernet Network Controllers, Standalone Digital Control Units, workstations, software, sensors, transducers, relays, valves, dampers, damper operators, control panels, and other accessory equipment, along with a complete system of electrical interlocking wiring to fill the intent of the specification and provide for a complete and operable system.

3. The BAS contractor shall review and study all HVAC drawings and the entire specification to familiarize themselves with the equipment and system operation and to verify the quantities and types of dampers, operators, alarms, etc. to be provided.

4. All interlocking wiring, wiring and installation of control devices associated with the equipment listed below shall be provided under this Contract. When the BAS system is fully installed and operational, the BAS Contractor and representatives of the Owner will review and check out the system – see System Acceptance and Testing section of this document. At that time, the BAS contractor shall demonstrate the operation of the system and prove that it complies with the intent of the drawings and specifications.

5. Provide services and manpower necessary for check out and testing of the system in coordination with the HVAC Contractor, Balancing Contractor and Owner's representative.

6. All work performed under this section of the specifications will comply with all governing codes, laws and governing bodies. If the drawings and/or specifications are in conflict with governing codes, the Contractor, with guidance from the engineer, shall submit a proposal with appropriate modifications to the project to meet code restrictions. If this specification and associated drawings exceed governing code requirements, the specification will govern. The Contractor shall obtain and pay for all necessary construction permits and licenses.

F. SYSTEM DESCRIPTION

1. In accordance to the scope of work, the system shall also provide a graphical, web-based, operator interface that allows for instant access to any system through a standard browser. The contractor must provide PC-based programming workstations, operator workstations and microcomputer controllers of modular design providing distributed processing capability, and allowing future expansion of both input/output points and processing/control functions.

2. For this project, the system shall consist of the following components:

   a. Administration and Programming Workstation(s): Unless already existing on the customer site, the BAS Contractor shall furnish (qty) Administration and Programming Workstation Computers as described in Part 2 of the specification. These workstations must be running the standard workstation software developed and tested by the manufacturer of the network server controllers and the standalone controllers. No third party front-end workstation software will be acceptable. Workstations must conform to the B-OWS BACnet device profile.
   b. Web-Based Operator Workstations: The BAS Contractor shall furnish licenses for web connection to the BAS system. Web-based users shall have access to all system points and graphics, shall be able to receive and acknowledge alarms, and shall be able to control setpoints and other parameters. All engineering work, such as trends, reports, graphics, etc. that are accomplished from the WorkStation shall be available for viewing through the web browser interface without additional changes. The web-based interface must conform to the B-OWS BACnet device profile. There will be no need for any additional computer based hardware to support the web-based user interface.
   c. Ethernet-based Network Router and/or Network Server Controller(s): The BAS Contractor shall furnish Ethernet-based Network Server Controllers as described in Part 2 of the specification. These controllers will connect directly to the Operator Workstation over Ethernet at a minimum of 100mbps, and provide communication to the Standalone Digital Control Units and/or other Input/Output Modules. Network Server Controllers shall conform to BACnet device profile B-BC. Network controllers that utilize RS232 serial communications or ARCNET to communicate with the workstations will not be accepted.
   d. Network Controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as Network Server Controllers (B-BC).
   e. Standalone Digital Control Units (SDCUs): Provide the necessary quantity

and types of SDCUs to meet the requirements of the project for mechanical equipment control including air handlers, central plant control, and terminal unit control. Each SDCU will operate completely standalone, containing all of the I/O and programs to control its associated equipment. BACnet SDCUs shall be tested and certified by the BACnet Testing Laboratory (BTL).

3. The Local Area Network (LAN) shall be either a 10 or 100 Mpbs Ethernet network supporting BACnet, Modbus, Java, XML, HTTP, and CORBA IIOP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Server Controllers (NSCs), user workstations and a local host computer system**.**

4. The Enterprise Ethernet (IEEE 802.3) LAN shall utilize Carrier Sense Multiple/Access/Collision Detect (CSMA/CD), Address Resolution Protocol (ARP) and User Datagram Protocol (UDP) operating at 10 or 100 Mbps.

5. The system shall enable an open architecture that utilizes EIA standard 709.1, the LonTalk™ protocol and/or ANSI / ASHRAE™ Standard 135-2007, BACnet functionality to assure interoperability between all system components. Native support for the LonTalk™ protocol and the ANSI / ASHRAE™ Standard 135-2007, BACnet protocol are required to assure that the project is fully supported by the HVAC open protocols to reduce future building maintenance, upgrade, and expansion costs.

6. The system shall enable an architecture that utilizes a MS/TP selectable 9.6-76.8 KBaud protocol, as the common communication protocol between all controllers and integral ANSI / ASHRAE™ Standard 135-2008, BACnet functionality to assure interoperability between all system components. The AAC shall be capable of communicating as a MS/TP device or as a BACnet IP device communicating at 10/100 Mbps on a TCP/IP trunk. The ANSI / ASHRAE™ Standard 135-2008, BACnet protocol is required to assure that the project is fully supported by the leading HVAC open protocol to reduce future building maintenance, upgrade, and expansion costs.

7. LonTalk™ packets may be encapsulated into TCP/IP messages to take advantage of existing infrastructure or to increase network bandwidth where necessary or desired.

   a. Any such encapsulation of the LonTalk™ protocol into IP datagrams shall conform to existing LonMark™ guide functionality lines for such encapsulation and shall be based on industry standard protocols.
   b. The products used in constructing the BMS shall be LonMark™ compliant.
   c. In those instances in which Lon-Mark™ devices are not available, the BMS contractor shall provide device resource files and external interface definitions for LonMark devices.

8. The software tools required for network management of the LonTalk™ protocol and the ANSI / ASHRAE™ Standard 135-2008, BACnet protocol must be provided with the system. Drawings are diagrammatic only. Equipment and labor not

specifically referred to herein or on the plans and are required to meet the functional intent, shall be provided without additional cost to the Owner. Minimum BACnet compliance is Level 4; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet IP or MS/TP. Physical connection of LonWorks devices shall be via Ethernet IP or FTT-10A.

9. The system shall support Modbus TCP and RTU protocols natively, and not require the use of gateways.

10. Complete temperature control system to be DDC with electronic sensors and electronic/electric actuation of Mechanical Equipment Room (MER) valves and dampers and electronic actuation of terminal equipment valves and actuators as specified herein. The BMS is intended to seamlessly connect devices throughout the building regardless of subsystem type, i.e. variable frequency drives, low voltage lighting systems, electrical circuit breakers, power metering and card access should easily coexist on the same network channel.

    a. The supplied system must incorporate the ability to access all data using Java enabled browsers without requiring proprietary operator interface and configuration programs.
    b. Data shall reside on a supplier-installed server for all database access.
    c. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer’s internal Intranet network.

11. All work described in this section shall be installed, wired, and circuit tested by factory certified technicians qualified for this work and in the regular employment of the approved manufacturer's local field office. The approved manufacturer's local field office shall have a minimum of 10 years of installation experience with the manufacturer and shall provide documentation in the bid and submittal package verifying longevity of the installing company's relationship with the manufacturer when requested. Supervision, hardware and software engineering, and checkout of the system shall be by the employees of the approved manufacturer's local field office and shall not be subcontracted. The control contractor shall have an in place support facility within 200 miles of the site with factory certified technicians and engineers, spare parts inventory and all necessary test and diagnostic equipment for the installed system, and the control contractor shall have 24 hours/day, 7 days/week emergency service available.

12. Provide the Commissioning, configuration and diagnostic tool (CCDT), color display personal computer, software, and interfaces to provide uploading/downloading of High Point Count Controllers (AAC), Unitary Equipment Controllers (UEC) and VAV controllers (VAVDDC) monitoring all BACnet objects, monitoring overrides of all controller physical input/output points, and editing of controller resident time schedules.

13. Providr s Portable Operator’s Terminal (POT) color display personal computer, software, and interfaces to provide uploading/downloading of Custom Application Controller and Application Specific Controllers databases, monitoring of

all LonMark™ Standard Network Variables Types (SNVTs) including display of all bound SNVTs, monitoring and overrides of all controller physical input/output points, and editing of controller resident time schedules.

14. Deployed system must be configured to comply with United States DIACAP (Department of Defense Information Assurance Certification and Accreditation Process) so that no category 1 vulnerabilities are detected during the DIACAP process.

15. The system shall have the capability to provide a web-based AMBCx (automated monitoring based commissioning) system. The AMBCx system shall be able to interface directly with the project BAS and energy/performance metering system to provide information on HVAC systems that are being controlled. Pricing is to be a separate line item from the BAS proposal. See specification section 25 08 01 for exact requirements.

16. The system shall have the capability to provide a web-based APEO (automated predictive energy optimization) system and enable effective participation in local utility Demand Response (DR) programs. The vendor shall provide software and ongoing services that will identify actionable energy saving and peak reduction opportunities to assist the facility in achieving its energy and sustainability objectives, and automatically and continuously operate the systems necessary to achieve the targeted savings and reductions. Pricing is to be a separate line item from the BAS proposal. See specification section 25 13 13 for exact requirements.

G. WORK BY OTHERS

1. The BAS Contractor shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others' work.

2. The BAS Contractor shall furnish all control valves, sensor wells, flow meters and other similar equipment for installation by the Mechanical Contractor unless scheduled or specified to be provided with the equipment.

H. CODE COMPLIANCE

1. Provide BAS components and ancillary equipment, which are UL-916 listed and labeled.

2. All equipment or piping used in conditioned air streams, spaces or return air plenums shall comply with NFPA 90A Flame/Smoke/Fuel contribution rating of 25/50/0 and all applicable building codes or requirements.

3. All wiring shall conform to the National Electrical Code.

4. All smoke dampers shall be rated in accordance with UL 555S.

5. Comply with FCC rules, Part 15 regarding Class A radiation for computing devices

and low power communication equipment operating in commercial environments.

6. Comply with FCC, Part 68 rules for telephone modems and data sets.

I. SUBMITTALS

1. All shop drawings shall be prepared in Visio Professional or AutoCAD software. In addition to the drawings, the Contractor shall furnish a CD containing the identical information.

2. Shop drawings shall include a riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also included shall be individual schematics of each mechanical system showing all connected points with reference to their associated controller. Typicals will be allowed where appropriate.

3. Submittal data shall contain manufacturer's data on all hardware and software products required by the specification. Valve, damper and air flow station schedules shall indicate size, configuration, capacity and location of all equipment.

4. Submittals shall contain narrative descriptions of sequences of operation. Diagrams shall be on 11" by 17" foldouts.

5. Submit five (5) copies of submittal data and shop drawings to the Engineer for review prior to ordering or fabrication of the equipment. The Contractor, prior to submitting, shall check all documents for accuracy.

6. The Engineer will make corrections, if required, and return to the Contractor.

7. The following is a list of post construction submittals that shall be updated to reflect any changes during construction and re-submitted as "As-Built".

   a. System architecture drawing.
   b. Layout drawing for each control panel
   c. Wiring diagram for individual components
   d. System flow diagram for each controlled system
   e. Instrumentation list for each controlled system
   f. Sequence of control
   g. Operation and Maintenance Manuals

8. Information common to the entire system shall be provided. This shall include but not be limited to the following.

   a. Product manuals for the key software tasks.
   b. Operating the system.
   c. Administrating the system.
   d. Engineering the operator workstation.
   e. Application programming.
   f. Engineering the network.
   g. Setting up the web server.

h. Report creation.
i. Graphics creation.
j. All other engineering tasks.
k. System Architecture Diagram.
l. Reference the product manual that includes instructions on executing the task.
m. Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
n. Licenses, guarantees, and warranty documents for equipment and systems.
o. Submit one copy for each building, plus two extra copies.

9. Information common to the systems in a single building shall be provided.

a. System architecture diagram for components within the building annotated with specific location information.
b. As-built drawing for each control panel.
c. As-built wiring design diagram for all components.
d. Installation design details for each I/O device.
e. As-built system flow diagram for each system.
f. Sequence of control for each system.
g. Product data sheet for each component.
h. Installation data sheet for each component.
i. Submit two copies for each building and two extra copies.

10. Software shall be provided:

a. Submit a copy of all software installed on the servers and workstations.
b. Submit all licensing information for all software installed on the servers and workstations.
c. Submit a copy of all software used to execute the project even if the software was not installed on the servers and workstations.
d. Submit all licensing information for all of the software used to execute the project.
e. All software revisions shall be as installed at the time of the system acceptance.
f. Firmware Files
g. Submit a copy of all firmware files that were downloaded to or pre-installed on any devices installed as part of this project.
h. This does not apply to firmware that is permanently burned on a chip at the factory and can only be replaced by replacing the chip.
i. Submit a copy of all application files that were created during the execution of the project.
j. Submit a copy of all graphic page files created during the execution of the project.

J. COORDINATION

1. Coordinate equipment from other divisions including "Intrusion Detection," "Lighting Controls," "Motor Control Centers," "Panel boards," "Miscellaneous

Integrated systems" and "Fire Alarm" to achieve compatibility with equipment that interfaces with those systems. It is expected that qualified vendor representatives will be present during startup for any of the above mentioned integrations as required. Costs for this support should be covered by the associated vendor as part of their base bid.

2. Coordinate supply of conditioned electrical circuits for control units and operator workstation.

3. Coordinate location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete".

4. Coordinate with the Owner's IT department on locations for NSC's, Ethernet communication cabling and TCP/IP addresses.

K. OWNERSHIP

1. The Owner shall retain licenses to software for this project.

2. The Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition off this contractor. Such license shall grant use of all programs and application software to the Owner as defined by the manufacturer's license agreement, but shall protect the manufacturer's rights to disclosure of Trade Secrets contained within such software.

3. The licensing agreement shall not preclude the use of the software by individuals under contract to the owner for commissioning, servicing or altering the system in the future. Use of the software by individuals under contract to the owner shall be restricted to use on the owner's computers and only for the purpose of commissioning, servicing, or altering the installed system.

4. All project developed software, files and documentation shall become the property of the Owner. These include but are not limited to:

   a. Server and workstation software
   b. Application programming tools
   c. Configuration tools
   d. Network diagnostic tools
   e. Addressing tools
   f. Application files
   g. Configuration files
   h. Graphic files
   i. Report files
   j. Graphic symbol libraries
   k. All documentation

L. QUALITY ASSURANCE – SYSTEM STARTUP AND COMMISSIONING

1. Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BAS will be tested against the appropriate sequence of operation specified herein. Successful completion of the system test shall constitute the beginning of the warranty period. A written report will be submitted to the owner indicating that the installed system functions in accordance with the plans and specifications.

2. The BAS contractor shall commission and set in operating condition all major equipment and systems, such as the chilled water, hot water and all air handling systems, in the presence of the equipment manufacturer's representatives, as applicable, and the Owner and Architect's representatives.

3. The BAS Contractor shall provide a technician for manpower and engineering services required to assist the HVAC Contractor and Balancing Contractor in testing, adjusting, and balancing all systems in the building. The BAS Contractor shall coordinate all requirements to provide a complete air balance with the Balancing Contractor and shall include all labor and materials in his contract.

4. Startup Testing shall be performed for each task on the startup test checklist, which shall be initialed by the technician and dated upon test completion. Any deviations from the submitted installation plan shall also be recorded.

5. Required elements of the startup testing include:

    a. Measurement of voltage sources, primary and secondary
    b. Verification of proper controller power wiring.
    c. Verification of component inventory when compared to the submittals.
    d. Verification of labeling on components and wiring.
    e. Verification of connection integrity and quality (loose strands and tight connections).
    f. Verification of bus topology, grounding of shields and installation of termination devices.
    g. Verification of point checkout.
    h. Each I/O device is landed per the submittals and functions per the sequence of control.
    i. Analog sensors are properly scaled and a value is reported
    j. Binary sensors have the correct normal position and the state is correctly reported.
    k. Analog outputs have the correct normal position and move full stroke when so commanded.
    l. Binary outputs have the correct normal state and respond appropriately to energize/de-energize commands.
    m. Documentation of analog sensor calibration (measured value, reported value and calculated offset).
    n. Documentation of Loop tuning (sample rate, gain and integral time constant).

6. A Startup and Testing Report shall be provided upon test completion.

M. WARRANTY AND MAINTENANCE

1. All components, system software, and parts furnished and installed by the BMS contractor shall be guaranteed against defects in materials and workmanship for 1 year of substantial completion. Labor to repair, reprogram, or replace these components shall be furnished by the BMS contractor at no charge during normal working hours during the warranty period. Materials furnished but not installed by the BMS contractor shall be covered to the extent of the product only. Installation labor shall be the responsibility of the trade contractor performing the installation. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software disks. The Contractor shall respond to the owner's request for warranty service within 24 standard working hours.

N. TRAINING

1. The BAS Contractor shall provide on-site training to the Owner's representative and maintenance personnel per the following description:

2. On-site training shall consist of a minimum of (2) hours of hands-on instruction geared at the operation and maintenance of the systems. The curriculum shall include:

   a. System Overview
   b. System Software and Operation
   c. System access
   d. Software features overview
   e. Changing setpoints and other attributes
   f. Scheduling
   g. Editing programmed variables
   h. Displaying color graphics
   i. Running reports
   j. Workstation maintenance
   k. Viewing application programming
   l. Operational sequences including start-up, shutdown, adjusting and balancing.
   m. Equipment maintenance.

23 09 00.2 PRODUCTS

A. SYSTEM ARCHITECTURE

1. General

   a. The Building Automation System (BAS) shall consist of Network Server/Controllers (NSCs), a family of Standalone Digital Control Units (SDCUs), Administration and Programming Workstations (APWs), and Web- based Operator Workstations (WOWs). The BAS shall provide control, alarm detection, scheduling, reporting and information management for the entire facility, and Wide Area Network (WAN) if applicable.
   b. An Enterprise Level BAS shall consist of an Enterprise Server, which enables multiple NSCs (including all graphics, alarms, schedules, trends,

programming, and configuration) to be accessible from a single Workstation simultaneously for operations and engineering tasks.

c. The Enterprise Level BAS shall be able to host up to 250 servers, or NSCs, beneath it.

d. For Enterprise reporting capability and robust reporting capability outside of the trend chart and listing ability of the Workstation, a Reports Server shall be installed on a Microsoft Windows based computer. The Reports Server can be installed on the same computer as the Enterprise Server.

e. The system shall be designed with a top-level 10/100bT Ethernet network, using the BACnet/IP, LonWorks IP, and/or Modbus TCP protocol.

f. Modbus RTU/ASCII (and J-bus), Modbus TCP, BACnet MS/TP, BACnet IP, LonTalk FTT-10A, and WebServices shall be native to the NSCs. There shall not be a need to provide multiple NSCs to support all the network protocols, nor should there be a need to supply additional software to allow all three protocols to be natively supported. A sub-network of SDCUs using the BACnet MS/TP, LonTalk FTT-10A, and/or Modbus RTU protocol shall connect the local, stand-alone controllers with Ethernet-level Network Server Controllers/IP Routers.

2. TCP/IP Level

a. The TCP/IP layer connects all of the buildings on a single Wide Area Network (WAN) isolated behind the campus firewall. Fixed IP addresses for connections to the campus WAN shall be used for each device that connects to the WAN.

3. Fieldbus Level with Standalone Digital Control Units (SDCUs)

a. The fieldbus layer shall be support all of the following types of SDCUs:

1) BACnet SDCU requirements: The system shall consist of one or more BACnet MS/TP field buses managed by the Network Server Controller. Minimum speed shall be 76.8kbps. The field bus layer consists of an RS485, token passing bus that supports up to 127 Standalone Digital Control Units (SDCUs) for operation of HVAC and lighting equipment. These devices shall conform to BACnet standard 135-2007. The NSCs shall be capable of at least two BACnet MS/TP field buses for a total capability of 254 SDCUs per NSC.

2) LonWorks SDCU requirements: The system shall consist of one or more LonWorks FTT-10A field buses managed by the Network Server Controller. Minimum speed shall be 76.8kbps. The field bus layer shall consist of up to 64 Lonworks SDCUs using peer-to-peer, event-driven communication for operation of HVAC and lighting equipment. If using TAC Xenta controllers, a total combination of Xenta and LonWorks SDCUs should consist of up to 64 in total, with a maximum of 30 for the Xenta line. If using I/A MNL controllers only, you may have up to 127 SDCUs per field bus level.

3) Modbus SDCU requirements: The system shall consist of one or more Modbus RTU (RS-485 or RS-232) field buses managed by the Network Server Controller. The field bus layer shall consist of up to 31 SDCUs for operation of HVAC, power metering, and lighting equipment. If utilizing Modbus TCP, the field bus layer shall consist

of up to 100 SDCUs for operation of HVAC, power metering, and lighting equipment. The NSCs shall be capable of at least two Modbus RTU field buses for a total capability of 62 SDCUs per NSC.

4) NETWORK 8000 SDCU requirements: The system shall consist of one or more ASD or LCM field buses managed by the Network Server Controller. The field bus layer shall consist of up to 128 ASD SDCUs or 31 LCM SDCUs for operation of HVAC, power metering, and lighting equipment.

5) I/NET SDCU requirements: The system shall consist of one or more controller LANs and subLANs managed by the Network Server Controller. The network shall consist of up to 100,000 I/NET points capable through numerous links and devices for operation of HVAC, power metering, and lighting equipment.

4. BAS LAN Segmentation

a. The BAS shall be capable of being segmented, through software, into multiple local area networks (LANs) distributed over a wide area network (WAN). Workstations can manage a single LAN (or building), and/or the entire system with all portions of that LAN maintaining its own, current database.

5. Standard Network Support

a. All NSCs, Workstation(s) and Servers shall be capable of residing directly on the owner's Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the NSC's, Workstation(s), and Server(s) shall be capable ofusing standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches and hubs. With this design the owner may utilize the investment of an existing or new enterprise network or structured cabling system. This also allows the option of the maintenance of the LAN/WAN to be performed by the owner's Information Systems Department as all devices utilize standard TCP/IP components.

6. System Expansion

a. The BAS system shall be scalable and expandable at all levels of the system using the same software interface, and the same TCP/IP level and fieldbus level controllers. Systems that require replacement of either the workstation software or field controllers in order to expand the system shall not be acceptable.

b. Web-based operation shall be supported directly by the NSCs and require no additional software, other than a Java supported network browser.

c. The system shall be capable of using graphical and/or line application programming language for the Network Server Controllers.

7. Support For Open Systems Protocols

a. All Network Server Controllers must natively support the BACnet IP, BACnet MS/TP, LonWorks FTT-10, Modbus TCP, Modbus RTU (RS-485 and RS-232), and Modbus ASCII protocols.

B. OPERATOR WORKSTATION REQUIREMENTS

1. General

a. The operator workstation portion of the BAS shall consist of one or more full-powered configuration and programming workstations, and one or more web-based operator workstations. For this project provide a minimum of 10 concurrent operator users and/or 2 concurrent engineering users within the enterprise server.

b. The programming and configuration workstation software shall allow any user with adequate permission to create and/or modify any or all parts of the NSC and/or Enterprise Server database.

c. All configuration workstations shall be personal computers operating under the Microsoft Windows operating system. The application software shall be capable of communication to all Network Server Controllers and shall feature high-resolution color graphics, alarming, trend charting. It shall be user configurable for all data collection and data presentation functions.

d. A minimum of 1 Workstation shall be allowed on the Ethernet network. In this client/server configuration, any changes or additions made from one workstation will automatically appear on all other workstations since the changes are accomplished to the databases within the NSC. Systems with a central database will not be acceptable.

2. Administration/Programming Workstation & Enterprise Server Requirements

a. The Enterprise Server (existing) shall consist of the following:

1) Processor

a) 2.6 GHz or higher

2) Memory

a) 4GB or higher

3) Operating systems:

a) Microsoft Windows 10 (Professional, Enterprise, or Ultimate)
b) Microsoft Windows Server 2008 R2 64-bit (Standard, Enterprise, Datacenter, Web, or Itanium)
c) Microsoft Windows Server 2012 R2 64-bit (Standard, Datacenter, Essentials, or Foundation)

4) 10/100MBPS Ethernet NIC
5) 250 GB hard disk
6) Required additional software:

a) Microsoft .Net 4.5

7) License agreement for all applicable software

3. Web-Based Operator PC Requirements

   a. Any user on the network can access the system, using the following software:

      1) Internet Explorer 10 or 11
      2) Google Chrome
      3) Java-enabled-7.0 Update 51 or newer

4. General Administration and Programming Workstation Software

   a. System architecture shall be truly client server in that the Workstation shall operate as the client while the NSCs shall operate as the servers. The client is responsible for the data presentation and validation of inputs while the server is responsible for data gathering and delivery.
   b. The workstation functions shall include monitoring and programming of all DDC controllers. Monitoring consists of alarming, reporting, graphic displays, long term data storage, automatic data collection, and operator-initiated control actions such as schedule and setpoint adjustments.
   c. Programming of SDCUs shall be capable of being done either off-line or on-line from any operator workstation. All information will be available in graphic or text displays stored at the NSC. Graphic displays will feature animation effects to enhance the presentation of the data, to alert operators of problems, and to facilitate location of information throughout the DDC system. All operator functions shall be selectable through a mouse.

5. User Interface

   a. The BAS workstation software shall allow the creation of a custom, browser-style interface linked to the user when logging into any workstation. Additionally, it shall be possible to create customized workspaces that can be assigned to user groups. This interface shall support the creation of "hot-spots" that the user may link to view/edit any object in the system or run any object editor or configuration tool contained in the software. Furthermore, this interface must be able to be configured to become a user's "PC Desktop" – with all the links that a user needs to run other applications. This, along with the Windows user security capabilities, will enable a system administrator to setup workstation accounts that not only limit the capabilities of the user within the BAS software, but may also limit what a user can do on the PC and/or LAN/WAN. This might be used to ensure, for example, that the user of an alarm monitoring workstation is unable to shutdown the active alarm viewer and/or unable to load software onto the PC.
   b. System shall be able to automatically switch between displayed metric vs. imperial units based on the workstation/webstations localization.
   c. The BMS workstation/webstations shall be capable of multiple language display, including English, Spanish, German, French, Japanese, Finish, Swedish, and traditional and simplified Chinese.
   d. Servers and clients shall have the ability to be located in different time

zones, which are then synchronized via the NTP server.

6. User Security

   a. The software shall be designed so that each user of the software can have a unique username and password. This username/password combination shall be linked to a set of capabilities within the software, set by and editable only by, a system administrator. The sets of capabilities shall range from View only, Acknowledge alarms, Enable/disable and change values, Program, and Administer. The system shall allow the above capabilities to be applied independently to each and every class of object in the system. The system must allow a minimum of 256 users to be configured per workstation. Additionally, the software shall enable the ability to add/remove users based upon Microsoft Windows Security Domains that enable the customer IT department to assist in user access.

7. Configuration Interface

   a. The workstation software shall use a familiar Windows Explorer style interface for an operator or programmer to view and/or edit any object (controller, point, alarm, report, schedule, etc.) in the entire system. In addition, this interface shall present a "network map" of all controllers and their associated points, programs, graphics, alarms, and reports in an easy to understand structure. All object names shall be alphanumeric and use Windows long filename conventions.
   b. The configuration interface shall also include support for user defined object types. These object types shall be used as building blocks for the creation of the BAS database. They shall be created form the base object types within the system input, output, string variables, setpoints, etc., alarm algorithms, alarm notification objects, reports, graphics displays, schedules, and programs. Groups of user defined object types shall be ableto be set up as a predefined aggregate of subsystems and systems. The configuration interface shall support copying/pasting and exporting/importing portions of the database for additional efficiency. The system shall also maintain a link to all "child" objects created. If a user wishes to make a change to a parent object, the software shall ask the user if he/she wants to update all of the child objects with the change.

8. Color Graphic Displays

   a. The system shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems, or building schematics. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition operators shall be able to command equipment or change setpoints from a graphic through the use of the mouse.
   b. Requirements of the color graphic subsystem include:

      1) At a minimum, the user shall have the ability to import .gif, .png, .bmp, .jpeg, .tif, and CAD generated picture files as background displays, and layering shall be possible.
      2) It shall be possible for the user to use JavaScript to customize the

behavior of each graphic.

3) The editor shall use Scalable Vector Graphics (SVG) technology.
4) A built-in library of animated objects such as dampers, fans, pumps, buttons, knobs, gauges, ad graphs which can be "dropped" on a graphic through the use of a software configuration "wizard". These objects shall enable operators to interact with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels.
5) Using the mouse, operators shall be able to adjust setpoints, start or stop equipment, modify PID loop parameters, or change schedules.
6) Status changes or alarm conditions must be able to be highlighted by objects changing screen location, size, color, text, blinking or changing from one display to another.
7) Ability to link graphic displays through user defined objects, alarm testing, or the result of a mathematical expression. Operators must be able to change from one graphic to another by selecting an object with a mouse - no menus will be required.
8) It shall be possible to create and save graphical components and JavaScript code in reusable and transferrable, customized libraries.
9) Graphics should rescale based on whatever monitor or viewing device is being used.
10) Be able to create graphics on varying layers the can be moved and repeated.
11) Be able to create graphics within varying window panes that can be moved and/or re-referenced. For example, creating the graphical menu within a pane and referencing it on every graphics page, therefore not rebuilding thus allowing for a single spot for updates that get pushed to all the pages that reference it.

c. Additionally, the Graphics Editor portion of the Engineering Software shall provide the following capabilities:

1) Create and save pages.
2) Group and ungroup symbols.
3) Modify an existing symbol.
4) Modify an existing graphic page.
5) Rotate and mirror a symbol.
6) Place a symbol on a page.
7) Place analog dynamic data in decimal format on a page.
8) Place binary dynamic data using state descriptors on a page.
9) Create motion through the use of animated .gif files or JavaScript.
10) Place test mode indication on a page.
11) Place manual mode indication on a page.
12) Place links using a fixed symbol or flyover on a page.
13) Links to other graphics.
14) Links to web sites.
15) Links to notes.
16) Links to time schedules.
17) Links to any .exe file on the operator work station.
18) Links to .doc files.
19) Assign a background color.
20) Assign a foreground color.

21) Place alarm indicators on a page.
22) Change symbol/text/value color as a function of an analog variable.
23) Change a symbol/text/value color as a function of a binary state.
24) Change symbol/text/value as a function of a binary state.
25) All symbols used by Schneider Electric Buildings Business in the creation of graphic pages shall be saved to a library file for use by the owner.

9. Automatic monitoring

a. The software shall allow for the automatic collection of data and reporting from any controller or NSC. The frequency of data collection shall be user-configurable.

10. Alarm Management

a. The software shall be capable of accepting alarms directly from NSCs or controllers, or generating alarms based on evaluation of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm (regardless of its origination) will be integrated into the overall alarm management system and will appear in all standard alarm reports, be available for operator acknowledgment, and have the option for displaying graphics, or reports.
b. Alarm management features shall include:

1) A minimum of 1000 alarm notification levels. Each notification level will establish a unique set of parameters for controlling alarm display, distribution, acknowledgment, keyboard annunciation, and record keeping.
2) Automatic logging in the database of the alarm message, point name, point value, source device, timestamp of alarm, username and time of acknowledgement, username and time of alarm silence (soft acknowledgement)
3) Playing an audible sound on alarm initiation or return to normal.
4) Sending an email page to anyone specifically listed on the initial occurrence of an alarm. The ability to utilize email paging of alarms shall be a standard feature of the software integrated with the operating system's mail application interface (MAPI). No special software interfaces shall be required and no email client software must be running in order for email to be distributed.
5) Individual alarms shall be able to be re-routed to a user at user-specified times and dates. For example, a critical high temp alarm can be configured to be routed to a Facilities Dept. workstation during normal working hours (7am-6pm, Mon-Fri) and to a Central Alarming workstation at all other times.
6) An active alarm viewer shall be included which can be customized for each user or user type to hide or display any alarm attributes.
7) The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of user actions for certain alarms.
8) The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down

list of causes for certain alarms. This ensures accountability (audit trail) for the response to critical alarms.

9) The active alarm viewer can be configured such that an operator must confirm that all of the steps in a check list have been accomplished prior to acknowledging the alarm.

10. The active alarm viewer shall, if filtered, show the quantity of visible and total number of alarms that are not equal to 'normal' and the quantity of disabled and hidden alarms.

11) An operator shall have the capability to assign an alarm to another user of the system.

11. Report Generation

a. The Reports Server shall be able to process large amounts of data and produce meaningful reports to facilitate analysis and optimization of each installation.

b. Reports shall be possible to generate and view from the operator Workstation, and/or Webstation, and/or directly from a reports-only web interface.

c. A library of predefined automatically generated reports that prompt users for input prior to generation shall be available. The properties and configurations made to these reports shall be possible to save as Dashboard reports, so that the configurations are saved for future used.

d. It shall be possible to create reports standard tools, such as Microsoft Report Builder 2.0 or Visual Studio, shall be used for customized reports.

e. Additional reports or sets of reports shall be downloadable, transferrable, and importable

f. All reports shall be able to be set up to automatically run or be generated on demand.

g. Each report shall be capable of being automatically emailed to a recipient in Microsoft Word, Excel, and/or Adobe .pdf format.

h. Reports can be of any length and contain any point attributes from any controller on the network.

i. Image management functionality shall be possible to enable the system administrators to easily upload new logos or images to the system.

j. It shall be possible to run other executable programs whenever a report is initiated.

k. Report Generator activity can be tied to the alarm management system, so that any of the configured reports can be displayed in response to an alarm condition.

l. Minimum supplied reports shall include:

1) Activities Per Server Report
2) Activities Per User Report
3) Alarm Amount by Category Report
4) Alarm Amount by Type Report
5) Alarms Per Sever Report
6) Current Alarm Report
7) Most Active Alarm Report
8) System Errors Per Server Report
9) Top Activities Report
10) Top Alarms Report
11) Top System Errors Report

12) Trend Log Comparison Report
13) User Logins Report
14) Users and Groups Reports

m. Minimum Energy Reports shall include:

1) Energy Monitoring Calendar Consumption Report: Shall provide an interactive report that shows the energy usage on one or multiple selected days.
2) Energy Monitoring Consumption Breakdown Report: Shall provide a report on energy consumption broken down using sub-metering.
3) Energy Monitoring Consumption Report: Shall show the energy consumption against a specified target value.

n. Reports Server Hardware Requirements

1) Processor

a) 2.0 GHz or higher

2) Memory
a) 64GB or higher

3) Hard Disk

a) 1 TB or higher

o. Reports Server Software Requirements

1. Operating System:

a) Microsoft Windows Server 2008 R2 64-bit (Standard, Enterprise, Datacenter, Web, or Itanium)
b) Microsoft Windows Server 2012 R2 64-bit (Standard, Datacenter, Essentials, Foundation

2. SQL Versions:

a) Microsoft SQL Server 2008 Express with Advanced Services (64-bit)
b) Microsoft SQL Server 2008 R2 Standard (64-bit)
c) Microsoft SQL Server 2012 Express or Standard Edition

3. Additional required software

a) Microsoft .Net 4.5

12. Scheduling

a. From the workstation or webstation, it shall be possible to configure and download schedules for any of the controllers on the network.
b. Time of day schedules shall be in a calendar style and viewable in both a

graphical and tabular view.

c. Schedules shall be programmable for a minimum of one year in advance.
d. To change the schedule for a particular day, a user shall simply select the day and make the desired modifications.
e. Additionally, from the operator webstations, each schedule will appear on the screen viewable as the entire year, monthly, week and day. A simple mouse click shall allow switching between views. It shall also be possible to scroll from one month to the next and view or alter any of the schedule times.
f. Schedules will be assigned to specific controllers and stored in their local RAM memory. Any changes made at the workstation will be automatically updated to the corresponding schedule in the controller.
g. It shall be possible to assign a lead schedule such that shadow/local schedules are updated based upon changes in the Lead.
h. It shall be possible to assign a list(s) of exception event days, dates, date ranges to a schedule.
i. It shall be possible to view combined views showing the calendar and all prioritized exemptions on one screen.
j. It should accommodate a minimum of 16 priority levels.
k. Values should be able to be controlled directly from a schedule, without the need for special program logic.

13. Programmer's Environment

a. Programming in the NSC shall be either in graphical block format or line-programming format or both.
b. Programming of the NSC shall be available offline from system prior to deployment into the field. All engineering tasks shall be possible, except, of course, the viewing of live tasks or values.
c. The programmer's environment will include access to a superset of the same programming language supported in the SDCUs.
d. NSC devices will support both script programming language as well as the graphical function block programming language. For both languages, the programmer will be able to configure application software for custom program development, and write global control programs.
e. It shall be possible to save custom programs as libraries for reuse throughout the system. A wizard tool shall be available for loading programs from a library file in the program editor.
f. It shall be possible to view graphical programming live and real-time from the Workstation.
g. The system shall be capable of creating 'binding templates' allowing the user to bind multiple points to multiple objects all at once.
h. Key terms should appear when typing (IntelliType).
i. Applications should be able to be assigned different priorities and cycle times for a prioritized execution of different function.
j. The system shall be able to create objects that allow common objects such as power meters, VFD drives, etc. to be integrated into the system with simple import actions without the need of complicated programming or configuration setups.

14. Saving/Reloading

a. The workstation software shall have an application to save and restore NSC and field controller memory files.
b. For the NSC, this application shall not be limited to saving and reloading an entire controller – it must also be able to save/reload individual objects in the controller. This allows off-line debugging of control programs, for example, and then reloading of just the modified information.

15. Audit Trail

a. The workstation software shall automatically log and timestamp every operation that a user performs at a workstation, from logging on and off a workstation to changing a point value, modifying a program, enabling/disabling an object, viewing a graphic display, running a report, modifying a schedule, etc.
b. It shall be possible to view a history of alarms, user actions, and commands for any system object individually or at least the last 5000 records of all events for the entire system from Workstation.
c. It shall be possible to save custom filtered views of event information that are viewable and configurable in Workstation.
d. It shall be capable to search and view all forced values within the system.

16. Fault Tolerant Enterprise Server Operation (Top level NSC)

a. A single component failure in the system shall not cause the entire system to fail. All system users shall be informed of any detectable component failure via an alarm event. System users shall not be logged off as a result of a system failure or switchover.

17. Web-based Operator Software

a. General

1) Day-to-day operation of the system shall be accessible through a standard web browser interface, allowing technicians and operators to view any part of the system from anywhere on the network.
2) The system shall be able to be accessed on site via a mobile device environment with, at a minimum, access to overwrite and view system values.

b. Graphic Displays

1) The browser-based interface must share the same graphical displays as the Administration and Programming Workstations, presenting dynamic data on site layouts, floor plans, and equipment graphics. The browser's graphics shall support commands to change setpoints, enable/disable equipment and start/stop equipment.
2) Through the browser interface, operators must be able to navigate through the entire system, and change the value or status of any point in any controller. Changes are effective immediately to the controller, with a record of the change stored in the system database.

c. Alarm Management

1) Systems requiring additional client software to be installed on a PC for viewing the webstation from that PC will not be considered.
2) Through the browser interface, a live alarm viewer identical to the alarm viewer on the Administration and Programming workstation shall be presented, if the user's password allows it. Users must be able to receive alarms, silence alarms, and acknowledge alarms through a browser. If desired, specific operator text must be able to be added to the alarm record before acknowledgement, attachments shall be viewable, and alarm checklists shall be available.

18. Groups and Schedules

a. Through the browser interface, operators must be able to view pre-defined groups of points, with their values updated automatically.
b. Through the browser interface, operators must be able to change schedules – change start and stop times, add new times to a schedule, and modify calendars.

19. User Accounts and Audit Trail

a. The same user accounts shall be used for the browser interface and for the operator workstations. Operators must not be forced to memorize multiple passwords.
b. All commands and user activity through the browser interface shall be recorded in the system's activity log, which can be later searched and retrieved by user, date, or both.

20. Web Services

a. The installed system shall be able to use web services to "consume" information within the Network Server/Controllers (NSCs) with other products and systems. Inability to perform web services within the NSCs will be unacceptable.

1) Shall be able to "consume" data into the system via SOAP and REST web services.
2) Shall be able to "serve" and "consume" data from other Schneider Electric systems such as:

a) StruxureWare Data Center Expert
b) StruxureWare Power Monitoring Expec

C. NETWORK SERVER CONTROLLERS (NSCs)

1. Network Router Controllers shall combine both network routing functions, control functions, and server functions into a single unit.

2. The BACnet NSC shall be classified as a "native" BACnet device, supporting the

BACnet Network Server Controller (B-BC) profile. Controllers that support a lesser profile such as B-SA are not acceptable. NSCs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Network Server Controllers (B-BC).

3. The Network Server Controller shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NRS.

4. They shall also be responsible for monitoring and controlling their own HVAC equipment such as an AHU or boiler.

5. They shall also contain graphics, trends, trend charts, alarm views, and other similar presentation objects that can be served to workstations or web-based interfaces. A sufficient number of NSCs shall be supplied to fully meet the requirements of this specification and the attached point list.

6. It shall be capable of executing application control programs to provide:

   a. Calendar functions
   b. Scheduling
   c. Trending
   d. Alarm monitoring and routing
   e. Time synchronization by means of an Internet site including automatic synchronization
   f. Native integration of LonWorks controller data and Modbus controller data or BACnet controller data and Modbus controller data
   g. Network Management functions for all LonWorks based devices

7. Hardware Specifications

   a. Memory:

      1) The operating system of the controller, application programs, and all other portions of the configuration database, shall be stored in non-volatile, FLASH memory. Servers/Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory.

   b. Each NRC shall providethe following on-board hardware for communication:

      1) One 10/100bT Ethernet for communication to Workstations, other NRCs and onto the Internet
      2) Two RS-485 ports for communication to BACnet MSTP bus or serial Modbus (software configurable)
      3) One TP/FT port for communication to LonWorks devices.
      4) One Device USB port
      5) Two host USB Ports

   c. The NSC shall conform to a small footprint no larger than 100W x 125H x 75D mm (3.94W x 4.92H x 2.95D in).

8. Modular Expandability:

   a. The system shall employ a modular I/O design to allow expansion. Input and output capacity is to be provided through plug-in modules of various types. It shall be possible to combine I/O modules as desired to meet the I/O requirements for individual control applications.
   b. One shall be able to "hot-change" (hot-swap) the I/O modules preserving the system on-line without any intervention on the software; addressing and configuration shall be automatic
   c. If for any reason the backplane of the modular I/O system were to fail, I/O module addresses will be protected.

9. Hardware Override Switches:

   a. All digital outputs shall, optionally, include three position manual override switches to allow selection of the ON, OFF, or AUTO output state. These switches shall be built into the unit and shall provide feedback to the controller so that the position of the override switch can be obtained through software. In addition each analog output shall be equipped with an override potentiometer to allow manual adjustment of the analog output signal over its full range, when the 3 position manual override switch is placed in the ON position.

10. Universal Input Temperatures

   a. All universal inputs directly connected to the NSC via modular expansion shall be capable of using the following thermistors for use in the system without any external converters needed.

      1) 10 kohm Type I (Continuum)
      2) 10 kohm Type II (I/NET)
      3) 10 kohm Type III (Satchwell)
      4) 10 kohm Type IV (FD)
      5) Linearized 10 kohm Type V (FD w/11k shunt)
      6) Linearized 10 kohm (Satchwell)
      7) 1.8 kohm (Xenta)
      8) 1 kohm (Balco)
      9) 20 kohm (Honeywell)
      10) 2.2 kohm (Johnson)

   b. In addition to the above, the system shall be capable of using the below RTD sensors, however it is not required that all universal inputs be compatible with them.

      1) PT100 (Siemens)
      2) PT1000 (Sauter)
      3) Ni1000 (Danfoss)

11. Local Status Indicator Lamps:

   a. The NSC shall provide as a minimum LED indication of CPU status, Ethernet LAN status, and field bus status. For each input or output,

provide LED indication of the value of the point (On/Off). The LED indication shall support software configuration to set whether the illumination of the LED corresponds to On or Off or whether the color when illuminated is Red or Green.

12. Real Time Clock (RTC):
    a. Each NSC shall include a battery-backed, real time clock, accurate to 10 seconds per day. The RTC shall provide the following: time of day, day, month, year, and day of week. Each NSC will allow for its own UTC offset, depending upon the time zone. When the time zone is set, the NSC will also store the appropriate times for daylight savings time.

13. Power Supply:

    a. The 24 VDC power supply for the NSCs shall provide 30 watts of available power for the NSC and associated IO modules. The system shall support the use of more than one power supply if heavily power consuming modules are required.
    b. The power supply, NSC, and I/O modules shall connect power wise and communication wise via the separate terminal base allowing for ease of replacement and no separate or loose wiring.

14. Automatic Restart After Power Failure:

    a. Upon restoration of power after an outage, the NSC shall automatically and without human intervention update all monitored functions, resume operation based on current, synchronize time and status, and implement special start-up strategies as required.

15. Battery backup:

    a. The NSC shall include an on-board battery to back up the controller's RAM memory. The battery shall provide accumulated backup of all RAM and clock functions for at least 30 days. In the case of a power failure, the NSC shall first try to restart from the RAM memory. If that memory is corrupted or unusable, then the NSC shall restart itself from its application program stored in its FLASH memory.

16. Software Specifications

    a. The operating system of the controller, application programs, and all other portions of the configuration database such as graphics, trends, alarms, views, etc., shall be stored in non-volatile, FLASH memory. There will be no restrictions placed on the type of application programs in the system. Each NSC shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.
    b. Each NSC shall have an available capacity of 4 GB of memory. This shall represent 2 GB for application and historical data and 2 GB dedicated for

backup storage.

c. User Programming Language: The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be either a script-based structured text or graphical function block based and fully programmable by the user. The language shall be structured to allow for the configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, and histories. Users shall be able to place comments anywhere in the body of either script or function block programs.

d. Network Server Controllers that use a "canned" program method will not be accepted.

17. Control Software:

a. The NSC shall have the ability to perform the following pre-tested control algorithms:

1) Proportional, Integral plus Derivative Control (PID)
2) Two Position Control
3) Digital Filter
4) Ratio Calculator
5) Equipment Cycling Protection

18. Mathematical Functions:

a. Each controller shall be capable of performing basic mathematical functions (+, -, *, /), squares, square roots, exponential, logarithms, Boolean logic statements, or combinations of both. The controllers shall be capable of performing complex logical statements including operators such as >, <, =, and, or, exclusive or, etc. These must be able to be used in the same equations with the mathematical operators and nested up to five parentheses deep.

19. NSCs shall have the ability to perform any or all of the following energy management routines:

a. Time of Day Scheduling
b. Calendar Based Scheduling
c. Holiday Scheduling
d. Temporary Schedule Overrides
e. Optimal Start
f. Optimal Stop
g. Night Setback Control
h. Enthalpy Switchover (Economizer)
i. Peak Demand Limiting
j. Temperature Compensated Duty Cycling
k. CFM Tracking
l. Heating/Cooling Interlock
m. Hot/Cold Deck Reset

n. Hot Water Reset
o. Chilled Water Reset
p. Condenser Water Reset
q. Chiller Sequencing

20. History Logging:

a. Each NSC controller shall be capable of LOCALLY logging any input, output, calculated value or other system variable either over user defined time intervals ranging from 1 second to 1440 minutes or based upon a user configurable change of value. A minimum of 1000 logs, with a minimum of 100,000 records, shall be stored. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to a higher level NSC long term archiving based upon user-defined time intervals, or manual command.
b. For extended trend logging a minimum of 1500 trends shall be capable, with a minimum number of 600,000 records within.
c. Management of a power meter replacement to ensure meter log data is accurate shall be possible in the NSC.
d. Every hardware input and output point, hosted within the NSC and attached I/O modules, shall be trended automatically without the requirement for manual creation, and each of these logs shall log values based upon a change of value and store at least 500 trend samples before replacing the oldest sample with new data.
e. The presentation of logged data shall be built into the server capabilities of the NSC Presentation can be in time stamped list formats or in a chart format with fully configurable pen colors, weights, scales and time spans.

21. Alarm Management:

a. For each system point, alarms can be created based on high/low limits or in comparison to other point values. All alarms will be tested each scan of the NSC and can result in the display of one or more alarm messages or reports.
b. There is no limit to the number of alarms that can be created for any point
c. Alarms can be configured to be generated based upon a single system condition or multiple system conditions.
d. Alarms will be generated based on an evaluation of the alarm conditions and can be presented to the user in a fully configurable order, by priority, by time, by category, etc. These configurable alarm views will be presented to a user upon logging into the system regardless of whether the log in takes place at a WorkStation or a Webstation.
e. The alarm management system shall support the ability to create and select cause and action notes to be selected and associated with an alarm event. Checklists shall also be possible in order to present to an operator a suggested mode of troubleshooting. When acknowledging an alarm, it shall be possible to assign it to a user of the system such that the user is notified of the assignment and is made responsible for the alarm resolution.
f. Alarms must be capable of being routed to any BACnet workstation that conforms to the B-OWS device profile and uses the BACnet/IP protocol.

22. Embedded Web Server

a. Each NSC must have the ability to serve out web pages containing the same information that is available from the WorkStation. The development of the screens to accomplish shall not require any additional engineering labor over that required to show them at the WorkStation itself.

D. BACnet FIELDBUS AND BACnet SDCUs

1. Networking

a. IP Network: All devices that connect to the WAN shall be capable of operating at 10 megabits per second or 100 megabits per second.
b. IP To Field Bus Routing Devices

1) A Network Server Controller shall be used to provide this functionality.
2) These devices shall be configurable locally with IP crossover cable and configurable via the IP network.
3) The routing configuration shall be such that only data packets from the field bus devices that need to travel over the IP level of the architecture are forwarded.

2. Field Bus Wiring and Termination

a. The wiring of components shall use a bus or daisy chain concept with no tees, stubs, or free topology.
b. Each field bus shall have a termination resistor at both ends of each segment.

3. Repeaters

a. Repeaters are required to connect two segments.

b. Repeaters shall be installed in an enclosure. The enclosure may be in an interstitial space.

4. Field Bus Devices

a. General Requirements

1) Devices shall have a light indicating that they are powered.
2) Devices shall be locally powered. Link powered devices (power is furnished from a central source over the field bus cable) are not acceptable.
3) Application programs shall be stored in a manner such that a loss of power does not result in a loss of the application program or configuration parameter settings. (Battery backup, flash memory, etc.)

5. Network Server Controllers (NSCs)

   a. If NSCs have embedded I/O, all of the requirements for I/O that are described under Advance Application Controllers shall apply.
   b. Shall support the export of data to NSCs from other vendors that support the data sharing, read property service.
   c. hall support the export of data using Change of Value (COV) initiation to NSCs from other vendors that support the subscription to data using the COV concept.
   d. Shall support the export of data to any BACnet OWS that supports the data sharing, read property service.
   e. Shall support the export of data using Change of Value (COV) initiation to any BACnet OWS that supports the subscription to data using the COV concept.
   f. Shall provide trend log support for all of the devices on the field bus. They shall provide sufficient memory to store up to 300 samples for each variable required to be trended by the sequence of control.
   g. Shall support the exporting of trend log data to any BACnet OWS that supports the read range BACnet service for trending.
   h. Shall provide time schedule support for all of the devices on the field bus.
   i. Shall support the editing of time schedule entries from any BACnet OWS that supports the BACnet service for writing of time schedule parameters.
   j. Shall provide alarm message initiation for all alarms conditions from any of the field bus devices.
   k. Shall deliver alarm messages to any BACnet OWS that supports the BACnet service for receiving alarm messages and is configured to be a recipient of the notification.
   l. Shall support alarm acknowledgement from any BACnet OWS that supports the BACnet service for executing alarm/event acknowledgement.
   m. Shall support the control of the out of service property and assignment of value or state to analog and binary objects from any BACnet OWS that supports writing to the out of service property and the value property of analog and binary objects.
   n. Shall support the receipt and response to Time Synchronization commands from any device that supports the BACnet service for initiating time synchronization commands.
   o. Shall support the "Who is?" and "I am." BACnet service.
   p. Shall support the "'Who has?" and "I have." BACnet service.
   q. Shall support Backup and Restore commands from any BACnet OWS that supports the initiation of Backup and Restore commands.
   r. Shall be BTL certified.

6. Advance Application Controllers (AAC)

   a. The key characteristics of a AAC are:

      1) They have physical input and output circuits for the connection of analog input devices, binary input devices, pulse input devices, analog output devices, and binary output devices. The number and

type of input and output devices supported will vary by model.

2) They may or may not provide support for additional input and output devices beyond the number of circuits that are provided on the basic circuit board. Support for additional I/O shall be provided by additional circuit boards that physically connect to the basic controller.
3) The application to be executed by a AAC is created by an application engineer using the vendor's application programming tool.
4) If local time schedules are embedded, the AAC shall support the editing of time schedule entries from any BACnet OWS that supports the BACnet service for writing of time schedule parameters.
5) If local trend logging is embedded, the AAC shall support the exporting of trend log data to any BACnet OWS that supports the read range BACnet service for trending.
6) If local alarm message initiation is embedded, the AAC shall:

    a) Deliver alarm messages to any BACnet OWS that supports the BACnet service for receiving alarm messages and is configured to be a recipient off the alarm message.
    b) Support alarm acknowledgement from any BACnet OWS that supports the BACnet service for executing alarm/event acknowledgement.

7) Shall support the reading of analog and binary data from any BACnet OWS or Building Controller that supports the BACnet service for the reading of data.
8) Shall support the control of the out of service property and assignment of value or state to analog and binary objects from any BACnet OWS that supports writing to the out of service property and the value property of analog and binary objects.
9) Shall support the "Who is" and "I am." BACnet services.
10) Shall support the "Who has" and "I have." BACnet services.

b. Analog Input Circuits

1) The resolution of the A/D chip shall not be greater than 0.01 Volts per increment. For an A/D converter that has a measurement range of 0 to 10 VDC and is 10 bit, the resolution is 10/1024 or 0.00976 Volts per increment.
2) For non-flow sensors, the control logic shall provide support for the use of a calibration offset such that the raw measured value is added to the (+/-) offset to create a calibration value to be used by the control logic and reported to the Operator Workstation (OWS).
3) For flow sensors, the control logic shall provide support for the use of an adjustable gain and an adjustable offset such that a two point calibration concept can be executed (both a low range value and a high range value are adjusted to match values determined by a calibration instrument).

4) For non-linear sensors such as thermistors and flow sensors the AAC shall provide software support for the linearization of the input signal.

c. Binary Input Circuits

1) Dry contact sensors shall wire to the controller with two wires.
2) An external power supply in the sensor circuit shall not be required.

d. Pulse Input Circuits

1) Pulse input sensors shall wire to the controller with two wires.
2) An external power supply in the sensor circuit shall not be required.
3) The pulse input circuit shall be able to process up to 20 pulses per second.

e. True Analog Output Circuits

1) The logical commands shall be processed by a digital to analog (D/A) converter chip. The 0% to 100% control signal shall be scalable to the full output range which shall be either 0 to 10 VDC, 4 to 20 milliamps or 0 to 20 milliamps or to ranges within the full output range (Example: 0 to 100% creates 3 to 6 VDC where the full output range is 0 to 10 VDC).
2) The resolution of the D/A chip shall not be greater than 0.04 Volts per increment or 0.08 milliamps per increment.

f. Binary Output Circuits

1) Single pole, single throw or single pole, double throw relays with support for up to 230 VAC and a maximum current of 2 amps.
2) Voltage sourcing or externally powered triacs with support for up to 30 VAC and 0.5 amps at 24 VAC.

g. Program Execution

1) Process control loops shall operate in parallel and not in sequence unless specifically required to operate in sequence by the sequence of control.
2) The application shall have the ability to determine if a power cycle to the controller has occurred and the application programmer shall be able to use the indication of a power cycle to modify the sequence of controller immediately following a power cycle.

h. Local Interface

1) The controller shall support the connection of a portable interface device such as a laptop computer or vendor unique hand-held device. Via this local interface, an operator shall be able to:

a) Adjust application parameters.
b) Execute manual control of input and output points.
c) View dynamic data.

7. Application Specific Devices

a. Application specific devices shall have fixed function configurable applications.
b. If the application can be altered by the vendor's application programmable tool, the device is an advanced application controller and not an application specific device.
c. Application specific devices shall be BTL certified

E. DDC SENSORS AND POINT HARDWARD

1. Temperature Sensors

a. Acceptable Manufacturers: Veris Industries
b. All temperature devices shall use precision thermistors accurate to +/- 1 degree F over a range of –30 to 230 degrees F. Space temperature sensors shall be accurate to +/- .5 degrees F over a range of 40 to 100 degrees F.
c. Room Sensor: Standard space sensors shall be available in an [off white] [black] enclosure made of high impact ABS plastic for mounting on a standard electrical box. Basis of Design: Veris TW Series

1) Where manual overrides are required, the sensor housing shall feature both an optional sliding mechanism for adjusting the space temperature setpoint, as well as a push button for selecting after hours operation.
2) Where a local display is specified, the sensor shall incorporate an LCD display for viewing the space temperature, setpoint and other operator selectable parameters. Using built in buttons, operators shall be able to adjust setpoints directly from the sensor.

d. Duct Probe Sensor: Sensing element shall be fully encapsulated in potting material within a stainless steel probe. Useable in air handling applications where the coil or duct area is less than 14 square feet. Basis of Design: Veris TD Series
e. Duct Averaging Sensor: Averaging sensors shall be employed in ducts which are larger than 14 square feet. The averaging sensor tube shall contain at least one thermistor for every 3 feet, with a minimum tube length of 6 feet. The averaging sensor shall be constructed of rigid or flexible copper tubing. Basis of Design: Veris TA Series
f. Outside Air Sensor: Provide the sensing element on the building's north side. Sensing element shall be fully encapsulated in potting material within a stainless steel probe. Probe shall be encased in PVC solar radiation shield and mounted in a weatherproof enclosure. Operating range -40 to 122 F, Basis of Design: Veris TO Series
g. A pneumatic signal shall not be allowed for sensing temperature.

2. Humidity Wall Transmitter

   a. Acceptable Manufacturer: Veris Industries
   b. Transmitters shall be accurate to +/- 2 % at full scale.
   c. Transmitter shall have replaceable sensing element.
   d. Sensor type shall be thin-film capacitive.
   e. Sensor element shall contain multipoint calibration on-board in nonvolatile memory
   f. Operating range shall be 0 - 100% RH noncondensing, 50 to 95 F
   g. Output shall be field selectable 4-20 mA or 0-5/0-10 VDC.
   h. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
   i. Transmitter shall be available in an [off white] [black] enclosure made of high impact ABS plastic for mounting on a standard electrical box.
   j. Transmitter shall have LCD display
   k. Transmitter shall be available with a certification of NIST calibration
   l. Transmitter shall be available with an integrated temperature sensor
   m. Basis of Design: Veris HWL Series

3. Humidity Duct Transmitter

   a. Acceptable Manufacturer: Veris Industries
   b. Transmitters shall be accurate to +/-2 % at full scale.
   c. Transmitter shall be fully encapsulated in potting material within a stainless steel probe.
   d. Transmitter shall have replaceable sensing element.
   e. Sensor type shall be thin-film capacitive.
   f. Sensor element shall contain multipoint calibration on-board in nonvolatile memory
   g. Operating range shall be 0 - 100% RH noncondensing, -40 to 122 F
   h. Output shall be 4-20 mA or 0-5/0-10 VDC.
   i. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
   j. Transmitter shall be available with a certification of NIST calibration
   k. Transmitter shall be available with an integrated temperature sensor
   l. Basis of Design: Veris HD Series

4. Humidity Outdoor Transmitter

   a. Acceptable Manufacturer: Veris Industries
   b. Transmitters shall be accurate to +/- 2% at full scale.
   c. Transmitter shall be fully encapsulated in potting material within a stainless steel probe. Probe shall be encased in PVC solar radiation shield and mounted in a weatherproof enclosure.
   d. Transmitter shall have replaceable sensing element.
   e. Sensor type shall be thin-film capacitive.
   f. Sensor element shall contain multipoint calibration on-board in nonvolatile memory
   g. Operating range shall be 0 - 100% RH noncondensing, -40 to 122 F
   h. Output shall be 4-20 mA or 0-5/0-10 VDC.
   i. Transmitter shall accept 12-30 VDC or 24 VAC supply power.

j. Transmitter shall be available with a certification of NIST calibration
k. Transmitter shall be available with an integrated temperature sensor
l. Basis of Design: Veris HO Series

5. Carbon Dioxide Wall Transmitter

a. Acceptable Manufacturer: Veris Industries
b. Sensor type shall be Non-dispersive infrared (NDIR).
c. Accuracy shall be ±30 ppm ±2% of measured value with annual drift of ±10 ppm. Minimum five year recommended calibration interval.
d. Repeatability shall be ±20 ppm ±1% of measured value
e. Response Time shall be <60 seconds for 90% step change
f. Outputs shall be field selectable [Analog: 4-20mA or 0-5/0-10VDC] [Protocol: Modbus or BACnet] with [SPDT Relay 1A@30VDC] [temperature setpoint slider]
g. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
h. Temperature Range: [32° to 122°F (CO2 only)] [50° to 95°F (with humidity option)]
i. Output range shall be programmable 0-2000 or 0-5000 ppm
j. Transmitter shall be available in an [off white] [black] enclosure for mounting on a standard electrical box.
k. Transmitter shall have LCD display for commissioning and provide additional faceplate to conceal LCD display where occupants may misinterpret CO2 readings.
l. Transmitter shall be available with an integrated [humidity sensor] [temperature sensor]
m. Basis of Design: Veris CWL

6. Carbon Dioxide Duct Transmitter

a. Acceptable Manufacturer: Veris Industries
b. Sensor type shall be Non-dispersive infrared (NDIR).
c. Accuracy shall be ±30 ppm ±2% of measured value with annual drift of ±10 ppm. Minimum five year recommended calibration interval.
d. Repeatability shall be ±20 ppm ±1% of measured value
e. Response Time shall be <60 seconds for 90% step change
f. Outputs shall be field selectable Analog: 4-20mA or 0-5/0-10VDC with SPDT Relay 1A@30VDC
g. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
h. Temperature Range: 32° to 122°F
i. Output range shall be programmable 0-2000 or 0-5000 ppm
j. Enclosure shall not require remote pickup tubes and make use of integrated H-beam probe to channel air flow to sensor.
k. Enclosure lid shall require no screws and make use of snap on features for attachment
l. Enclosure shall be made of high impact ABS plastic
m. Transmitter shall have LCD display
n. Transmitter shall be available with an integrated [humidity sensor] [temperature sensor]
o. Basis of Design: Veris CDL

7. Air Pressure Transmitters

   a. Acceptable Manufacturers: Veris Industries
   b. Sensor shall be microprocessor profiled ceramic capacitive sensing element
   c. Transmitter shall have 14 selectable ranges from 0.1 – 10" WC
   d. Transmitter shall be +/- 1% accurate in each selected range including linearity, repeatability, hysteresis, stability, and temperature compensation.
   e. Transmitter shall be field configurable to mount on wall or duct with static probe
   f. Transmitter shall be field selectable for Unidirectional or Bidirectional
   g. Maximum operating pressure shall be 200% of design pressure.
   h. Output shall be field selectable 4-20 mA or 0-5/0-10 VDC linear.
   i. Transmitter shall accept 12-30 VDC or 24 VAC supply power
   j. Response time shall be field selectable T95 in 20 sec or T95 in 2 sec
   k. Transmitter shall have an LCD display
   l. Units shall be field selectable for WC or PA
   m. Transmitter shall have provision for zeroing by pushbutton or digital input.
   n. Transmitter shall be available with a certification of NIST calibration
   o. Basis of Design: Veris model PXU.

8. Liquid Differential Pressure Transmitters
   a. Acceptable Manufacturer: Veris Industries
   b. Transmitter shall be microprocessor based
   c. Transmitter shall use two independent gauge pressure sensors to measure and calculate differential pressure
   d. Transmitter shall have 4 switch selectable ranges
   e. Transmitter shall have test mode to produce full-scale output automatically.
   f. Transmitter shall have provision for zeroing by pushbutton or digital input.
   g. Transmitter shall have field selectable outputs of 0-5V, 0-10V, and 4-20mA.
   h. Transmitter shall have field selectable electronic surge damping
   i. Transmitter shall have an electronic port swap feature
   j. Transmitter shall accept 12-30 VDC or 24 VAC supply power
   k. Sensor shall be 17-4 PH stainless steel where it contacts the working fluid.
   l. Performance:
   m. Accuracy shall be ±1% F.S. and ±2% F.S. for lowest selectable range
   n. Long term stability shall be ±0.25%
   o. Sensor temperature operating range shall be -4° to 185°F
   p. Operating environment shall be 14° to 131°F; 10-90% RH noncondensing
   q. Proof pressure shall be 2x max. F.S. range
   r. Burst pressure shall be 5x max. F.S. range
   s. Transmitter shall be encased in a NEMA 4 enclosure
   t. Enclosure shall be white powder-coated aluminum
   u. Transmitter shall be available with a certification of NIST calibration
   v. Transmitter shall be available as preinstalled on a bypass valve manifold
   w. Basis of Design: Veris PW

9. Current Sensors

a. Current status switches shall be used to monitor fans, pumps, motors and electrical loads. Current switches shall be available in split core models, and offer either a digital or an analog signal to the automation system. Acceptable manufacturer is Veris Industries

10. Current Status Switches

a. Acceptable Manufacturer: Veris Industries
b. General: Factory programmed current sensor to detect motor undercurrent situations such as belt or coupling loss on constant loads. Sensor shall store motor current as operating parameter in non-volatile memory. Push-button to clear memory.
c. Visual LED indicator for status.
d. Split core sensor, induced powered from monitored load and isolated to 600 VAC rms. Sensor shall indicate status from 0.5 A to 175 A.
e. Normally open current sensor output. 0.1A at 30 VAC/DC.
f. Basis of Design: Veris Model H608.

11. Liquid Flow, Insertion Type Turbine Flowmeter
a. Acceptable Manufacturer: Veris Industries
b. General: Turbine-type insertion flow meter designed for use in pipe sizes 1 1/2" and greater. Available in hot tap configuration with isolation valves and mounting hardware to install or remove the sensor from pipeline that is difficult to shut down or drain
c. Performance:

1) Accuracy ±1% of rate over optimum flow range; ≥10 upstream and ≥5 downstream straight pipe diameters, uninterrupted flow
2) Repeatability ±0.5%
3) Velocity Range: 0.3 to 20 FPS
4) Pressure Drop 0.5 psi or less @ 10 ft/sec for all pipe sizes 1.5" dia and up
5) Pressure Rating: 1000 psi @ 70°F

d. Maximum Temperature Rating: 300°F
e. Materials: Stainless Steel or Brass body; Stainless steel impeller
f. Transmitter:

1) Power Supply: 12 - 30VAC or 8 - 35VDC.

a) Output: [Frequency] [4-20 mA] [Scaled Pulse]

2) Temperature Range: 14° to 150°F
3) Display: 8 character 3/8" LCD (Optional)
4) Enclosure: NEMA 4, Polypropylene with Viton® sealed acrylic cover

g. Basis of Design: Veris SDI series

12. Dampers

a. Automatic dampers, furnished by the Building Automation Contractor shall

be single or multiple blade as required. Dampers are to be installed by the HVAC Contractor under the supervision of the BAS Contractor. All blank-off plates and conversions necessary to install smaller than duct size dampers are the responsibility of the Sheet Metal Contractor.

b. Damper frames are to be constructed of 13 gauge galvanized sheet steel mechanically joined with linkage concealed in the side channel to eliminate noise as friction. Compressible spring stainless steel side seals and acetyl or bronze bearings shall also be provided.

c. Damper blade width shall not exceed eight inches. Seals and 3/8 inch square steel zinc plated pins are required. Blade rotation is to be parallel or opposed as shown on the schedules.

d. For high performance applications, control dampers will meet or exceed the UL Class I leakage rating.

e. Control and smoke dampers shall be Ruskin, or approved equal.

f. Provide opposed blade dampers for modulating applications and parallel blade for two position control.

13. Damper Actuators

a. Damper actuators shall be electronic, and shall be direct coupled over the shaft, without the need for connecting linkage. The actuator shall have electronic overload circuitry to prevent damage. For power-failure/safety applications, an internal mechanical or electrical capacitance type, spring return mechanism shall be built into the actuator housing. Non-spring return actuators shall have an external manual gear release to allow positioning of the damper when the actuator is not powered. Belimo, Trane, or approved equal.

14. Control Valves, Belimo, Trane, JCI or approved equal.

a. Control valves shall be two-way or three-way type for two-position or modulating service as scheduled or shown. Valves 1/2" through 2" shall be bronze body or cast brass ANSI Class 250, spring loaded, Teflon packing, quick opening for two-position service. Two-way valves to have replaceable composition disc, or stainless steel ball. 2-1/2" valves and larger shall be cast iron ANSI Class 125 with guided plug and Teflon packing.

b. Body and trim style and materials shall be per manufacturer's recommendations for design conditions and service shown, with equal percentage ports for modulating service.

c. Water valves shall fail normally open or closed as scheduled on plans or as follow: Heating coils in air handlers - normally open. Chilled water control valves - normally closed. Other applications - as scheduled or as required by sequence of operation. Zone valve shall maintain their last position in the event of a power failure.

15. Electric valve actuators, Belimo, Trane, JCI or approved equal.

a. Valve actuators shall be electronic, spring return, low voltage (24VAC), and properly selected for the valve body and service. Zone valve actuator shall be sized to meet the control application and they shall maintain their last

position in the event of a power failure.

b. Actuators shall be fully proportioning and be spring return for normally open or normally closed operation as called out in the sequence of operations.

16. Butterfly Valves, Belimo, Trane, Bray, XOMOX or approved equal.

a. Butterfly valves (for 4 inch and over service only) used for automatic control shall be lug type rated for 125 psi non shock water service to 180 deg F.
b. Valve body shall be ductile iron with B Nitrite (BUNA N) or EPDM molded seat and seals.
c. Disc material shall be cast bronze of aluminum bronze with ASTM A 492 Type 416SS stainless steel stem and fittings.
d. Valves shall be tight close off suitable for end of the line service.
e. Butterfly valves used for two position control shall be line size. Valves used for modulating control shall be sized for a minimum 5 psig differential pressure at full flow.
f. Three way valve mixing or diverting configurations shall have factory provided linkage kits specifically manufactured for the piping arrangement and actuator used.

17. Airflow Measuring Stations

a. Provide a thermal anemometer using instrument grade self heated thermistor sensors with thermistor temperature sensors.
b. The flow station shall operate over a range of 0 to 5,000 feet/min with an accuracy of +/- 2% over 500 feet/min and +/- 10 ft/min for reading less than 500 feet/min.

23 09 00.3 EXECUTION

A. CONTRACTOR RESPONSIBILITIES

1. General

a. Installation of the building automation system shall be performed by the Contractor or a subcontractor. However, all installation shall be under the personal supervision of the Contractor. The Contractor shall certify all work as proper and complete. Under no circumstances shall the design, scheduling, coordination, programming, training, and warranty requirements for the project be delegated to a subcontractor.

2. Code Compliance

a. All wiring shall be installed in accordance with all applicable electrical codes and will comply with equipment manufacturer's recommendations.

3. Cleanup

a. At the completion of the work, all equipment pertinent to this contract shall

be checked and thoroughly cleaned, and all other areas shall be cleaned around equipment provided under this contract**.**

B. WIRING, CONDUIT, AND CABLE

1. All wire will be copper and meet the minimum wire size and insulation class listed below:

Wire Class	Wire Size	Isolation Class
Power	12 Gauge	600 Volt
Class One	14 Gauge Std.	600 Volt
Class Two	Per Mfr.	300 Volt
Class Three	Per Mfr.	300 Volt
Communications	Per Mfr.	Per Mfr.

2. Power and Class One wiring may be run in the same conduit. Class Two and Three wiring and communications wiring may be run in the same conduit.

3. Where different wiring classes terminate within the same enclosure, maintain clearances and install barriers per the National Electric Code.

4. Where wiring is required to be installed in conduit, EMT shall be used. Conduit shall be minimum 1/2 inch galvanized EMT. Set screw fittings are acceptable for dry interior locations. Watertight compression fittings shall be used for exterior locations and interior locations subject to moisture. Provide conduit seal-off fitting where exterior conduits enter the building or between areas of high temperature/moisture differential.

5. Flexible metallic conduit shall be used for connections to motors, actuators, controllers, and sensors mounted on vibration producing equipment. Liquid-tight flexible conduit shall be use in exterior locations and interior locations subject to moisture.

6. Junction boxes shall be provided at all cable splices, equipment termination, and transitions from EMT to flexible conduit. Interior dry location J-boxes shall be galvanized pressed steel, nominal four-inch square with blank cover. Exterior and damp location JH-boxes shall be cast alloy FS boxes with threaded hubs and gasketed covers.

7. Where allowed by code and approved by Engineer and Owner prior to bid, the space above the ceiling is a supply or return air plenum, the wiring shall be plenum rated. Teflon wiring can be run without conduit above suspended ceilings.

8. Fiber optic cable shall include the following sizes; 50/125, 62.5/125 or 100/140.

9. Only glass fiber is acceptable, no plastic.

10. Fiber optic cable shall only be installed and terminated by an experienced

contractor. The BAS contractor shall submit to the Engineer the name of the intended contractor of the fiber optic cable with his submittal documents.

C. HARDWARE INSTALLATION

1. Installation Practices for Wiring

2. All controllers are to be mounted per the manufacturer's installation documentation.

3. The 120VAC power wiring to each Ethernet or Remote Site controller shall be a dedicated run, with a separate breaker. Each run will include a separate hot, neutral and ground wire. The ground wire will terminate at the breaker panel ground. This circuit will not feed any other circuit or device.

4. A true earth ground must be available in the building. Do not use a corroded or galvanized pipe, or structural steel.

5. Wires are to be attached to the building proper at regular intervals such that wiring does not droop. Wires are not to be affixed to or supported by pipes, conduit, etc.

6. Conduit in finished areas will be concealed in ceiling cavity spaces, lenums, furred spaces and wall construction. Exception; metallic surface raceway may be used in finished areas on masonry walls. All surface raceway in finished areas must be color matched to the existing finish within the limitations of standard manufactured colors.

7. Conduit, in non-finished areas where possible, will be concealed in ceiling cavity spaces, plenums, furred spaces, and wall construction. Exposed conduit will run parallel to or at right angles to the building structure.

8. Wires are to be kept a minimum of three (3) inches from hot water, steam, or condensate piping.

9. Where sensor wires leave the conduit system, they are to be protected by a plastic insert.

10. Wire will not be allowed to run across telephone equipment areas.

D. INSTALLATION PRACTICES FOR FIELD DEVICES

1. Well-mounted sensors will include thermal conducting compound within the well to insure good heat transfer to the sensor.

2. Actuators will be firmly mounted to give positive movement and linkage will be adjusted to give smooth continuous movement throughout 100 percent of the stroke.

3. Water line mounted sensors shall be removable without shutting down the system in which they are installed.

4. For duct static pressure sensors, the high pressure port shall be connected to a static pressure probe inserted into the duct. The low pressure port shall be left open to the plenum area at the point that the high pressure port is tapped into the ductwork.

5. For building static pressure sensors, the high pressure port shall be inserted into the space via a static pressure pick-up. Pipe the low pressure port to the outside of the building.

E. ENCLOSURES

1. For all I/O requiring field interface devices, these devices where practical will be mounted in a field interface panel (FIP). The Contractor shall provide an enclosure which protects the device(s) from dust, moisture, conceals integral wiring and moving parts.

2. FIPs shall contain power supplies for sensors, interface relays and contactors, and safety circuits.

3. The FIP enclosure shall be of steel construction with baked enamel finish; NEMA 1 rated.

4. All wiring to and from the FIP will be to screw type terminals or lever nuts. Analog or communications wiring may use the FIP as a raceway without terminating. The use of wire nuts within the FIP is prohibited.

5. All outside mounted enclosures shall meet the NEMA-3R rating.

F. IDENTIFICATION

1. Identify all control wires with labeling tape or sleeves using words, letters, or numbers that can be exactly cross-referenced with as-built drawings.

2. All field enclosures, other than controllers, shall be labeled.

3. Junction box covers will be marked to indicate that they are a part of the BAS system.

4. All I/O field devices (except space sensors) that are not mounted within FIP's shall be labeled.

5. All I/O field devices inside FIP's shall be labeled.

G. LOCATION

1. The location of sensors is per mechanical and architectural drawings.

2. Space humidity or temperature sensors will be mounted away from machinery generating heat, direct light and diffuser air streams.

3. Outdoor air sensors will be mounted on the north building face directly in the

outside air. Install these sensors such that the effects of heat radiated from the building or sunlight is minimized.

4. Field enclosures shall be located immediately adjacent to the controller panel(s) to which it is being interfaced.

H. SOFTWARE INSTALLATION

1. The Contractor shall provide all labor necessary to install, initialize, start-up and debug all system software as described in this section. This includes any operating system software or other third party software necessary for successful operation of the system.

I. DATABASE CONFIGURATION

1. The Contractor will provide all labor to configure those portions of the database that are required by the points list and sequence of operation.

J. COLOR GRAPHIC DISPLAYS

1. Unless otherwise directed by the owner, the Contractor will provide color graphic displays as depicted in the mechanical drawings for each system and floor plan. For each system or floor plan, the display shall contain the associated points identified in the point list and allow for setpoint changes as required by the owner.

K. REPORTS

1. The Contractor will configure a minimum of 4 reports for the owner. These reports shall, at a minimum, be able to provide:

   a. Trend comparison data
   b. Alarm status and prevalence information
   c. System user data

L. POINT TO POINT CHECKOUT

1. Each I/O device (both field mounted as well as those located in FIPs) shall be inspected and verified for proper installation and functionality. A checkout sheet itemizing each device shall be filled out, dated and approved by the Project Manager for submission to the owner or owner's representative.

M. CONTROLLER AND WORKSTATION CHECKOUT

1. A field checkout of all controllers and front end equipment (computers, printers, modems, etc.) shall be conducted to verify proper operation of both hardware and software.

N. SYSTEM ACCEPTANCE TESTING

1. All application software will be verified and compared against the sequences of

operation.

2. Control loops will be exercised by inducing a setpoint shift of at least 10% and observing whether the system successfully returns the process variable to setpoint.

3. Test alarms in the system and validate that the system generates the appropriate alarm message, that the message appears at all prescribed destinations (workstations or printers), and that any other related actions occur as defined (i.e. graphic panels are invoked, reports are generated, etc.).

4. Perform an operational test of each unique graphic display and report to verify that the item exists, that the appearance and content are correct, and that any special features work as intended.

5. Perform an operational test of each third party interface that has been included as part of the automation system. Verify that all points are properly polled, that alarms have been configured, and that any associated graphics and reports have been completed. If the interface involves a file transfer over Ethernet, test any logic that controls the transmission of the file, and verify the content of the specified information.

23 09 00.04 SEQUENCE OF OPERATION

A. AIR HANDLING UNIT

1. The unit shall be controlled through a space mounted temperature, humidity and CO2 sensor. The sensors may be combined into a single unit.

2. Supply fan start/stop: the supply fan will be started according to the schedule. If the supply fan status does not match the commanded value, an alarm will be generated. When the supply fan status indicates the fan started, the control sequence will be enabled. Outside air damper shall be closed in unoccupied setting. In occupied mode, the damper shall modulate to maintain space CO2 setpoint.

3. Space temperature control

   a. Cooling mode. The chilled water coil control valve shall modulate to maintain space setpoint. The hot water coil control valve shall be fully closed to the coil.

   b. Heating mode. The heating coil control valve shall modulate to maintain space setpoint. The chilled water coil control valve shall be fully closed to the coil.

   c. Dehumidification mode. If the outside air temperature is above 55F (adj) and space humidity exceeds setpoint (60% adj), the chilled water coil control valve shall fully open (hot water control valve shall be closed). The unit fan shall operate at low speed. Unit shall remain in dehum mode until humidity setpoint is satisfied or space temperature drops 2F (adj) below cooling setpoint.

4. Night setback/night setup: When in "unoccupied" mode, the unit operates as a constant volume unit and will cycle as necessary to maintain the night setback zone temperature or humidity at set point.

5. A differential pressure sensor across the filter shall monitor status and alarm the BAS whenever service is required.

6. Safety:

    a. All of the safety devices are manual reset; the device that has tripped must be manually reset before restarting the air handling unit.
    b. If a temperature low limit switch senses a temperature below setpoint the supply fan will be shutdown.

7. Shutdown:

    a. When the unit is shutdown by either a stop command or system safety the unit will be set as follows:

        1) Supply fan will be off
        2) Outside air damper will close
        3) Cooling valve will close
        4) Heating valve will open

8. AHU system point list

    a. Supply fan start/stop/status
    b. Filter status
    c. Outside air damper actuator output
    d. Discharge air temperature
    e. Control valve outputs
    f. Space temperature/humidity
    g. Space CO2
    h. Low limit thermostat status

B. <u>OTHER</u>

1. Refer to fan schedule for control requirements. On fans that are operated with a switch provide integration with the BAS to allow for scheduling/fan shutdown during unoccupied hours.

2. All points (unit start/stop, temperature settings, etc.) shall be viewable and adjustable through the building graphics.

3. Provide a space mounted sensor in all areas served by ductless split systems or electric/hot water unit heaters.

DIVISION 23

SECTION 23 20 00: HVAC PIPING

23 20 00.01 GENERAL

A. SCOPE

1. The provisions of Section 23 05 00 apply to all work in this Section.

2. Furnish and install all refrigerant, chilled water, hot water, make up water, and condensate drain piping as shall be required in order to provide a complete and satisfactory system.

3. The Mechanical Contractor shall furnish and install all necessary valves and specialties to make the installation complete and as specified below. All specialty items unless otherwise noted shall be for operation on at least 125 pound psig working pressure as rated in accordance with the standards of ASA.

23 20 00.02 PRODUCTS

A. CHILLED WATER AND HOT WATER PIPING

1. All new pipe used in entire system except where otherwise shown or specified, shall be standard weight Schedule 40 black steel pipe with weights and dimensions in accordance with American Standard Association B36-10 as manufactured by National Tube Company, Birmingham Tank Company, Bethlehem Steel Company or approved equal.

2. At the contractor's option, piping 2" and smaller may be hard drawn copper tubing ASTM B 88 Type "L". Fittings for copper tubing shall be ANSI B16.18 or B16.22 solder joint fittings. Ends of pipe shall be reamed, pipe and fittings cleaned. Use only 95-5 (95% tin and 5% antimony) solder with non-corrosive flux on 1-1/4" and smaller and on 1-1/2" and larger use silver solder (Minimum 12% Silver), with a melting point greater than 1000oF. Submit solder for approval.

B. MAKE-UP WATER PIPING

1. Make-up water piping above grade, shall be Type "L" hard copper tubing with wrought copper sweated fittings. Copper pipe to conform to ASTM Specifications B-88 and fittings to conform to ASA Specifications B-16-22.

2. Joints in copper piping to be reamed, cleaned, fluxed and soldered with 95% tin, 5% antimony solder. Joints between dissimilar metals to be made with red brass fittings.

C. DRAIN PIPING

1. All drain lines shall be PVC drain pipe conforming to ASTM D 1785. Minimum of 1-1/4" unless otherwise shown. Drain lines in mechanical plenums shall be wrapped with 1" thick plenum wrap.

E. UNDERGROUND CHILL WATER PIPING

1. Pipe shall be manufactured from a PP-R resin (Fusiolen) meeting the short-term properties and long-term strength requirements of ASTM F 2389. The pipe shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All pipe shall be made in an extrusion process. All pipe shall comply with the rated pressure requirements of ASTM F 2389. All pipe shall be certified by NSF international as complying with NSF 14, NSF 61, and ASTM F 2389 or CSA B137.11. Pipe shall be suitable for use in chilled water service and shall be rated at 150 PSI at 200F.

2. Fittings shall be manufactured from a PP-R resin (Fusiolen) meeting the short-term properties and long-term strength requirements of ASTM F 2389. The fittings shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All fittings shall be certified by nsf international as complying with NSF 14, NSF 61, and ASTM F 2389 or CSA B137.11.

3. Polypropylene fittings: socket fusion, butt fusion, electrofusion, or fusion outlet fittings shall be used for fusion weld joints between pipe and fittings.

4. Mechanical fittings and transition fittings shall be used where transitions are made to other piping materials or to valves and appurtenances.

5. Polypropylene pipe shall not be threaded. Threaded transition fittings per ASTM F 2389 shall be used where a threaded connection is required.

6. Transition fittings. Plastic-to-metal transition fittings shall be PP-R one-piece fitting with threaded stainless steel, brass, or copper insert and one PP-R fusion weld joint end.

F. UNDERGROUND HOT WATER PIPING

1. Carrier pipe shall be steel ASTM A-53, Grade B., ERW (Type E) or seamless (Type S), standard weight for sizes 5" and larger, and shall be ASTM A-120/A-53, continuous weld (Type F), standard weight for sizes 4" and smaller. Seamless pipe smaller than 2" shall be ASTM A-106/A53, Grade B. Condensate return piping shall be Schedule 80. When practical, piping shall be provided in 40-foot double-random lengths. All steel piping shall have ends cut square and beveled for butt-welding. Straight sections of factory insulated pipe shall have 6" of exposed pipe at each end of field joint fabrication.

2. Polyurethane foam insulation shall be injected with one shot into the annular space between carrier pipe and jacket with a minimum thickness of one inch. Insulation shall be rigid, 90-95% closed cell polyurethane with a 2 to 3 pounds per cubic foot density and coefficient of thermal conductivity (K-Factor) of 0.14 and shall conform to ASTM C-591. Maximum operating temperature shall not exceed 250 degrees F. Insulation thickness shall be specified by calling out appropriate carrier pipe and jacket size combinations as listed on Thermacor Drawing No. A-5059 or A-5059A, as appropriate.

3. Jacketing material shall be extruded white polyvinyl chloride, consisting of clean, virgin NSF approved Class 12454-B PVC compound, conforming to ASTM D-1784,

Type 1, Grade 1. PVC jacket shall have a wall thickness in mils equal to ten times the nominal jacket diameter and shall not be less than 60-mils. High density polyethylene (HDPE), conforming to ASTM D-1248, shall be used for jacketing larger than 20". Wall thickness for HDPE jacketing shall be 90-mils for sizes 8" and smaller, 100-mils for 10" - 12", 150 mils for 14" - 22", and 225-mils for 24" and larger. Jacketing for above ground, outdoors installations shall contain ultraviolet inhibitors for protection from sunlight. No FRP jacket allowed.

4. Straight run joints are insulated using urethane foam to the thickness specified, jacketed with PVC sleeves and sealed with polyethylene backed, pressure sensitive bituminous rubber tape, 30-mils thick. Above ground installations shall use white, pressure sensitive PVC tape.

5. Fittings are factory prefabricated and preinsulated with urethane to the thickness specified, jacketed with a PVC fitting cover and then wrapped with polyethylene backed, pressure sensitive bituminous rubber tape, 30-mils thick. Carrier pipe fittings shall be butt-welded, except sizes smaller than 2" shall be socket-welded. If required by project specifications, welds shall be radiographically inspected. At the Engineer's option, and for all above ground installations, fittings shall be jacketed using thermally butt-fused mitered sections of the same jacket material used on straight pipe sections. Fittings include expansion loops, elbows, tees, reducers and anchors. At the Engineer's option, fittings may be field insulated with liquid urethane foam insulation, jacketed with a PVC fitting cover and then wrapped with polyethylene backed, pressure sensitive bituminous rubber tape, 30-mils thick. Above ground installations shall use white, pressure sensitive PVC tape.

6. Expansion/contraction compensation will be accomplished utilizing factory prefabricated and preinsulated expansion elbows, Z-bends, expansion loops and anchors specifically designed for the intended application. External expansion compensation will be provided utilizing flexible expansion bolsters, extending three feet on either side, both inside and outside the radius of the fitting.

F. REFRIGERANT PIPING

1. All refrigerant piping shall be Type "K" hard drawn copper of "ACR" tubing with wrought copper sweat fittings. All joints are to be made with hard solder such as "Sil-Fos" or "Silver Solder."

2. All joints in refrigeration pipe work shall be soldered with the use of nitrogen gas. Refrigerant piping shall be tested, evacuated, charged with nitrogen and completely dried before charging with freon.

3. All refrigerant piping underground shall be encased in plastic or PVC conduit.

4. Refrigerant piping shall include best grade brass refrigerant fittings, consisting of expansion valve, solenoid valve, sight glass with moisture indicator, filter dryer, check valves and/or specialties as may be recommended or required by the manufacturer or as shown on the drawings.

G. VALVES

1. All new valves shall be as specified below by figure number and shall be one manufacturer throughout.

2. Spring check valves shall be installed on water lines 2-1/2 inches and above. Valves shall be non-slam type of such design that closing is controlled by spring action so designed to return disc or leaves to seat at zero velocity or before reversal of flow. Disc or leaves shall be free-flowing with no greasing or counterweights required. Body shall be semi-steel, 125 psi rated. Disc or leaves and seat shall be bronze with stainless steel spring.

Manufacturer	Wafer 125#	Flanged 125#
NIBCO	W910-B	F910-B
MUELLER	91-AP	105M-AP
MISSION		

3. Butterfly valves shall be lug type and suitable for water service. Valves shall have EPDM seats suitable for temperature up to 275 degrees Fahrenheit and pressure up to 150 psig. Body shall be cast iron, disc shall be aluminum bronze, and shafts shall be stainless steel. Valves 2" to 6" shall be interim positive lock, lever operators. Valves 8" and larger shall have encased gear operators with hand whl. Bodies shall be lug type. All working parts shall be field replaceable. All valves shall be equipped with extended neck for insulation up to 2" thick. Manufacturer must certify valves (2" through 16") to be capable of providing bubble tight seal at 200 psi when used for end of line service without the need of a flange on the down stream side. Valves 18" and larger must be capable of 150 psi end of line service.

Manufacturer	Lug 150#
NIBCO	LD2000
CRANE	14-TL
STOCKHAM	LD-711-BS3-E

4. Hose end gate valves shall be screwed connection, bronze as specified above. Hose connection shall be as specified above. Hose connection shall be suitable for l/2" hose.

Manufacturer	Hose End 125#
NIBCO	T113-HC
CRANE	451
STOCKHAM	-

5. Ball valves shall be bronze, two piece construction rated for 125 SWP/400 WOG. Valves shall have full port with Teflon seats. Stem shall be of silicon bronze. Sizes 1/4"-2".

MANUFACTURER	THREADED 125#	SOLDER 125#
NIBCO	T580	S580
APOLLO	70-100	70-200
STOCKHAM	S214-BR-T-T	S214-BR-T-S

H. SPECIALTIES

1. Gaskets: This Contractor shall furnish and install at each flange connection, Johns-Manville Service Gasket N. 60, or approved equal.

2. Flow Balance Valves: Flow balance valves, where shown, shall be Bell and Gossett Circuit Setter, or approved equal, size indicated in each case. Provide (1) differential meter to be turned over to Owner with operation and maintenance manuals.

3. Automatic Control Valves: All automatic control valves shall be of the modulating or proportioning type. See temperature controls.

4. Strainers for water service with end suction pumps shall be bolted top basket type with 40-mesh monel screen. For other water service where space is insufficient for basket strainers, and for steam service strainers shall be Y-type with 40-mesh monel screen. Strainers shall have blow-down tappings, removable baskets and be iron bodied with flanged ends.

5. Pressure gauges shall be designed for the service. Gauge size shall be 4-1/2" diameter with black lettering on a white field. Provide snubber and shutoff cock. Gauge scale shall be twice the normal pressure of the line in which it is installed. Gauge shall be Bourdon tube type with bushed movement and cast aluminum case. Accuracy shall be 90% of the entire range. Gauges no higher than 6' above finish floor. Scale range shall be 0-100 psi.

6. Pipe thermometers shall be adjustable angle type and shall be provided with extensions for all thermometers mounted through insulation. thermometers shall have ranges suitable for the service. Minimum length shall be 12" and each graduation of the scale shall represent not more than 20F. All exposed parts of the thermometer, except the case, shall be heavy chrome plated brass.

7. Flow indicators shall be Bell and Gossett Type TFI, or equal (size as required).

23 20 00.03 EXECUTION

A. PIPE AND PIPE FITTINGS

1. Provide all piping and connections to all items of equipment as shown and/or required to fully complete the system indicated, including drains and other connections. The drawings show the arrangement desired and the Contractor shall follow the drawings as accurately as possible. If conflict should arise, the Contractor shall verify all measurements on the job and cut pipe unless specifically noted for expansion loops. All piping shall be reamed or filed and cleaned to remove burrs and other obstructions.

2. The Contractor shall be responsible for installing all piping work in a neat workmanlike manner. This shall be interpreted to mean that all piping shall be neatly aligned, installed and supported in equally spaced parallel runs using trapeze hangers where applicable, install square, true and plumb with walls, equipment or other related surfaces using standard fittings. Any pipe work installed in a disorderly or unworkmanlike manner as adjudged by the Architect shall be corrected by the Contractor at the Contractor's expense.

B. CHILLED WATER AND HOT WATER PIPING

1. Piping and Pipe Work: Grade all piping properly to insure noiseless circulation of water without formation of pockets. Unless otherwise called for in the plans and specifications, horizonal pipe runs shall be graded to permit complete drainage of the system.

2. All piping 2" diameter or smaller shall be threaded. Piping 2-1/2 inches and larger shall be welded. Joints at valves and equipment in piping 2-1/2 inches and larger shall be flanged. All threads shall be cut with clean and true dies.

3. Install eccentric reducers to change size of mains installed with eccentricity up to keep the top of mains level in the piping.

4. Welding: All welding of joints in piping connections done in the field shall be in accordance with the requirements of the American Standard Code for Pressure Piping.

5. Welding may be either by Metal Arc-Welding Process of the Oxyacetylene Welding Process and in general conformance with procedures established in the latest edition of Appendix B to Section 6 of the ASA Code for Pressure Piping B31.1.

6. Welding fittings shall be used with welded piping. These shall be welding pattern in accordance with ASTM Specifications A-234 and ASA Standard B16.9. Such fittings shall be provided at all changes in direction or changes in pipe size except as hereinafter provided.

7. Weldolet or Threadolet fittings may be used in lieu of welded fittings for branch connection to size 2-1/2" and larger mains, provided branch is two or more pipe sizes smaller than the main.

8. Fittings: Fittings in welded piping shall be standard weight welding fittings, with radii of 1-1/2" the diameter and equal to Tube Turns, Ladish, Taylor Forge or approved equal. See "welding" section for lateral connections and welding fittings standards.

9. Fittings in threaded piping shall be standard weight, malleable iron, screw pattern. Except where otherwise noted, fittings shall be rated for 125 pounds per square inch gauge working pressure and shall be manufactured by Crane, Flagg, Stockham or approved equal.

10. During erection, care shall be taken to remove all dirt, scale and other foreign matter from inside the piping before tying in long sections or installing valves.

11. Copper piping:

    a. Piping shall be installed so as to be free floating. 125 pound copper sweat pattern unions shall be provided in the piping as indicated on the drawings.
    b. Unions shall be installed at each piece of equipment.

C. UNDERGROUND CHILL WATER PIPING

1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to

size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

2. Installers shall be trained and certified to install the pipe per the manufacturer's guidelines. Contact your local aquatherm representative for training.

3. Remove standing water in the bottom of trench.

4. Do not backfill piping trench until field quality-control testing has been completed and results approved.

5. Install piping at uniform grade of 0.2 percent. Install drains, consisting of a tee fitting, nps 3/4 (dn 20) ball valve, and short nps 3/4 (dn 20) threaded nipple with cap, at low points and elsewhere as required for system drainage. Install manual air vents at high points.

6. In conduits, install drain valves at low points and manual air vents at high points.

7. Install components with pressure rating equal to or greater than system operating pressure.

8. Install piping free of sags and bends.

9. Install fittings for changes in direction and branch connections.

10. Thrust blocks shall not be required with pp-r piping.

11. Expansion loops shall not be required for direct buried underground pp-r piping.

12. Joint construction

    a. Ream ends of pipes and tubes and remove burrs.
    b. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
    c. Fusion joints: fusion join polypropylene pipe in accordance with astm d2657, astm f 2389, and the manufacturer's instructions.
    d. Flanged joints: select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

13. Identification. Install continuous metallic/plastic underground warning tapes during back filling of trenches for underground hydronic piping. Locate tapes 6 to 8 inches below finished grade, directly over piping. Alternatively install 8 - 10 gage copper wire at 6” - 8” directly over the pipeline. Provide warning tapes above the wire at 6” to 8” below the finished grade directly over the pipeline.

14. Field quality control

    a. While still accessible all piping shall be pressure/leak tested to the manufacturer's standards. Tests shall be carried out using water, compressed air or a mixture of the two. The test pressure shall be as indicated in the pressure leak testing procedures required by the manufacturer. Any leaks

detected shall be repaired at the contractor's expense by removing the leaking part and replacing with new parts welded per the pipe manufacturer's guidelines.

b. Prepare test and inspection reports. Deliver to architect, owner and manufacturer to obtain product warranty

D. UNDERGROUND HOT WATER PIPING

1. Pre-engineered systems shall be provided with all straight pipe and fittings factory preinsulated and prefabricated to job dimensions. Field engineered systems shall be provided with factory insulated straight pipe sections and factory prefabricated fittings, or, at the Engineer's option, field fabricated fittings insulated with kits provided by the system manufacturer.

2. Underground systems shall be buried in a trench of not less than two (2) feet deeper than the top of the pipe and not less than eighteen inches wider than the combined O.D. of all piping systems. A minimum thickness of 24 inches of compacted backfill over the top of the pipe will meet H-20 highway loading.

3. Trench bottom shall have a minimum of 6" of sand, gravel, or clean, select fill material as a cushion for the piping. All field cutting of the pipe shall be performed in accordance with the manufacturer's installation instructions.

4. A hydrostatic pressure test, as required by project specifications, shall be performed at one and one-half times the normal system operating pressure for not less than two hours. Care shall be taken to insure all trapped air is removed from the system prior to the test. Appropriate safety precautions shall be taken to guard against possible injury to personnel in the event of a failure.

5. Field service shalll be provided by a certified manufacturer's representative or company field service technician. The technician will be available at the job a minimum of three times to check unloading, storing, and handling of pipe, joint installation, pressure testing and backfilling techniques. This service will be costed as part of the project technical services required by the preinsulated pipe manufacturer.

E. BLOWING-OUT SYSTEM

1. All piping and equipment shall be thoroughly blown-out under pressure and clean of all foreign matter wasting condensate through temporary connections so long as necessary to thoroughly clean before system is placed in operation. Use every precaution to prevent pipe compound, scale, dirt, welding and other objectionable matter getting into piping system and equipment.

F. HANGERS

1. All piping shall be supported on not less than 10' centers and within 30" of each change of direction except that piping 1-1/4" size and smaller shall be supported on 8'-0" centers.

2. All piping shall be hung by means of split type wrought iron hanger rings similar to Grinnell Figure 104 except as otherwise noted. Copper piping not insulated shall be hung from copper plated hangers similar to Figure CT-97. All insulated piping shall

be hung by means of clevis type hangers sized to fit outside of insulation, Grinnell Figure 260.

3. Pipe hangers shall be supported by means of iron hanger rods from the building construction or from structural steel members, and in an approved manner. Where required, piping shall be hung from angle iron slips or suitable brackets attached to sides of masonry construction.

4. All insulated piping shall be provided with insulating protection sheet metal saddles. These shall be 20 gauge galvanized iron. Saddles shall be of a length equal to two times the outside diameter of the insulation and shall extend to above the center line of the pipe.

5. Spring type isolators and wood blocking under insulation jacket shall be provided at large piping subject to vibrations as indicated in the plans and details. Contractor shall provide spring isolator submittal indicating construction, spacing, loading and efficiency.

6. Where piping passes through masonry construction, steel pipe sleeves shall be provided, sized to allow at least 1/2" clearance around pipe or insulation where pipe is insulated. Sleeves shall be flush with finished walls and extend 1/2" above finish floors. A watertight seal shall be provided between floor and sleeve and space between pipe and sleeve shall be caulked with lead wool.

G. TEST

1. Pressure test all chilled water and hot water piping at a pressure of 150 psig for 24 hours. Architect shall be notified 72 hours before test is to be performed.

DIVISION 23

SECTION 23 25 00: WATER TREATMENT

23 25 00.01 GENERAL

A. SCOPE

1. The provisions of Section 23 05 00 apply to all the work in this Section.

2. Furnish and install water treatment including equipment required to provide a complete and satisfactory job.

B. SUBMITTALS

1. Submit the following in accordance with Section 23 05 00:

   a. Manufacturer's cuts.
   b. Certified capacity ratings.
   c. Installation instructions.
   d. Operating and Maintenance Instructions.

23 25 00.02 PRODUCTS

A. GENERAL

1. The Contractor will furnish, install and provide all equipment, chemicals and the necessary service for a Water Treatment Program. A single water treatment company shall be responsible for all products and services and be a recognized specialist in the field of industrial water treatment for a minimum of ten years. The water treatment company shall have regional water analysis laboratories, research and development facilities, plus technical service representatives located within the trading area of the job site.

B. PRE-OPERATIONAL SYSTEM CLEAN-OUT

1. All water lines and related equipment shall be thoroughly flushed out with pre-cleaning chemicals designed to remove deposition such as pipe dope, oils, loose rust and mill scale and other extraneous materials. Add recommended dosages of pre-cleaner chemical products and circulate throughout the water system. Drain, fill and flush water system until no foreign matter is observed and total alkalinity of the rinse water is equal to that of the makeup water.

C. CHEMICAL FEEDING AND CONTROL EQUIPMENT - WATER SYSTEMS

1. For each water system, contractor shall install a one-shot feeder with funnel, and air release valve. The one-shot feeder shall have a minimum capacity of the five gallons and be designed to meet the pressure requirements of the system. If an existing shot feeder is present it may be reused.

D. WATER TREATMENT CHEMICALS - WATER SYSTEM

1. Furnish one year's supply of the recommended formula for scale and corrosion protection of close recirculating system. Formulation shall not contain any ingredients which are harmful to system materials of construction.

E. TESTING EQUIPMENT

1. Furnish Mogul basic water test equipment, spare re-agents for maintaining control of program standards in the water systems. Test kits will include the following:

   a. Re-agents and apparatus for determination of corrosion inhibitor level in the water system.
   b. Re-agents and apparatus for determination of pH, P & M, alkalinity and chlorides.

23 25 00.03 EXECUTION

A. WATER TREATMENT SERVICE PROGRAM

1. The chemical supplier shall provide all consulting services for a period of one year from start-up of the cooling system which will include:

   a. Installation and system start-up procedure recommendations.
   b. Pre-operation system clean-out procedure supervision.
   c. Initial water analysis and recommendations.
   d. Training of operating personnel on proper feeding and control techniques.
   e. Periodic field service and consultation meetings.
   f. Any necessary log sheets and record forms.
   g. Any required laboratory and technical assistance.

2. All services will be provided by a qualified, full-time representative of the chemical supplier.

DIVISION 23

SECTION 23 30 00 AIR DISTRIBUTION

23 30 00.01 GENERAL

A. SCOPE

1. Furnish and install all sheet metal work shown or called for including ductwork and connections to fans and equipment.

2. 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.

3. The provisions of Section 23 05 00 apply to all the work in this Section.

B. SUBMITTALS

1. Submit the following in accordance with Section 23 05 00:

   a. Manufacturer's cuts.
   b. Certified capacity ratings.
   c. Installation instructions.

C. RELATED DOCUMENTS

1. Section 23 07 00 - Insulation.

23 30 00.02 PRODUCTS

A. GENERAL

1. 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 19 of the 2012 ASHRAE Systems and Equipment Handbook or the appropriate SMACNA Standards.

2. Duct sizes on drawings represent gross sheet metal dimensions. Allowance has been made, where applicable, for duct liner.

B. LOW PRESSURE DUCTWORK

1. Low pressure ductwork shall be constructed of zinc coated sheet steel and shall conform to the 2nd Edition of SMACNA HVAC Duct Construction Standards -Metal and Flexible, 1995, as follows:

   a. Rectangular Duct:

      1) 1" w.g. pressure class - Table 1-4.

b. Round Duct:

1) 2" w.g. pressure class - Table 3-2A.

B. GENERAL EXHAUST DUCTWORK

1. Unless otherwise noted, all exhaust ductwork shall be constructed the same as specified for low pressure ductwork.

C. FLEXIBLE DUCTWORK

1. Flexible air duct for connections between low pressure duct to diffusers shall be equal to Thermaflex M-KE. Duct shall be listed by Underwriter's Laboratories under UL 181 standards as Class 1 flexible air duct material and shall comply with NFPA Standards 90A and 90B. Duct shall be rated to operate at pressures up to 6" w.g. for sizes 10" and 4" w.g. for sizes 12" and above. Maximum length of flexible air duct shall be 6 feet.

2. Duct shall be a factory fabricated assembly composed of a polymeric liner duct bonded permanently to a coated spring steel wire helix and supporting a fiberglass insulating blanket. Outer vapor barrier shall be of fiberglass reinforced film laminate. Connections shall be made with Thermaflex, or equal, duct straps.

D. FIRE DAMPERS

1. Furnish and install, at locations shown on plans, or where required by code, fire dampers constructed and tested in accordance with UL Safety Standard 555. Each fire damper shall have 1-1/2 hour fire protection rating. In addition each fire damper shall include a 212^{o}F fusible link, and shall include a UL label in accordance with established UL labeling procedures. Damper manufacturer's literature submitted for approval prior to installation shall include comprehensive performance data developed from testing in accordance with AMCA Standard 500 and shall illustrate pressure drops for all sizes of dampers required at all anticipated airflow rates. Fire dampers shall be equipped for vertical or horizontal installation as required by the location shown. Fire dampers required by the location shown. Fire dampers shall be installed in wall and floor openings utilizing steel sleeves, angles, other materials and practices required to provide an installation equivalent to that utilized by the manufacturer when dampers were tested at UL. Installation shall be in accordance with the damper manufacturer's instructions. Fire dampers shall be style "A", "B" or "C" as required.

E. COMBINATION FIRE/SMOKE DAMPERS

1. Furnish and install at locations shown on plans, or as described in schedules, combination fire smoke dampers meeting or exceeding the following specifications. Frame shall be a minimum of 16 gage (1.52) galvanized steel formed into a structural hat channel shape with tabbed corners for specifications. Frame shall be a minimum of 16 gage (1.52) galvanized steel formed into a structural hat channel shape with tabbed corners for reinforcement. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame. The blades shall be airfoil shaped double skin construction with 14 (1.90) gage equivalent thickness. Blade edge seals shall be silicone rubber and galvanized steel mechanically locked in blade edge (adhesive or clip fastened seals not acceptable) and shall withstand 450oF. Jamb seals shall be

stainless steel flexible metal compression type. Blade action must be parallel blade or opposed as shown on the schedule.

2. Each combination fire smoke damper shall be 1-1/2 hour fire rated under UL Standard 555, and shall further be classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems under the latest version of UL555S, and bear a UL label attesting to same. Damper manufacturer shall have tested, and qualified with UL, a complete range of damper sizes covering all dampers required by this specification. Testing and UL qualifying a single damper size is not acceptable. The leakage rating under UL555S shall be no higher than leakage class 1 (4 cfm/ft. a 1" w.g. and 8 cfm/ft. at 4" w.g. or .02 m3/s/m2 at 249 Pa or .04 m3/s/m2 at 996 Pa). As part of the UL qualification, dampers shall have demonstrated a capacity to operate (to open and close) under HVAC system operating conditions, with pressures of at least 4" w.g. (996 Pa) in the closed position, and 4000 fpm (20.32m/s) air velocity in the open position.

3. In addition to the leakage ratings already specified herein, the combination fire smoke dampers and their actuators shall be qualified under UL555S to an elevated temperature of 250oF, depending upon the actuator. Appropriate electric actuators shall be installed by the damper manufacturer at time of damper fabrication. Damper and actuator shall be supplied as a single entity which meets all applicable UL555 and UL555S qualifications for both dampers and actuators. Manufacturer shall provide factory assembled sleeve of 16" (406) minimum length (contractor to verify requirement). Factory supplied caulked sleeve shall be 20 gage (.91) for dampers through 84" (2134) wide and 18 gage (1.21) above 84" (2134) wide. Damper and actuator assembly shall be factory cycled 10 times to assure operation.

4. Fusible Link. Each combination fire smoke damper shall be equipped with a fusible link which shall melt at (specifier select one) 165oF (74oC) causing damper to close and lock in a closed position.

F. ACCESS DOORS

1. Ventifabrics, Krueger or Duro-Dyne, (Min. 12" x 10" - use 16" x 12" where size permits) insulated doors shall be provided for fire dampers, control dampers, smoke dampers, smoke detectors, and other locations where shown. Door shall be minimum 24 gauge galvanized, double construction with 1" insulation complete collar mounting frame, steel butt hinges, felt gaskets, fasteners and handles. Doors shall be labeled as to function, (fire damper, smoke detector, etc.).

G. TURNING VANES

1. Turning vanes and Deflector Controls, Barber-Colman, Carnes Corporation, Kruger or Titus in length up to 18"; Aero-Dyne Duro-Dyne, or Airsan double thickness about 24" in length, installed in rails.

H. FLEXIBLE CONNECTIONS

1. Flexible duct connections shall be provided where ductwork connects to equipment; ventifabrics or Duro-Dyne 28 ounce minimum waterproof and fire retardant woven glass fabric double coated with neoprene, approved by UL. Maximum length of flexible connections shall be 10 inches.

I. MANUAL DAMPERS

1. American Warming and Ventilating Company Type DAA-P-50, opposed blade, constructed with 15 gauge steel blades. Manual dampers shall be provided with Ventlock No. 637 hand operated locking quadrants located outside of ducts. Locking quadrants shall be elevated 1-1/2" for insulation. Manual dampers 18" x 10" or smaller may be single blade type construction of 16 gauge galvanized sheet metal. Dampers of Ruskin, Krueger, Louvers and Dampers, or Advanced Air, Inc. will be acceptable.

J. SPLITTER DAMPERS

1. Install where shown and at duct splits; provide with Ventlock No. 690 self-locking device; constructed of 16 gauge galvanized steel with hemmed leading edge and reinforced at hinged side.

K. GRILLES, REGISTERS AND DIFFUSERS

1. Grilles, registers and diffusers shall be of the type, size and design as shown on the drawings and/or as specified below. Grilles within the same room or areas shall be of the same type and style to provide architectural uniformity.

2. Each supply, return and exhaust device shall be of the proper design as indicated to handle quantities of air within the space with maximum diffusion and without objectionable air movement or noise level.

3. Each supply outlet and register shall have a volume damper control operable from the front of the device with removable key. Where indicated on the drawings, all side wall registers shall be equipped with deflectors.

23 30 00.03 EXECUTION

A. DUCTWORK

1. 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.

2. 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 that 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.

3. Turning vanes shall be provided at all tees and square elbows. Turning vanes shall be factory fabricated and designed in accordance with the SMACNA or ASHRAE

Guide for formed vanes. The first set of turning vanes on the leaving side of fans shall be of the acoustical type to aid in the elimination of unit noise with the exception of room fan coil units.

4. Splitter dampers and volume extractors shall be provided in all low velocity ductwork for proper air distribution. Each damper shall be provided, lubricated bearings at both ends of the shafts, adjustments quadrant, and locking devices and shall be constructed of galvanized iron or steel sheet one gauge heavier than the duct in which they are installed. Access doors shall be located at all splitter dampers.

5. Handholes of not less than 6" x 6" shall be provided at all points where access is required. Manholes of not less than 18" x 24" shall be provided at all points where it is necessary to clean or remove parts of equipment. All access doors and handholes shall be rubber gasketed insulated type with frame and latches.

6. Install access doors at each fire damper and combination fire/smoke damper. Label all access doors.

7. All ductwork must be sealed in accordance with Seal Class C as defined in SMACNA HVAC Duct Construction Standards - Metal and Flexible, 1995.

B. DUCT HANGERS AND SUPPORTS

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

C. WALL PENETRATIONS

1. Where ducts pass through non-rated walls and is exposed to view the duct shall be finished with suitable metal collar.

2. Where ducts pass through one hour fire walls, provide not less than 1/2" clearance between the duct and combustible material. Seal the clearance space with non-combustible material retained, and the duct secured in place by steel collars of a gauge equivalent to that of the duct and fastened to both the duct and the enclosure.

3. Where fire dampers are shown or required, dampers shall be installed per manufacturer's UL listing.

D. CLEANING DUCT SYSTEMS

1. 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.

DIVISION 23

SECTION 23 34 00: FANS

23 34 00.01 GENERAL

A. SCOPE

1. The provisions of Section 23 05 00 apply to all the work in this Section.

2. Furnish and install fans as required to provide a complete and satisfactory job.

B. SUBMITTALS

1. Submit the following in accordance with Section 23 05 00:

   a. Manufacturer's cuts.
   b. Certified capacity ratings.
   c. Installation instructions.
   d. Operating and Maintenance Instructions.

23 34 00.02 PRODUCTS

A. IN-LINE FANS - DIRECT DRIVE

1. Supply or exhaust fans shall be direct driven in-line type. The square fan housing shall be four sides of heavy gauge galvanized steel. One of the sides shall be hinged and shall support the motor and wheel assembly allowing the assembly to swing out for cleaning, inspection, or service without dismantling the unit in any way. The motor shall be isolated from the air stream by a motor enclosure and shall draw cooling air from outside the fan housing.

2. The fan inlet shall be spun venturi throat overlapped by a backward curved centrifugal wheel with spun cone for maximum performance.

3. Fans shall be internally insulated with 1" thick duct liner.

4. Air and sound shall be AMCA licensed.

B. CEILING EXHAUST FAN

1. Type: The fan shall have a forward curved centrifugal wheel.

2. Housing: The fan housing shall be constructed of heavy gauge galvanized steel. The housing interior shall be acoustically lined with 1/2" thick insulation. The discharge outlet shall be adaptable for horizontal or vertical mounting.

3. Motor: The motor shall be mounted on resilient elastic grommets.

23 34 00.03 EXECUTION

A. INSTALLATION

1. Fan shall be installed in accordance with manufacturer's installation instructions.

DIVISION 23

SECTION 23 37 26: LOUVERS

23 37 26.01 GENERAL

A. DESCRIPTION

1. Work Included: Provide exterior metal louvers where shown on the Drawings, as specified herein, and as needed for a complete and proper installation.

B. QUALITY ASSURANCE

1. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

C. SUBMITTALS

1. Submit materials list of items proposed to be provided under this Section.

2. Submit manufacturer's specifications and other data needed to prove compliance with the specified requirements.

3. Submit Shop Drawings in sufficient detail to show fabrication, installation, anchorage, and interface of the work of this Section with the work of adjacent trades.

4. Submit samples of the proposed products, showing profiles, joining, and finish.

5. Submit manufacturer's recommended installation procedures which, when approved by the Architect, will become the basis for accepting or rejecting actual installation procedures used on the Work.

23 37 26.02 PRODUCTS

A. METAL LOUVERS

1. Standard Intake/Exhaust

a. Provide metal louvers in the arrangements and dimensions shown on the drawings, and with the following attributes:

1) Provide louver blades and frames fabricated from 6063-T5 alloy, with a minimum thickness of 0.081" in all sections.
2) Fabricate from extruded or roll-formed aluminum only; brake-shapes will not be acceptable.
3) Louver Depth: 6".
4) Blade Angle: Mfg. standard.
5) Blade Centers: 5 3/32".

6) Provide birdscreen of ½" square 14 ga. Aluminum, finished similar to the louvers. Install at interior side of louver.
7) Provide 70% KYNAR 500 finish, color selected by Architect.
8) Accessories: Sill and jamb extensions, flashing and wall anchors, solid blank-off panels.

23 37 26.03 EXECUTION

A. SURFACE CONDITIONS

1. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

B. INSTALLATION

1. Coordinate as required with other trades to assure proper and adequate provisions in the work of those trades for interface with the work of this Section.

2. Install the work of this Section in strict accordance with the approved Shop Drawings and the recommendations of the manufacturers as approved by the Architect, anchoring all components firmly into position in true alignment with a tolerance of one in 1000 vertically and horizontally. Use concealed stainless steel fasteners.

3. Coordinate installation of these fixed louvers with any operable louvers provided in the mechanical section. The entire louvered opening shall be caulked and sealed at the edges to minimize water penetration.

DIVISION 23

SECTION 23 73 16: BLOWER COIL AIR HANDLING UNIT

23 73 16.01 GENERAL

A. SCOPE

1. The provisions of Section 23 05 00 apply to all the work in this Section.

2. Furnish and install blower coil air handling unit as required to provide a complete and satisfactory job.

B. SUBMITTALS

1. Submit the following in accordance with Section 23 05 00:

   a. Manufacturer's cuts.
   b. Certified capacity ratings.
   c. Installation instructions.
   d. Operating and Maintenance Instructions.

23 73 16.02 PRODUCTS

A. BLOWER COIL AIR HANDLING UNITS

1. General: Manufacturer shall provide unit arranged for draw through application. Blow through is not acceptable due to condensate carryover.

2. Hydronic Coils: Copper tubes mechanically expanded into evenly spaced aluminum fins rated for 200 psig and 200 degrees F. Coils shall be capable of being rotated in the field for left hand or right hand connection. Provide drain pan under main coil with primary and auxiliary drain connections on coil connection side.

3. Drain Pan: Drain Pan(s) shall be constructed of 304 stainless steel. Galvanized steel is not acceptable. Drain pan(s) shall have main and auxiliary drain connections with auxiliary connection higher than main connection. The drain pan shall be capable of being rotated in the field between right and left hand connections. Provide float switch in drain pan.

   a. Drain pan shall be sloped in two planes to ensure complete condensate drainage. Drain pan(s) shall have main and auxiliary drain connections with auxiliary outlet higher than main.
   b. Coil(s) shall be suspended above the drain pan to facilitate easy and complete inspection, cleaning and removal. Coil(s) may not sit in drain pan.
   c. The drain pan shall be capable of being rotated in the field between right and left hand connections.

4. Cabinet: Unit modules shall be completely factory assembled including all coils, fans, motors, drives, dampers and filters. Casing shall be manufactured of heavy gauge galvanized steel. All removable panels shall be gasketed to minimize air leakage.

a. Units shall ship as one or two modules completely factory assembled including all coils, fans, motors, drives, dampers and filters.
b. Access Panels: Removable access panels shall be provided on both sides of the unit to facilitate service access to drain pans, motors, drive components and bearings. Panels shall be gasketed. Access panel for filter removal shall be provided on both sides of the unit. Access panel fasteners shall be self-captivating to prevent loss with weld nuts or hardened steel thread clips for long term reliability. Standard sheet metal screws engaged in sheet metal are not acceptable.

5. INSULATION - Matt - Interior surface of unit casing acoustically and thermally lined with a minimum of 1 inch, R-Value 4.2, 1.9 lb./cu. ft. density glass fiber with high density facing. Insulation shall be UL listed and meet NFPA-90A and UL 181 requirements.

6. Fans: The fan shall consist of a centrifugal forward curved wheel, dynamically balanced and belt driven. Two fan wheels are not acceptable due to center bearing being inaccessible for repair or replacement. Fan shaft bearings shall be permanently sealed ball bearing with a minimum L50 design life of 200,000 hours. All drive components shall be dynamically balanced and sized for a 1.2 service factor.

7. Motors:

   a. All motors shall be EC type.
   b. All motors shall be factory installed, wired and run tested.

8. Filter: Easily removable one inch thick throwaway filter for both room air and outside air. Separate filters for outside air and room air are not acceptable. All units shall use standard filter sizes.

23 73 16.03 EXECUTION

A. INSTALLATION

1. Blower coil shall be installed in accordance with the manufacturer's recommendations.

2. Blower coil shall be installed in fully accessible locations.

DIVISION 23

SECTION 23 81 43: SPLIT SYSTEM HEAT PUMP

23 81 43.01 GENERAL

A. SCOPE

1. The provisions of Section 23 05 00 apply to all the work in this Section.

2. Furnish and install split system heat pump required to provide a complete and satisfactory job.

B. SUBMITTALS Submit the following in accordance with Section 23 05 00:

1. Manufacturer's cuts.

2. Certified capacity ratings.

3. Installation instructions.

4. Operating and Maintenance Instructions.

23 81 43.02 PRODUCTS

A. SPLIT SYSTEM HEAT PUMP (DUCTLESS)

1. Furnish and install an air cooled heat pump/direct expansion fan coil combination. The heat pump outdoor section shall be factory assembled, having direct drive fans with horizontal air discharge, reciprocating compressor, refrigerant coil fan motor(s) prewired control panel and a holding charge of refrigerant. The indoor fan coil unit shall have horizontal discharge and will include refrigerant coil, fan and motor, condensate pan with drain, thermal expansion valve, prewired control panel and remote thermostat control.

2. Refrigerant coils shall be of nonferrous construction with mechanically bonded, smooth plate fins. All tube joints shall be brazed with phoscopper or silver alloy. Coils shall be pressure tested at the factory.

3. Unit shall be furnished with direct drive, propeller type fans arranged for horizontal discharge. Condenser fan motors shall have inherent protection, and shall be of the permanently lubricated type resiliently mounted for quiet operation. Each fan shall have a safety guard.

4. Evaporator fan section shall have forward curved blade, double inlet fans mounted on a solid shaft. Fan shall be statically and dynamically balanced and shall run on permanently lubricated bearings.

5. Cabinets shall be made of galvanized steel, bonderized and finished with baked enamel.

6. Compressor shall be serviceable hermetic type. It shall be mounted so as to avoid

vibration. It shall be equipped with high and low pressure protection.

7. System Control. The system shall utilize a microprocessor controller with diagnostic capability, located in the indoor unit. Wall mounted remote control with operation indicator lamps to be used for temperature control, airflow selection rate (including automatic airflow rate change according to room temperature), heating/cooling mode selection, motorized air vane operation, economy operation selection feature, and on/off switching.

8. Room Air Dampers. Indoor unit shall have motorized air vanes which sweep air from front to back of room by modulating the horizontal air vanes in the vertical plane. Air vanes can be set in a fixed position by a switch on the remote control. Horizontal discharge shall be manually adjusted to desired direction by setting vertical vanes located behind the horizontal motorized air vanes.

9. Return Air shall be filtered by means of easily removable, washable filters. The filters shall be accessible without tools or exposure to hazardous electrical or moving parts. Provision shall be made to have a filtered outdoor air duct connection to provide fresh air to the unit.

10. Manufacturer shall have been established in the United States for a period of 5 years and shall have parts and service organizations located not more than 100 miles from the site.

23 81 43.03 EXECUTION

A. INSTALLATION

1. Fan coil and heat pump shall be installed in accordance with the manufacturer's recommendations.

2. Fan coil and heat pump shall be installed in fully accessible locations.