DIVISION 15

MECHANICALS

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PART 1 - GENERAL

1.1 Work Included:

A. The General Conditions, Supplementary General Conditions and Division 1 - General Requirements are a part of this Section.

B. Furnish all labor, materials, tools, equipment and services, necessary and incidental, to install all mechanical work and related systems shown on the Drawings, indicated in the Specification or necessary to provide a finished installation. The finished installation shall be in perfect working condition and be ready for continuous and satisfactory operation.

C. Unless specifically mentioned as work to be done by others, all instructions and requirements in Specifications and on Drawings shall be performed by the Principal Contractor for this Division of the work. The following definitions shall apply.

1. Where the word "provide" is used in connection with a system, equipment or item, it shall be construed to mean the furnishing and installing of the systems, equipment or item.

2. Where the phrase "as directed" is used, it shall be construed to mean as directed by the Architect or his authorized representative.

D. The installation of the mechanical systems shall include, but not be limited to, the following:

1. Provide modification of existing soil and vent system to accommodate new architectural layout.

2. Provide modification of existing domestic water distribution system to accommodate new architectural layout.

3. Provide modification of existing natural gas distribution system from the meter to all gas appliances.

4. Provide mechanical demolition as indicated on drawings.

5. Provide single zone air handling unit.

6. Provide inline return air fan.

7. Provide variable refrigerant flow system.

8. Provide dedicated outside air system.

9. Provide extension of existing fire protection systems.

10. Provide RWC piping modifications.

11. Provide steam to hot water convertor.

12. Provide heating hot water pumps, piping modifications.

13. Provide an air distribution system to include registers, grilles, diffusers and all other duct appurtenances.

14. Provide exhaust fans.

15. Provide air conditioning condensate piping.

16. Provide chilled water piping modifications.

1.2 Related Work:

A. Division 1 - General

B. Division 2 - Sitework

C. Division 3 - Concrete

D. Division 5 - Metals

E. Division 16 - Electrical

1.3 Quality Assurance:

A. Qualification of Manufacturers:

1. Products used in the work of this Section shall be produced by manufacturers regularly engaged in manufacture of similar items and with a history of satisfactory production acceptable to the Engineer.

B. Qualification of Contractors:

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 installation of the work of this Section and of the work in the other required sections.

2. Contractors are to be licensed and qualified to make mechanical installations.

C. Codes and Standards:

1. All equipment furnished under this Specification shall be free from defects in workmanship and materials. All equipment, systems and work shall meet the requirements of the latest edition published by the following organizations as minimum standards.

   National Fire Protection Association.
   Air Moving and Conditioning Association.
   Underwriter's Laboratories, Inc.
   American Society of Heating, Refrigeration, Air Conditioning Engineers.
   American National Standards Institute.
   Local Plumbing Regulations.
   Sheet Metal and Air Conditioning Contractors National Association.
   Local Gas Supplier Requirements.

2. All work shall also meet the minimum requirements of codes and standards of local and state agencies having jurisdiction.

D. Include in the work, without extra cost to the Owner, any labor, materials, services, apparatus and drawings required to comply with all applicable laws, ordinances, rules and regulations, whether or not shown on Drawings and/or specified.

1.4 Permits and Inspections:

A. Obtain and pay for all necessary drawings, permits and certificates required by the various governing agencies having jurisdiction. Deliver to the Architect, all permits for construction before starting work and certificates of test, inspection and approval before the date of final acceptance of the job.

1.5 Review and Materials:

A. Where the Specifications and Drawings state that equipment shall be manufactured by one specified manufacturer "or approved equal", the subcontractor shall submit proposals in the form of shop drawings for alternative equipment that is equal in quality, durability, appearance, strength, performance, design, physical dimensions and arrangement to the equipment offered by the specified manufacturer.

B. The Contractor may provide a substitute that is equal to any product specified and if the Contractor wishes to provide a proposed substitute, he shall make written application to the Engineer for approval of such substitute, certifying in writing that the proposed substitute shall perform adequately the duties imposed by the general design, be similar and of equal substance to that specified and be suited to the same use and capable of performing the same function as that specified. This shall be done at least 10 days prior to bid opening. Late applications will not be considered. Approval of substitute products will be issued by addendum only.

C. Where a Subcontractor proposes to use an item of equipment other than that specified or detailed on the Drawings that is approved by the Engineer and that

requires redesign of the structure, partitions, foundations, piping, wiring or any other part of the mechanical, electrical or architectural layout, then such redesign, additional work, new drawings and detailing required for it shall be provided without extra compensation.

PART 2 - PRODUCTS

2.1 Equipment:

A. All equipment shall be the capacity and types specified and as shown on the Equipment Schedule in the Drawings and shall be the listed manufacturer and model number or shall be an equal approved in advance by the Engineer.

B. All materials and equipment furnished and installed under this division of the Contract shall be new, of standard first grade quality and correctly designed for their specific purpose.

C. All equipment and materials furnished shall be the manufacturer's standard item of production unless specifically specified or required to be modified to suit job conditions. Sizes, material, finish, dimensions and the capacities for the specified application shall be published in catalogs for national distribution by the manufacturer. Ratings and capacities shall be certified by a recognized rating bureau.

D. All materials and equipment of one and the same kind, type or classification and used for identical purposes shall be made by the same manufacturer.

PART 3 - EXECUTION

3.1 Local Conditions:

A. Examine the premises and observe the conditions under which work will be done and all other circumstances which will affect the mechanical work before submitting bid. The submittal of a bid will indicate that the Mechanical Contractor has full knowledge of the problems involved in the performance of the work.

B. Verify, in the field, scale dimensions on plans.

C. Contractor shall note that portions of the existing building will remain operational during construction.

D. Check architectural, structural and electrical plans to avert possible installation conflicts.

E. Prior to installation of materials and equipment, discrepancies between plans and actual field conditions or between plans and specifications shall promptly be brought to the attention of the Architect for a decision.

3.2 Mechanical Drawings:

A. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the Contract. Drawings are not to be scaled. The Architectural Drawings and details shall be examined for exact location of fixtures and equipment. Where they are not definitely located, this information shall be obtained from the Architect.

B. The Contractor shall follow Drawings in laying out work and check drawings of other trades to verify spaces in which work shall 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.

C. The locations shown on the Drawings are approximate and are to serve as a guide for installation. The shifting of locations to meet field conditions (before installation) will be expected and this shall be done at no increased cost.

D. The general arrangement of ducts, piping and equipment shall be as shown on the Contract Drawings. Detailed drawings of proposed changes because of field conditions or other causes shall be submitted to the Architect for approval. Such changes shall be made without additional cost to the Owner. The Contractor shall carefully examine all Contract Drawings and shall be responsible for the proper fittings of materials and equipment in each location, as indicated.

3.3 "As Built" Drawings:

A. A separate set of white background Mechanical prints marked in red ink "As Built" shall be kept in good condition at the job site during progress of construction. Mark to indicate changes as they occur in the field installation of equipment.

B. Show location of equipment, pipes, etc.

C. At all times, these Drawings shall be up-to-date and available at the site for verification. Before final payment is approved, the Drawings shall be made correct and delivered to the Architect.

D. At the completion of the job, the contractor shall obtain the AutoCAD drawing files from the Engineer at cost ($50.00) and update file from the “as-built” drawings. The updated AutoCAD files shall also be delivered to the Architect.

3.4 Coordination With Other Trades:

A. The Contractor shall coordinate the mechanical work with all other trades. All work shall be so arranged that there will be no delay in the proper installation and completion of any part or parts of all piping systems and mechanical equipment. All mechanical work shall be installed in proper sequence with other trades without any unnecessary delay.

B. The Contractor shall confer with all subcontractors engaged in the construction of the project, regarding work which may in any way affect his installation. Whenever interferences occur, before installing any of the work in question, the Contractor shall consult with all subcontractors and shall come to an agreement with them as to the exact location and level of his piping and/or parts of his equipment.

C. The Contractor shall be solely responsible for the proper arrangement of his piping and equipment.

3.5 Operations and Maintenance Manuals:

A. Furnish 3 sets of Operation Manuals in loose leaf binders. The manuals shall include:

1. Descriptive brochures on all equipment.

2. Maintenance instructions.

3. Lubrication schedule.

4. Parts list for all equipment.

5. Service phone number of installing company.

6. Table of Contents.

7. ATC diagrams.

3.6 Instruction of Owner's Representative:

A. Instruct the Owner's Representative in the proper operation and maintenance of all elements of the mechanical systems. A minimum of 8 hours shall be spent in formal instruction. Each person present at the training shall complete a sign in sheet. The sign in sheet shall have the minimum categories: name, company, signature, position held with company, training date, start time, end time & training type. At the completion of the training the contractor shall submit this form for approval.

3.7 Warranty:

A. All materials, equipment and workmanship shall be warranted to be free from defects and shall be maintained by the Contractor for a period of one year from the date of formal completion and acceptance of the project.

3.8 Completeness:

A. It is the intent of these Specifications to provide a complete system.

Completeness shall mean not only that all material and equipment has been installed properly, but that all material and equipment has been installed and has been adjusted and that, in the opinion of the Architect/Engineer, all material and equipment is operating as designed and specified.

(END OF SECTION)

PART 1 - GENERAL

1.1 Work Included:

A. Supports and Anchors.

B. Vibration Isolation.

C. Identification and Painting.

D. Flashing.

E. Sleeves.

F. Electric Motor and Coordination.

G. Accessibility.

H. Protection.

I. Thermometers and gauges.

J. Expansions.

1.2 Related Work:

A. Section 15110 - Pipe and Pipe Fittings.

B. Section 15120 – Valves, Cocks and Faucets.

C. Section 15850 - Ductwork.

D. Division 3 - Concrete.

E. Division 16 - Electrical.

PART 2 - PRODUCTS

2.1 Hangers and Supports:

A. Pipe and Equipment.

1. Clevis Hanger - Black steel, copper-plated for copper pipe or steel.

2. Trapeze Hangers - Steel channels with welded spacers and hanger rods.

3. Wall Support - Cast iron hook.

4. Vertical - Steel riser clamp.

5. Pipe Covering Saddles - 16 gauge galvanized steel (12" long, half round).

B. Sleeves shall be Schedule 40 steel pipe, flush with surface to be penetrated.

C. Thermometers and Gauges.

1. Thermometers shall be red reading mercury type, 7" scale swivel type and well socket. Weksler Type AA5 or approved equal by Trerice or Taylor.

a. Heating 30-240 degrees in 2 degree increments.

b. Chilled water 0-120 degrees in 1 degree increments.

2. Gauges shall be Bourdon type, bronze type. Aluminum or phenolic case, 4 ½" dials with gage cock, Weksler Type CA1 or approved equal by Trerice or Taylor.

a. Heating 0-60 psi in 1 psi increments.

PART 3 - EXECUTION

3.1 Vibration Isolation:

A. All equipment shall operate without objectionable noises or vibrations as determined by the Architect. If such objectionable noises or vibrations should be produced and transmitted to the occupied portions of the building by apparatus, piping, ducts or other parts of the mechanical system, the Contractor shall make the necessary changes and/or additions, as approved by the Architect without extra cost to the Owner to eliminate the noises or vibrations.

B. Provide vibration isolation as shown on the Drawings as specified by Mason, Flexonics, Vibration Mountings and Controls or Korfund.

3.2 Electrical Motors and Coordination:

A. Motors shall be of sufficient size for the duty to be performed and shall not exceed their full-rated load when the driven equipment is operating at specified capacity and under the most severe conditions likely to be encountered. Horsepower and voltage characteristics shall be as indicated. All motors shall be dripproof high efficiency unless otherwise indicated. Single-phase motors shall be furnished with built-in thermal protection. Motors shall have a minimum P.F. of 90% or provide power factor corrective devices as required for motors with H.P. greater than 1.5.

B. Provisions of Division 16 apply to all wiring required under this Division.

C. Provide to the Electrical Contractor, data on all equipment to be furnished under Division 15.

3.3 Accessibility:

A. Provide access doors or panels for concealed portions of the work requiring accessibility for operation and maintenance. Minimum door size is 12" x 12". Door to be same rating as system in which they are installed.

B. Install all mechanical work to permit removal (without damage to other parts) of fan shafts and wheels, filters, belt guards, sheaves and drives and all other parts requiring periodic replacement or maintenance.

3.4 Protection and Tests:

A. Tests.

1. Leave concealed or insulated work uncovered until required tests have been completed.

2. Conduct pressure, performance and operating tests as required for each system or equipment unit in the presence of the Architect/Engineer or their designated representative.

3. Obtain certificates of approval in compliance with regulations or agencies having jurisdiction.

4. Testing shall prove conclusively that the work is in accordance with these Specifications.

B. Protection.

1. The Contractor shall protect all work and material from damage by his work or workmen and shall be liable for all damage thus caused.

2. The Contractor shall be responsible for work and equipment until 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 are not immediately installed. He shall close open ends of work with temporary covers or plugs during storage and construction to prevent entry of obstructing material.

3.5 Cutting and Patching:

A. Refer to the General Conditions for cutting and patching responsibility.

B. Other Divisions of this Contract will provide sleeves through new concrete, walls and slabs and will construct chases for pipes and ducts in new walls, providing this Division furnished accurate information in time to do the work. If the data is incorrect or not given in time, this Division is responsible for the required cutting.

C. No cutting of structural members or the drilling of holes through beams shall be done without the specific permission of the Architect.

3.6 Sleeves:

A. Provide sleeves for all pipes passing through wall, foundation and partitions by galvanized steel sleeves through the full thickness of construction. Sleeve shall be a minimum of ½" larger than enclosed pipe and insulation. Terminate floor sleeves 1" above finished floor. Caulk sleeves on walls and floor with fire rated caulk. Penetrations of fire-rated assemblies shall be sealed with a UL rated fire-retardant sealer system.

3.7 Hanger and Supports:

A. Pipe hangers for service on all horizontal overhead runs of pipe shall be of heavy wrought iron or malleable iron construction, approved adjustable type, designed to permit withdrawal and replacement of hangers without dismantling the pipe and of a size proportionate with the weight of the pipe supported.

1. Insulated copper tubing - black steel clevis hanger with pipe covering protection saddles sized for the insulating diameter.

2. Uninsulated copper tubing - copper-plated black steel clevis hanger.

3. Uninsulated steel pipe - black steel clevis hanger.

4. Insulated steel pipe - black steel clevis hanger with pipe covering protection saddles sized for the insulating diameter.

3.8 Identification and Painting:

A. Painting.

1. Do not paint factory enameled surfaces. Retouch as necessary to restore finish to original condition.

2. Carefully clean all other portions of the work and leave in "First Class" condition for painting. Painting is under another division of this Contract.

B. Identification.

1. All equipment shall have securely attached, a manufacturer's nameplate, giving data as to design and operation characteristics. Nameplates shall not be painted, covered or otherwise obscured.

2. All operational equipment, control devices and similar equipment shall have nameplates giving the name and number of the item of equipment. Nameplates shall be two-toned engraved or embossed plastic. Nameplates shall be securely attached to the equipment or panel or where this is not practicable, they shall be attached by brass link chains.

3. All new exposed piping through the building, all piping installed within accessible shafts and all piping installed in accessible spaces above ceilings under this Division shall have stenciled legend, giving the nature of the service, i.e., "Hot Water Return", together with stenciled arrows indicating the direction of flow. Characters to be not less than 1 ½" high, generally, and not less than 2" high where the pipes are 12' or more above the floor. Legends and arrows shall be placed adjacent to each change of direction and intermediately not over 50' apart. Pipe legends shall conform to ANSI color code A13.14975.

C. Valves.

1. Identify all valves provided under this Division with a grommeted tag attached to the valve by a brass chain.

2. Tag information to include valve number and service of valved line.

3. Provide additional metal signs attached to adjacent pipe by brass chains, giving pertinent warnings, sequencing information, etc., as required.

4. Prepare lists of all valve tags, giving the number and location of each valve and the equipment or portion of the system controlled. Prepare separate lists for each of the piping services, color-coded to match the valve tags and prepared with consecutive numbers for all valves within the same zone.

5. Provide one copy of all valve tag lists, each enclosed in a glazed metal or hardwood frame with glass cover and hung where directed.

6. Provide one copy of all start-up procedures, valve positioning, sequencing, switch-overs, pertinent warnings, etc., for all systems, enclosed in glazed metal or hardwood frames and hung where directed.

7. Provide 3 bound copies of all valve tag lists and start-up procedures (see 5 and 6 above) prepared in directory form, as approved.

3.9 Flashing and Counter Flashing:

A. Flashing of all roof openings will be under another division of this Contract except that the work in this Division includes flashing of vents. Coordinate with roofer on flashing boot.

B. Provide weatherproof and watertight counterflashing for all roof openings required for the work in this Division.

3.10 Anchor Bolts:

A. Provide and set in place, at the time foundations, bases and curbs are poured, all anchor bolts as required for the work.

B. Set bolts in pipe sleeves of approximately twice the bolt diameter and length equal to the embedded length of the bolt.

C. When the equipment is set in its proper position, the bolt sleeves and space between the rough foundations, bases or curbs of the equipment shall be completely filled with thin cement grout.

3.11 Concrete Foundations and Bases:

A. All concrete and reinforcing required for the work, except backfill, shall be provided under this division of the Contract. Concrete work shall conform to Division 3 Concrete. All pads shall extend 6" beyond machine base in all directions with top edge chamfered. Insert 6" steel dowel rods into floors to anchor pads.

3.12 Escutcheons:

A. Provide all exposed plumbing short branch connections to fixtures and/or equipment passing through wall or floors with pressed brass, chromium-plated, solid-type escutcheons.

3.13 Pipe Expansions:

A. The installation of all pipes shall be as to allow for expansions using offsets, expansion loops and swing joints as may be necessary to prevent undue strain on piping and connected equipment. Pipe guides shall be installed where required for proper installation of the expansion systems. Install in accordance with the standards of the Expansion Joint Manufacturer's Association.

(END OF SECTION)

PART 1 - GENERAL

1.1 Work Included:

A. Pipe, Fittings and Connections.

1.2 Related Work:

A. Section 15100 – General Products and Materials.

B. Section 15120 – Valves, Cocks and Faucets.

1.3 Quality Assurance:

A. Provide certification from the manufacturer that their product conforms to the requirements of the appropriate standard.

B. Provide welder certification.

PART 2 - PRODUCTS

2.1 Pipe and Tube:

A. Steel pipe, ANSI/ASTM A-53/A-53M, black Schedule 40.

B. Steel pipe, ANSI/ASTM A-53, black Schedule 40, Grade B.

C. Steel pipe, ANSI/ASTM A-53/A-53M, cold rolled, grooved, black schedule 40.

D. Copper tube ASTM B88, seamless type L, hard.

E. Copper tube B280, seamless type ACR, hard, capped, and cleaned.

F. PVC plastic pipe ASTM D-2665, D-1784 Schedule 40 DWV.

2.2 Pipe and Tube Joints and Fittings:

A. Steel pipe fittings, ANSI/ASME B16.3, malleable iron threaded 150 lb.

B. Steel pipe fitting, ASTM A-105, forged steel, butt weld.

C. Steel pipe fittings, ASTM A-105, grooved steel.

D. Wrought copper, solder joint, ANSI/ASME B16.22.

E. PVC plastic drainage, ANSI/ASTM D-2665, D-1784.

2.3 Unions:

A. Malleable iron unions, galvanized, Class I (150 psi), bronze-to-iron ground joint, Federal Specification WW-W531, ASTM A-126, ASTM-153.

PART 3 - EXECUTION

3.1 Materials:

A. Domestic Water Piping.

1. Above ground, type L, copper tubing (hard) with wrought fittings.

B. Sanitary, Storm Water and Vent Piping.

1. Above ground, plastic PVC Schedule 40 DWV with PVC drainage fittings.

C. Natural Gas Piping.

1. Above ground, steel pipe, black, Schedule 40 with malleable iron threaded fittings.

D. Chilled Water, Heating Water Piping.

1. 2" and below: Type L copper tubing (hard) with wrought fitting.

2. Greater than 2": Welded steel pipe, black, Schedule 40 with forged welded fittings or flanges.

E. Sprinkler Piping.

1. Steel pipe black, Schedule 10, (2 ½" and greater), Schedule 40 (2" and smaller) malleable fittings, welded fittings, or grooved.

F. Condensate.

1. Schedule 40 PVC pipe and drainage fittings.

G. Steam Piping and Steam Condensate.

1. Steel pipe black, Schedule 40 with forged or welded fittings.

H. Refrigerant Piping.

1. Copper tube type "ACR" hard capped and cleaned with brazed silfoss connections.

3.2 Installation - General:

A. For purposes of clearness and legibility, piping drawings are essentially diagrammatic and indicate only sizes, connection points and routes. It is not intended or implied that all offsets, rises and drops are shown. Install piping as required to fit structure, avoid obstruction and retain clearances, access, headroom, openings and passageways.

B. Run all piping parallel and straight with adjacent walls or ceilings. Run concealed in finished rooms.

C. Set all rough-ins exactly to measurements furnished by the manufacturer, except as noted on the Drawings or in the respective equipment schedule.

D. Use fittings for all offsets or changes in direction of piping. Springing, bending, or forcing of pipe is prohibited.

E. Run piping free of traps, sags, or bends. Grade and valve for complete drainage and control of the system.

F. Keep all openings in the work covered or plugged to prevent accumulation of obstructions in the system.

G. Cut pipe and tubing squarely and remove burrs to full diameter of pipe. Remove metal particles and clean each section of foreign materials before assembling.

H. Cut pipe threads to full depth of die. Threads to comply with ASA B2.1 and to be cut with clear, sharp dies.

I. Piping shall include all vents required and low points of the system shall included drain valves and hose connections.

J. Pressure piping shall be neither embedded in concrete nor concealed below floor slab within buildings, except where specifically indicated on the Drawings.

K. No pipes shall be placed so that they will be likely to freeze unless they are fully protected against freezing by some method acceptable to the Architect.

L. Reduced fittings shall be used wherever possible. The use of bushings shall be held to a minimum. Eccentric reducers shall be used throughout, except in vertical lines, in which case, concentric reducers can be used. All connections to equipment shall be made with unions (ground joint or flanged) and elbow swings to facilitate easy removal of equipment. Connections to equipment with sizes smaller than piping shall have the reduction in size made at the final connection, i.e., reducing elbow or stop.

3.3 Pipe Joints and Connection:

A. Steel Pipe.

1. Screwed pipe up through 2" - apply pipe cement or dope to the male thread only.

2. Flanged joints shall be faced true, provided with gaskets and made perfectly square and tight. All gaskets shall be as thin as the finish of the flange face permits.

3. Welded pipe 2½" and larger - All welding shall be performed by the shielded metallic arc method of fusion welding in accordance with the latest issue of the ASA Code for Pressure Piping by Certified Welders and in accordance with the recommendations of the American Welding Society. All welders shall be certified, and provide proof of certification. All butt welded joints 4" in size and smaller shall have backing rings. Welding rod shall be of the proper type and diameter for the joint being worked. Hot rods will not be permitted. All welds shall be thoroughly cleaned of slag by a wire brush or use of light pneumatic scaling hammer. Excessive crowing of the bead, deep ripples or undercutting will not be permitted. Field bevels and shop bevels shall be done by a mechanical means or by flame cutting.

4. Grooved Pipe - Grooved pipe couplings shall be Victaulic, Stockham, Grinnell, or approved equal. Couplings shall be Victaulic Style 77 and/or Style 75 or approved equal with housing fabricated in two or more parts of ductile iron castings in accordance with ASTM A536, Grade 65-45-12. Coupling gasket shall be Victaulic Grade "E" EPDM or approved equal, per ASTM D2000. Coupling bolts shall be oval neck track head type with hexagonal, heavy nuts, per ASTM A-183. All pipe fittings used with grooved couplings shall be fabricated of ductile iron or malleable iron castings in accord with ASTM A-536 or ASTM A-47. Where malleable castings are not available, standard fittings fabricated with Schedule 40 steel pipe or standard wall seamless welded fittings with grooved ends may be used. Before assembly of couplings, lightly coat pipe ends and outside of gaskets with cup grease or graphite past to facilitate installation. Pipe grooving shall be in accordance with the manufacturer's specifications contained in latest published literature.

B. Plastic PVC Pipe.

1. Form solvent joints in PVC pipe and fittings to ANSI/ASTM D-2855.

2. Cut pipe square and clean surfaces to be joined. Provide cleaning solvent and primer prior to cementing. Apply cement to both surfaces and turn the pipe slightly while inserting to assure even distribution.

C. Copper Tubing.

1. Form hot soldered joints in copper, brass or bronze fittings with 95-5 solder.

2. Defective joints shall be disassembled, cleaned and resoldered.

D. Dielectric Connections.

1. Steel or cast iron to copper pipe connections shall be made using electrolysis preventing dielectric unions. Direct contact between ferrous and nonferrous metals will not be permitted.

E. Refrigerant Piping.

1. Form hot brazed joints in copper, brass, or bronze fittings with silfoss solder.

2. Defective joints shall be disassembled, cleaned, and brazed.

(END OF SECTION)

PART 1 - GENERAL

1.1 Work Included:

A. Gate Valves.

B. Globe Valves.

C. Check Valves.

D. Plug Cocks.

E. Drain Valves.

F. Balance Valves.

1.2 Related Work:

A. Section 15110 - Pipe and Pipe Fittings.

1.3 Submittals:

A. Submit detailed shop drawings. Clearly indicate make, model, location, type, size, and pressure rating.

PART 2 - PRODUCTS

2.1 Manufacturer:

A. Provide valves of same manufacturer throughout, where possible.

B. Provide valves with manufacturer's name and pressure rating clearly marked on outside of body.

C. Valves shall be NIBCO or approved equal by DeZurik, Jenkins, Stockham or Milwaukee.

D. Balancing valves shall be Bell & Gossett Circuit Setters or approved equal by TACO or Griswold.

2.2 Gate Valves (Steam):

A. Gate valves, 125 psi S.S., 200 psi non-shock W.O.G., bronze, ASTM B-62 (2" and smaller).

1. Screwed bonnet, rising stem, solid disc, threaded or solder joint, NIBCO

T-111, S-111.

2. Screwed bonnet, non-rising stem, solid disc, threaded or solder joint, NIBCO T-113, T-123, S-113, S-123.

B. Gate valves, 125 psi S.S., 200 psi non-shock W.O.G., steel (2 ½ and larger).

1. Bolted bonnet, rising stem, solid disc, flanged joint, NIBCO F-617-0.

2. Bolted bonnet, non-rising stem, solid disc, flanged joint, NIBCO F-619.

C. Gate valves, 175 psi non-shock W.W.P (Sprinkler).

1. Bolted bonnet, UL FM approved, solid wedge disc, iron body, O,S & Y flanged joint, NIBCO F-607-0.

2. Screwed bonnet, UL FM approved, solid wedge disc, bronze body, O,S & Y threaded joint, NIBCO T-104-0.

D. Stop and waste, 125 psi.

1. Screwed bonnet, rising stem, solder joint, NIBCO 726.

2.3 Drain Valve:

A. Drain valve, bronze compression stop with hose thread. NIBCO #74.

2.4 Globe Valve:

A. Globe valve, 125 psi S.S., 200 psi non shock W.O.G., bronze (2" and smaller).

1. Screwed bonnet, rising stem, composition disc, threaded or solder joint, NIBCO T-211W,S-211W.

2.5 Plug Valve:

A. Plug Valve, 175 psi non-shock W.O.G.

1. Semi-steel, screwed joint, permanently lubricated bushing. DeZurik Figure 425 or approved equal.

2.6 Check Valve:

A. Check valve, 125 psi S.S., 200 psi non-shock W.O.G., bronze ASTM B-62.

1. Swing check, screw cap, composition disc, screwed joint, Stockham B-310 NIBCO T-413-Y.

2. Swing check, screw cap, composition disc, solder joint, Stockham B-311 NIBCO S-413-B.

2.7 Balancing Valve:

A. Bronze body/brass ball with differential pressure readout ports and calibrated name plates. Provide one calibrated meter for the building. Valve to be Bell and Gossett Circuit Setter or approved equal by Taco or Griswold.

2.8 Ball Valve:

A. Screwed joint Nibco T-580 or approved equal.

B. Solder joint Nibco S-580 or approved equal.

2.9 Vent Valves:

A. Manual Vent Valves: Provide manual vent valves designed to be operated manually with screwdriver or thumbscrew, 1/8" N.P.T. connection.

PART 3 - EXECUTION

3.1 General:

A. Install valves at all service connections and machinery or equipment, in all branch lines, at headers and at such points as may be required for sectionalizing purposes. Wherever possible, valves shall be located on the piping so that they can be reached from elements of the building with minimum recourse to the use of ladders.

B. The individual connections to equipment shall be provided with valves and unions, accessible located and arranged to permit their easy servicing or removal.

C. Valves installed in horizontal piping shall have stem no lower than the center of the pipe. Where inverted valve stem installations are necessary due to structural conditions, etc., permission must be obtained from the Architect before proceeding with valve installation.

3.2 Service:

A. Steam and Steam Condensate, Domestic Water, Chilled Water, and Heating Water.

1. 2" and smaller, Ball 125 psi solder or threaded.

2. 2 ½" and larger, Gate 125 psi flanged.

B. Natural Gas Service.

1. Plug valve 175 psi threaded

C. Sprinkler.

1. O, S&Y Gate valve 175 psi.

(END OF SECTION)

PART 1 - GENERAL

1.1 Work Included:

A. Piping Insulation.

B. Equipment Insulation.

1.2 Related Work:

A. Section 15190 - Duct Insulation.

1.3 Submittals:

A. Submit shop drawings and samples.

B. Submit shop drawings which indicate complete material data, a list of materials proposed for this project and indicate thickness of material for individual services.

1.4 Standards:

A. NFPA 255.

B. ASTM E-84.

C. UL 723.

D. ASHRAE 90.1.

PART 2 - PRODUCTS

2.1 Manufacturer:

A. Certainteed (CSG).

B. Owens-Corning.

C. Johns-Manville.

D. Knauf.

E. Armstrong.

2.2 General:

A. All insulation shall have a composite (insulation, jacket or facing and adhesive) fire hazard rating as tested by ASTM E-84, NFPA 255 or UL 723, not to exceed

25 flame spread and 50 smoke developed. Accessories such as coatings, tapes and adhesives shall have the same component ratings. All insulating materials or their containers shall have a label indicating compliance with the above rating.

2.3 Materials:

A. Cold Piping.

1. Insulation - Fine glass fiber insulation, 4 pcf with factory applied vapor barrier jacket, 'K' value at 75 degrees F of 0.26.

2. Jacket - Fire retardant vapor barrier jacket with a self-sealing lap (ASJ-SSL).

B. Hot Piping.

1. Insulation - Fine glass fiber insulation 4 pcf with factory applied general purpose jacket, 'K' value at 75 degrees F of 0.26.

2. Jacket - Fire retardant vapor barrier jacket with a self-sealing lap (ASJ-SSL).

C. Refrigerant Piping - Foamed plastic of closed cell structure, 'K' value at 75 degrees F of 0.28 with a maximum water vapor transmission rating of 0.1 perms.

D. Hot Equipment.

1. Insulation - Rigid glass fiber pipe and tank insulation 6 pcf with a 'K' value at 75 degrees F of 0.26.

2. Jacket - Fire retardant vapor barrier (ASJ).

PART 3 - EXECUTION

3.1 General:

A. Piping.

1. All pipe shall be tested before insulation, and insulation shall be applied over clean, dry surfaces, butting adjoining sections firmly together.

2. Apply insulation to pipe according to manufacturer's published recommendations. Ends of pipe insulation shall be sealed with a fire retardant vapor barrier coating at all fittings and valves and at all joints.

3. Insulate fittings with molded fiberglass fittings. All thicknesses to be equal to that of adjoining pipe covering.

B. Equipment.

1. Cut, score or miter insulation to fit contour of equipment and secure with ½" x 0.015" galvanized steel bands or 16 gage galvanized wire on 12" centers. Weld pins or stick clips with washers may be used for flat surfaces and spaced 18" apart. Stagger joints, where possible, and fill voids with insulating cement. Finish by one of the following.

2. Apply 1" galvanized wire mesh over entire surface and finish with two coats of insulating cement troweled to a hard finish.

3. Apply a smoothing coat of insulating cement. When dry, apply a coating of fire retardant lagging adhesive. Embed a layer of open weave glass cloth, overlapping all seams 2" and finish with a second coat of same adhesive.

4. Insulation with factory-applied universal glass cloth vapor barrier requires no additional finish. Joints in factory-applied facing shall be covered with 4" wide strips of same material and cemented in place.

C. Outdoor.

1. Jacket - Cover insulation exposed to outdoors with a .016 aluminum jacket with aluminum bands on 8" center.

3.2 Insulation Thickness:

A. Horizontal rainwater conductors, 1" thick fiberglass.

B. Refrigerant Piping – 1/2" thick closed cell foam.

C. Steam to Hot Water Convertor - 2" thick fiberglass.

D. Domestic hot and cold water piping - 1" thick fiberglass.

E. Heating water supply and return piping - 1" fiberglass.

F. Chilled water supply and return piping - 1 ½" fiberglass.

G. Air conditioning condensate piping: 1/2" thick fiberglass.

H. Handicapped lavatory and sink domestic water supplies and trap. Preformed PVC jacketed closed cell insulation (Truebro or approved equal).

(END OF SECTION)

PART 1 - GENERAL

1.1 Work Included:

A. Duct Thermal Insulation.

B. Duct Acoustic Insulation.

1.2 Related Work:

A. Section 15180 - Pipe Insulation.

B. Section 15850 - Ductwork

1.3 Submittals:

A. Submit shop drawings.

PART 2 - PRODUCTS

2.1 General:

A. Insulation materials shall be composite fire and smoke ratings maximum 25 for flame spread and 50 for smoke developed. Adhesives to be waterproof.

2.2 Manufacturers:

A. Manufacturer shall be Certainteed (CSG), Johns-Manville, Owens-Corning or Knauf.

2.3 Insulation type:

A. Flexible fiber glass blanket insulation, 1.0 PCF "K" factor of 0.27 at 75 degrees F. Provide with factory applied reinforced aluminum foil vapor barrier.

B. Acoustic Lining - Closed cell polymer foam insulation with a “K” factor of 0.25 at 75 degree F. The liner shall have no water absorption, no mold growth and no erosion per UL 181. Density shall be 1.5 pcf. Liner to be Imco sheet as manufactured by Imcoa or approved equal.

C. Rigid fiber glass insulation with a 'K' value of 0.24 at 75 degrees F. Provide with a factory applied reinforced aluminum foil vapor barrier. The density shall be 3 pcf.

PART 3 - EXECUTION

3.1 Preparation:

A. Test ductwork prior to covering.

B. Clean entire surface and dry prior to installation.

3.2 Insulation Schedule:

A. Supply and Return Concealed Duct.

1. Insulation – Flexible fiber glass blanket

2. Thickness – 2”

3. Facing – FSK (Foil Scrim Kraft)

B. Supply and Return Exposed Duct.

1. Insulation – Rigid fiber glass

2. Thickness – 2”

3. Facing – FSK

C. Supply and Return First Floor AHU-1 Ductwork in Addition to Wrap.

1. Insulation – Acoustic duct liner

2. Thickness – 1”

3.3 Installation:

A. Fiberglass Flexible Insulation - Insulation shall be butted with facing overlapping and sealed with fire retardant adhesive and tape. Ductwork shall be installed using a maximum compression of 25%. Ductwork over 24” wide shall be secured on the bottom of the ductwork with mechanical fasteners on 12” centers.

B. Acoustic Lining - Coated duct liner shall be cut to assure overlapped and compressed longitudinal corner joints. Apply liner with coated surface facing the air stream and adhere with 100% coverage of fire retardant adhesive. In addition secure the liner with mechanical fasteners 12" O.C. Ductwork sizes shown are net increase duct size to maintain net area. Acoustical lining shall be installed per SMACNA Standard. Pins shall be sized and installed per manufacturers’ recommendations and in no instance shall they compress the liner no more than 1/8” relative to the nominal thickness of the insulation.

C. Fiberglass Duct Board.

1. Interior - Insulation shall be fastened to duct with mechanical fasteners. Fasteners shall be spaced 12" to 18" on center with a minimum of two rows per side of duct. Secure insulation in place with washers firmly embedded in insulation. Seal all joints, breaks and punctures with fire retardant adhesive, reinforced with 3" wide strip similar to the facing.

(END OF SECTION)

PART 1 - GENERAL

1.1 Work Included:

A. Cleanouts.

B. Floor Drains.

C. Domestic Water Heaters.

D. System Scope.

E. Tests.

F. Recirculation Pumps.

1.2 Related Work:

A. Section 15110 - Pipe and Pipe Fittings.

B. Section 15450 - Plumbing Fixtures and Trim.

1.3 Submittals:

A. Submit manufacturer's product data and installation instructions.

PART 2 - PRODUCTS

2.1 Cleanouts:

A. Provide caulked or threaded type extended to finished floor or wall surface.

B. Access Covers.

1. Unfinished areas - Round with nickel bronze scored frames and plates.

2. Finished areas - Square or round with depressed center section for floor finish. Wall covers to have chromeplated caps.

C. Manufacturer.

1. Floor - Zurn ZN-1400-T or approved equal by Josam, Wade or Mifab.

2.2 Floor Drains:

A. General.

1. Provide caulked or threaded type, extended to finished floor.

2. Round or square cast iron with nickel bronze strainer.

B. Manufacturer.

1. Toilets - Zurn ZN-415S8 or approved equal by Josam, Wade or Mifab.

2.3 Domestic Water Heaters:

A. General.

1. Units shall be rated in accordance with ASHRAE 90-80.

B. Type.

1. Electric water heater shall be UL listed, factory tested, glass lining at 150 psi working pressure. Unit shall have extruded high density magnesium anode with electric element of zinc plated copper sheath. Controls shall include a thermostat and high temperature cutoff. The jacket shall provide access and enclose the fiberglass insulation. Unit shall carry a 5 year warranty and be rated under ASHRAE 90A-80.

2. Instantaneous electric water heater unit shall be complete with cast aluminum alloy casing, plastic housing with stainless steel parts and UL listed with flow control. Unit shall carry a one year warranty.

C. Manufacturer.

1. Water heaters shall be manufactured by A.O. Smith or approved equal by Lochinvar, or Ruud.

2. Instantaneous water heaters shall be manufactured by Chronomite or approved equal.

2.4 Backflow Preventer:

A. Double check type (774 Series) consisting of two spring-loaded poppet check valves, replaceable seats, two gate valves, and two test cocks. Unit to be rated at 150 psi working pressure and 210 degrees F water temperature. Unit to be Watts series 774-OSY or approved equal by Hersey Beeco, Watts, Ames or Wilkins.

1. Domestic shall be “lead free”.

2.5 Domestic Hot Water Recirculation Pumps:

A. Pumps shall be lead free, in-line type suitable for horizontal or vertical installation.

B. The body shall be bronze cast iron, 175 psi working pressure with gauge, vent, and drain ports.

C. Impeller shall be of non-ferrous material, enclosed type, dynamically balanced and keyed to shaft.

D. Seals shall be an internally-flushed mechanical seal with ceramic seat suitable for continuous operation at 225 degrees F.

E. Pumps shall be Bell and Gossett or approved equal by Amtrol/Thrush or TACO.

2.6 Condensate Pump:

A. Unit shall be constructed of a corrosion resistant, all plastic body and impeller. Corrosion resistant pump shall be energized by a mercury switch and incorporate an integral air bleed system, overflow safety switch and check valve. Unit to be 120 VAC with plug connection. Unit to be Little Giant or approved equal.

PART 3 - EXECUTION

3.1 Installation:

A. Install in accordance with specified manufacturer's recommendations.

B. Provide shock absorbers in the water supply piping at each piece of equipment and fixture having a quick closing valve in the water supply line. Shock absorbers to be sized in accordance with manufacturer's recommendations.

3.2 Scope:

A. Provide a sanitary drainage system from the existing sewer line inside the building to all new fixtures and components as shown.

B. Provide a water distribution system from the existing water line inside the building to all new fixtures and components as shown.

C. Provide a natural gas distribution system modifications to consolidate the service.

D. Provide plumbing demolition.

3.3 Tests:

A. Provide all temporary piping and connections to test the system as follows.

1. Domestic water piping, perform a hydrostatic test at 125 psi for 24 hours and prove the system tight.

2. Sanitary piping, fill the new drain and vent piping with water. Test no part of the piping with less than a 10' head of water, except the uppermost 10'. The water level must remain at the top of the system for a minimum of 30 minutes.

3. Upon completion of all tests and necessary repairs or replacements, all new hot and cold water piping shall be flushed for 10 minutes.

4. For natural gas piping, provide test of the gas piping in accordance with the local gas company's requirements.

3.4 Disinfection:

A. Completely disinfect the piping and system components with a solution of sodium hypochlorite as directed by the local health department.

(END OF SECTION)

PART 1 - GENERAL

1.1 Work Included:

A. Plumbing Fixtures.

B. Plumbing Trim.

1.2 Related Work:

A. Section 15120 – Valves, Cocks and Faucets.

B. Section 15400 - Plumbing.

1.3 Submittals:

A. Submit manufacturer's product data and installation instructions.

PART 2 - PRODUCTS

2.1 General:

A. Fixtures shall be as scheduled on the Drawings.

B. Provide new fixtures, free from flaws and blemishes, with finished surfaces clear, smooth and bright.

C. All visible portions of fixture brass and accessories shall be heavily chrome plated.

2.2 Fixtures:

A. Water closet shall be floor mounted, water-saver type with elongated bowl. Flushing system shall be flush valve. Construction shall be vitreous china with integral trap.

B. Lavatory shall be counter-mount, vitreous china, self-rimming type, oval, round or rectangular.

C. Lavatory shall be wall-mount, vitreous china or cast iron with integral overflow and splash. Provide wall bracket or concealed arm hangers.

D. Sinks shall be counter-mount, type 302 stainless steel, self-rimming with undercoating, pre-drilled 18 gauge polished to a 6K finish.

E. Electric water cooler shall be wall, floor surface or recess-mounted. Unit to be

100% lead free of stainless steel construction with HFC-134A hermetic compressor and condenser. Housing shall include integral supply grille and waste. Recessed units to be complete with rough-in box. Handicapped unit to be complete with pushbar.

F. Urinal shall be wall-mounted water saver type with integral trap. Construction shall be vitreous china.

G. Mop Basin - Shall be floor mounted molded stone with drain.

2.3 Trim:

A. Flush valve shall be exposed battery infrared type, chromeplated, diaphragm type with ADA compliant handle, vandal resistant cap, high copper-low zinc brass castings, escutcheon, integral screwdriver stop and vacuum breaker.

B. Faucets.

1. Lavatory - Chromeplated brass, battery infrared, washerless, combination supply fitting with indirect lift waste and aerator.

2. Mop Basin - Chromeplated brass, exposed wall type supply with cross handles, vacuum breaker, hose end spout.

3. Kitchen - Chromeplated brass, washerless, combination supply fitting with swivel spout, and crumb cup strainers.

C. Seats - Five ply, solid plastic, elongated, open front without cover. Complete with self-sustaining stainless steel hinge.

D. Miscellaneous.

1. Tailpieces - 17 gauge, chromeplated.

2. Trap - 17 gauge, chromeplated.

3. Flexible supplies and valve – Chromeplated with key stop.

4. Trap wrap - ADA fixtures, ASTM E-84-01.

2.4 Carriers:

A. Cast iron construction, corrosion resistant couplings, fixture bolts, trim and gaskets.

1. Urinals: Zurn ZR-1221 or approved equal by Josam or Wade.

2.5 Manufacturer:

A. Vitreous China - American Standard or approved equal by Kohler, Eljer/Zurn, or Crane.

B. Sinks (Stainless Steel) - Elkay or approved equal by Just.

C. Mop Basin - Fiat or approved equal.

D. Electric Water Cooler - Elkay or approved equal by Halsey-Taylor, Haws, or Oasis.

E. Brass – Sloan or approved equal by Delta, Kohler, Moen, Zurn or American Standard.

F. Flush Valves – Sloan “ECOS” series or approved equal by Delany or Zurn.

PART 3 - EXECUTION

3.1 Installation:

A. Install all fixtures in accordance with the manufacturer's recommendations and the plumbing code.

B. Clean all fixtures upon completion.

C. Provide suitable carriers for all wall-mounted equipment.

D. Provide rough-in dimensions per the manufacturer's recommendations.

(END OF SECTION)

PART 1 - GENERAL

1.1 Work Included:

A. Sprinkler Heads.

B. Valves.

C. Flow Switch.

D. Tamper Switch.

1.2 Related Work:

A. Section 15110 - Pipe and Pipe Fittings.

B. Section 15120 – Valves, Cocks and Faucets.

C. Division 16 - Electrical.

1.3 Submittals:

A. Prepare detailed shop drawings for the complete sprinkler system. Show the location of the heads, piping and other installation details. All drawings shall be accurately to scale in sheets of uniform size and shall provide the following data:

1. Name of Owner.

2. Location.

3. Roof and ceiling construction.

4. Water supplies.

5. Make, temperature, and type of sprinklers.

6. Number of sprinklers on each riser and total per fire area.

7. Location of all risers, mains, lines, etc.

8. Cutting length of pipe.

9. Crosses, tees, riser nipples and size.

10. Type of hangers.

11. Valve locations.

B. So that installation can be coordinated with other trades, shop drawings shall be prepared and forwarded to the Hagerstown City Fire Marshal for review and approval. Forward said shop drawings to the Architect for final review and approval before starting work.

1.4 Scope:

A. Extend the existing wet pipe fire protection system to cover the entire Washington County Admin. Complex. System extension shall be a hydraulically designed supervised wet pipe fire protection system per the drawing riser. System shall include all necessary piping, heads, valves, drains and required appurtenances for a complete approved system in accordance with the standards of NFPA, owner's insurance underwriter, and state and local agencies having jurisdiction over the installation.

PART 2 - PRODUCTS

2.1 Sprinkler Heads:

A. General.

1. All sprinkler heads shall be UL/NFPA approved. Temperature rating on fusible links to suit specific hazard area. Provide high temperature heads (286°F) within the recently renovated basement server mechanical and electrical rooms.

B. Upright Type Head.

1. Provide listed quick response brass finish spray orifice type.

C. Pendant Type Head.

1. Provide listed quick response chromeplated spray pendant type.

2.2 Valves:

A. Gate Type - O,S&Y type, 175 psi, UL approved.

2.3 Flow Switch:

A. Provide an approved flow switch for the system. Wiring to the fire alarm panel shall be by the electrical contractor.

2.4 Tamper Switch:

A. Provide electric tamper switches on O,S&Y valves. Wiring to the fire alarm panel shall be by the electrical contractor.

PART 3 - EXECUTION

3.1 General:

A. All work shall be done by a licensed shop (minimum of 5 years of experience) employing qualified sprinkler fitters, conforming to the best standards of the trade.

B. All sprinkler heads are to be located to clear mechanical and electrical items. Provide and install any additional sprinklers required by the authority having jurisdiction over the work and/or Owner's insurance underwriter.

C. Sprinkler piping shall be so installed that the system may be thoroughly drained. Pipe shall be straightened before installation to prevent pockets which would interfere with proper drainage.

D. Piping must be supported with acceptable hangers as listed in NFPA No. 13, Fig. 3510 and specified in NFPA No. 13, Sections 3500-3590. Maximum support spacing shall be 12' O.C. with no support closer than 18" to upright heads. Unsupported length between end sprinkler on branch line and the last hanger shall not exceed 2'. One inch arms over 12" long must be supported by a hanger. Install at least one hanger for each length of pipe. Where necessary, provide and install length of pipe. Where necessary, provide and install angle iron or channel trapeze for support of piping.

E. Entire system shall be installed in accordance with the regulations of National Fire Protection Association as set forth in the current edition of NFPA No. 13, and the requirements of the State of Maryland Fire Marshal.

F. Sprinkler branch piping shall be installed to drain at the main riser wherever possible.

G. Where sprinkler piping is trapped, install an approved auxiliary draw-off.

H. All draw-offs shall have a metal tag attached with the word "drain" inscribed thereon.

I. Study all plans and specifications pertaining to the other trades involved in the project and coordinate this work with the other trades.

J. All electrical wiring from the flow switches and tamper switches to the fire alarm panel shall be by the Electrical Contractor.

K. Verify all water data with local water departments prior to submitting a bid.

L. Provide wiring to remote alarm bell.

M. Install all sprinkler heads in center of tile.

N. See Section 15110 for allowable piping materials.

3.2 Testing:

A. The entire system shall be tested hydrostatically at not less than 200 psi for at least 2 hours with a loss of not more than 2 psi. The entire overhead system shall be checked to make sure that there are no leaks. All concealed joints shall be left uncovered until tests have been completed and accepted.

B. All tests shall be made in the presence of the Architect, the Owner and the Underwriter or such representative as they designate.

3.3 Certificate of Approval:

A. Upon completion of all work and tests, furnish to the Owner, a Certificate of Approval from the Owner's Insurance Underwriter, stating that all work has been inspected by their representative and that the entire automatic sprinkler system meets with all of their requirements and is approved.

3.4 Instruction of Owner:

A. Provide the Owner with 3 copies of the manufacturer's printed operating and maintenance instructions for all pieces of equipment in the system and instruct the Owner in the proper operation and maintenance of the equipment and system.

B. Provide the Owner with 3 copies of the new working drawings and a set of reproducible drawings at project completion.

3.5 Identification of Valves and Devices:

A. All drains valves and devices shall be provided with identification signs of the standard design adopted by the automatic sprinkler industry. Such signs shall be securely affixed to their respective valves and devices.

3.6 Sprinkler Cabinet:

A. Provide a wall-mounted, finished steel cabinet containing a minimum of 6 sprinkler heads and necessary sprinkler head wrenches.

(END OF SECTION)

PART 1 - GENERAL

1.1 Work Included:

A. Pumps.

B. Steam Traps.

C. Converter.

D. Expansion Tank.

E. Safety Valves.

F. Relief Valves.

1.2 Related Work:

A. Section 15110 - Pipe and Pipe Fittings.

B. Section 15120 – Valves, Cocks and Faucets.

C. Section 15180 - Insulation.

1.3 Submittals:

A. Submit shop drawings and product data.

PART 2 - PRODUCTS

2.1 Circulating Pumps:

A. Inline.

1. Pumps shall be in-line type suitable for horizontal or vertical installation.

2. The body shall be bronze cast iron, 175 psi working pressure with gauge, vent, and drain ports.

3. Impeller shall be of non-ferrous material, enclosed type, dynamically balanced and keyed to shaft.

4. Seals shall be an internally-flushed mechanical seal with ceramic seat suitable for continuous operation at 225 degrees F.

5. Pumps shall be Bell and Gossett or approved equal by Amtrol/Thrush, TACO, or Armstrong.

B. Base Mount Pump - Provide heating pumps as shown and scheduled on the drawing. The pump shall be designed for 175 psig working pressure with bronze fitted construction, cast iron casing, hydraulically and dynamically balanced, enclosed bronze impeller secured to a stainless steel shaft. The pump shall be end suction, single stage, grease lubricated with a flexible coupler to the motor including an OSHA coupling guard all mounted on a fabricated steel base. Mechanical seal shall be of the EPT, carbon and Tungsten Carbide type. Pump shall be Bell & Gossett series 1510 or approved equal by Taco, Amtrol/Thrush, or Armstrong.

2.2 Expansion Tanks:

A. Furnish and install, where indicated, approved expansion tanks of size noted. Tanks shall be of welded steel constructed in accordance with A.S.M.E. Code for unfired pressure vessels for a working pressure of 125 p.s.i.

B. Tanks shall be equipped with an air control fitting and a separate valve to drain tank.

C. Air separators for hot water heating systems shall be capable of effectively separating not less than 80 percent of the entrained air on the first passage of water and not less than 30 percent of the residual air on each subsequent passage of water.

D. All free air contained in the systems, and all entrained air bubbles carried by system water shall be eliminated at all system points. Furnish and install where indicated on the drawings. At these locations, the air separating and elimination component shall separate entrained air from flowing system water by the creation of a vortex which allows free air to rise in the center, the point of lowest velocity, to an air elimination device.

2.3 Safety Valves:

A. Steam safety valves to be iron body with bronze nozzle, disc, and guide. Safety valves to be manufactured in accordance with Section IV of ASME Boiler and Pressure Vessel Code and suitable for 15 psig at 250 degrees F.

B. Safety valves to be Model 930 as manufactured by Kunkle or approved equal.

2.4 Relief Valves:

A. Hot water relief valves to be cast iron body with bronze and brass trim. Relief valves to be manufactured in accordance with Section IV of ASME Boiler and Pressure Vessel Code and suitable for 160 psig and 250 degrees F maximum. Relief valves to be factory set for 60 psig and tamperproof.

B. Relief valves to be Model 137 as manufactured by Kunkle or approved equal.

2.5 Triple Duty Valve:

A. Provide a combination valve featuring a check valve with a liner, contoured disc and a calibrated adjustment feature permitting regulation of pump discharge flow and positive shut-off. Valves shall be designed to permit repacking under full line pressure. Unit shall be installed on discharge side of pump in a vertical position with the stem up. Allow for minimum clearance of valve stem. This unit shall be cast iron body construction suitable for maximum working pressure of 125 psig and maximum operating temperature of 300 degrees F. Units shall be as manufactured by Bell & Gossett, Taco, Amtrol/Thrush, or Armstrong.

2.6 Suction Diffuser:

A. Provide for pumps suction diffusers of size and type required by inlet flange and pipe size. Units shall consist of angle type body with inlet vanes and combination Diffuser-Strainer-Orifice Cylinder with 3/16" diameter openings for pump protection. A ceramic magnet shall be located within the flow and shall be removable for cleaning. The orifice cylinder shall be equipped with a disposable fine mesh strainer which shall be removed after system start-up. Orifice cylinder shall be designed to withstand pressure differential equal to pump shut-off head and have a free area equal to five times cross section area of pump suction opening. Vane length shall be no less than 2 ½ times the pump connection diameter. Unit shall be provided with adjustable support foot to carry weight of suction piping. Suction diffusers to be as manufactured by Bell & Gossett, Taco or Armstrong.

2.7 Air/Dirt Separator (Tangential):

A. The air separator shall be fabricate steel, constructed, tested and stamped in accordance with Section VIII of the ASME Code for a working pressure of 150 psi and bear the National Board number.

B. Air separators for hot water heating systems shall be capable of effectively separating not less than 100 percent of the entrained air on the first passage of water, 100% of the entrained air and up to 99.6% of the dissolved air in the system fluid. Dirt separation shall be at least 80% of all particles 30 micron and larger within 100 passes.

C. All free air contained in the systems, and all entrained air bubbles carried by system water shall be eliminated at all system points. Furnish and install where indicated on the drawings. At these locations, the air separating and elimination component shall separate entrained air from flowing system water by the creation of a vortex which allows free air to rise in the center, the point of lowest velocity to an air elimination device.

D. Unit to be Bell and Gossett or approved equal by TACO, Amtrol/Thrust, or Armstrong.

2.8 Steam Traps:

A. F&T - Trap shall be of the sump acting float type together with a thermostatic air vent. Trap body shall be cast iron or steel with working parts of suitable corrosion resistant material. Valves and valve seats shall be readily removable and interchangeable.

2.9 Steam to Hot Water Converter:

A. Converter shall be of ASME construction suitable for steam to hot water conversion. Unit shall be shell and tube U-bend design with removable bundle. Construction shall be steel shell, tube sheets with cast iron heads and copper tubes.

B. Unit shall be as scheduled on the drawings as manufactured by Taco or approved equal by Bell and Gossett.

PART 3 - EXECUTION

3.1 Installation:

A. Provide complete heating piping system as shown on the drawings.

B. Provide steam and condensate piping as shown.

C. Install equipment in accordance with the manufacturer's recommendations.

D. Provide chilled water modifications as shown.

3.2 Water Balancing:

A. The water distribution system shall be tested, adjusted and balanced to the quantities indicated on the contract document.

B. The Contractor shall obtain the services of independent test and balance agency that specializes in and whose business is limited to the testing and balancing of air conditioning systems. The agency selected shall be fully certified by the Associated Air Balance Council (AABC), or the National Environmental Balancing Bureau (NEBB). The agency shall submit qualifications to the Engineer for approval prior to commencing any work on this project. All final reports shall be signed by an AABC Test and Balance Engineer or a NEBB Certified Supervisor and shall include an official stamp.

C. Testing and balancing shall be performed in complete accordance with current AABC National Standards for Field Measurement and Instrumentation, or NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems applicable to water balancing.

D. Instruments used for testing and balancing of water systems must have been calibrated within a period six months and checked for accuracy prior to the start of work. Provide a list of instruments used on the project to include all serial and model numbers and calibration dates.

E. Six (6) copies of the complete test report shall be submitted to Engineer prior to final acceptance of the project.

F. The approved balancing agency shall monitor job progress during installation phase of contract to assure valves etc. are installed as shown or specified.

G. The Contractor shall submit name of the test and balance agency to the Architect and Consulting Mechanical Engineer for approval within thirty (30) days after receipt of construction contract by the air conditioning contractor. If the Contractor fails to submit the name of the selected test and balance agency within the above prescribed period, the Consulting Mechanical Engineer may select the certified AABC or NEBB agency of his choice and Contractor must then insure purchase order for this work as directed and assume all costs.

H. Balance the water flow to the quantities shown on the drawings.

I. Calibrated orifices and portable flow meters shall be used to balance water flow.

1. Water Quantity Adjustments - Pump capacities shall be determined by differential pressure measurements. Water circuits shall be adjusted by balancing cocks previously specified. All balancing cocks shall be permanently marked after balance is complete so that they may be restored to their correct position if disturbed.

2. Water Balancing Procedure - The contractor shall balance the system in accordance with the following procedures and requirements:

   a. Open all valves to full open position. Close coil bypass stop valves. Set mixing valve to full coil flow.

   b. Check pump rotation.

   c. Check expansion tanks to determine they are not air bound and the system is completely full of water.

   d. Check all air vents at high points of water systems and determine all are installed and operating freely.

   e. Set all temperature controls so all coils are calling for full heating. This should close all automatic bypass valves at coils.

   f. Check operating of automatic bypass valves.

   g. Check and set operating temperatures of heat exchangers to design requirements.

h. Complete air balance must have been accomplished before actual water balance begins.

i. Set hot water pumps to proper gallons per minute delivery.

j. Adjust water flow of hot water through converters.

k. Check leaving water temperatures and return water temperatures through the converter. Reset to correct design temperatures.

l. Check water temperatures at inlet side of heating coils. Note drop of temperatures from source.

m. Proceed to balance each hot water coil or baseboard radiator.

n. Upon completion of low readings and adjustments at baseboard, mark all settings and record data.

o. After adjustments to radiation are made, recheck settings at the pumps and converters and readjust if required.

p. Pump operating suction and discharge pressure and final T.D.H.

q. List all mechanical specifications of pumps.

r. Rated and actual running amperage of pump motor.

s. Contractor shall demonstrate a minimum of 5% random sampling to the Engineer/Owner during the system demonstration. Demonstration shall confirm the water balance report readings.

(END OF SECTION)

PART 1 - GENERAL

1.1 Work Included:

A. Electric Wall Heaters.

1.2 Related Work:

A. Division 16 - Electrical.

1.3 Standard:

A. National Electric Code.

B. UL.

1.4 Submittals:

A. Submit detailed shop drawings.

PART 2 - PRODUCTS

2.1 General:

A. All electric heating units shall be UL listed.

B. The capacity and type of unit shall be as scheduled on the drawings.

2.2 Electric Wall Heaters:

A. Casing shall be of heavy gauge steel construction with 16 gauge grille and 20 gauge housing. Unit shall be as scheduled on the Drawings.

B. The thermostat shall be unit-mounted. Provide rough-in box or surface mount as required.

C. Unit shall be manufactured by Q-Mark or approved equal by Markel, Raywall or Redd-I.

PART 3 - EXECUTION

3.1 Installation:

A. Install as shown on the plans. Protect the entire unit during construction. Install unit in accordance with the manufacturer's recommendations.

3.2 Cleaning:

A. Before putting in operation, the entire unit shall be cleaned, including coils, and any damage repaired with a satisfactory finish.

(END OF SECTION)

PART 1 – GENERAL

1.1 Work Included:

A. Sheetmetal Ductwork.

B. Duct Accessories.

C. Equipment Curb.

D. Louvers.

E. Air Balance.

1.2 Related Work:

A. Section 15860 - Exhaust Fans.

B. Section 15190 - Duct Insulation.

1.3 Quality Assurance:

A. SMACNA Duct Manuals and ASHRAE Handbooks.

B. NFPA 90A,B and 96.

1.4 Submittals:

A. Submit shop drawings and product data.

PART 2 - PRODUCTS

2.1 Ductwork:

A. Sheetmetal.

1. Galvanized - Hot-dipped galvanized sheet steel A527.

2. Weights and gauges - In accordance with SMACNA Duct Manuals and ASHRAE Handbooks.

B. Insulated Flexible Air Duct (R-6)(Duct Inside the Building Insulation):

1. Insulated flexible duct shall consist of a spiral polyester core liner with galvanized helix. Insulation shall be 2", 0.75 PCF fiberglass blanket R = 6.0) with a flame resistant aluminized reinforced vapor barrier.

2. Ducts shall be UL 181 Listed Class 1 having a maximum flame spread of 25 and maximum smoke developed of 50.

3. Length of insulated flexible duct shall not exceed four feet.

4. Insulated flexible duct shall be ATCO #076 or approved equal by Genflex or Hart & Cooley.

2.2 Fire Dampers and Fire/Smoke Dampers: (Dynamic)

A. Provide where shown on the Drawings fire dampers constructed in accordance with and as required by NFPA Pamphlet No. 90A and the Local Codes. Fire dampers in ducts shall be UL-555 labeled multi-blade type with UL approved fusible link. Links shall have 165 degree F melting points unless noted otherwise. The blades of the damper shall overlap and shall be so constructed as to remain in the closed position under fire conditions. Each damper shall be provided with a tightly fitted hinged access panel of sufficient size to make damper accessible for inspection, maintenance, and resetting. Fire dampers shall have free area equal to 95% of duct in which it is installed.

B. Provide where shown on the drawings fire/smoke dampers constructed in accordance with and as required by NFPA Pamphlet No. 90A and the Local Codes. Fire/smoke dampers in ducts shall be UL labeled multi-blade type with UL approved fusible link. Links shall have 165 degrees F melting points unless noted otherwise. In addition, provide an electric actuator to close the damper upon sensing smoke. The blades of the damper shall overlap and shall be so constructed as to remain in the closed position under fire conditions. Each damper shall be provided with a tightly fitted hinged access panel of sufficient size to make damper accessible for inspection, maintenance, and resetting. Fire/smoke dampers shall have free area equal to 95% of duct in which it is installed. Damper shall be Ruskin or approved equal by Phillips or Greenheck.

C. Fire dampers shall be Ruskin or approved equal by Air Balance, NCA, Greenheck, Untied Enertech or Prefco.

2.3 Smoke Dampers:

A. Provide where shown on the drawings smoke dampers constructed in accordance with and as required by NFPA Pamphlet No. 90A and the Local Codes.

B. Smoke dampers shall meet the requirements of UL Standard 555S.

C. Class II - Smoke damper shall leaks no more than 20 cubic feet per minute (.57 m^3/min) at 4 in. wg. (1 kPa) differential pressure.

D. Class I – Smoke damper shall leak no more than 8 cubic feet per minute (.23 m^3/min) at 4 in. wg. (1 kPa.) differential pressure.

E. Construction:

1. Frame: 5 inches x minimum 16 gage (127 x minimum 1.6 mm) roll formed, galvanized steel hat-shaped channel, reinforced at corners. Structurally equivalent to 13 gage (2.3 mm) U-channel type frame

2. Blades:
   a. Style: Single skin with 3 longitudinal grooves.
   b. Action: Opposed.
   c. Orientation: Horizontal.
   d. Material: Minimum 16 gage galvanized steel.

3. Seals:
   a. Blade: Inflatable silicone material mechanically attached to blade(glue-on or grip type seal are not acceptable)
   b. Jamb: Stainless steel, flexible metal compression type.

4. Linkage: Concealed in frame.

5. Axles: Minimum ½" diameter plated steel, hex shaped, mechanically attached to blade.

6. Actuator: External type, two position, fail close. Coordinate power requirements with section 15900 and Division 16000. Actuator shall close the damper upon sensing smoke.

7. Factory Sleeve: Minimum 20 gage thickens, 12" long.

8. Access Door: Each damper shall be provided with a tightly fitted hinged access panel of sufficient size to make damper accessible for inspection, maintenance.

9. Duct Smoke Detector: By division 1600.

F. Smoke dampers shall be Ruskin or approved equal by Air Balance, NCA, Greenheck, Untied Enertech or Prefco.

2.4 Flexible Connections:

A. Specification grade neoprene coated 30 oz./square yard canvas fastened to 24 gauge galvanized sheet steel. Durodyne Model MFN-100 or approved equal by Ventfabrics or Ductmate Industries.

2.5 Volume Dampers (Manual Balancing):

A. General.

1. Damper manufacturer's printed application and performance data including pressure, velocity and temperature limitations shall be submitted

for approval showing damper suitable for pressures to 1.0 in. wg (.25 kPa), velocities to 2000 fpm (10.2 m/s) and temperatures to 180^0 F (82^0C). Testing and ratings to be in accordance with AMCA Standard 500-D.

B. Rectangular Duct.

1. Single Blade: Volume dampers less than 10" in height shall be single blade.

a. Dampers shall consist of: a 18 gauge. (1.3mm) galvanized steel frame with 3 ½ inch (89mm) depth; blades fabricated from 20 gauge (1mm) galvanized steel; integral ½ inch (13mm) diameter axles.

b. Damper shall be Greenheck model MBD-10 or approved equal by Ruskin, Pottorff, Air Balance or American Warming and Ventilating.

2. Multiple Blade: Volume dampers 10" and greater in height shall be multiple blade.

a. Dampers shall consist of a 16 gauge (1.5mm) galvanized steel hat channel frame with 5 inch (127mm) depth; triple V type blades fabrication from 16 gauge (1.5mm) galvanized steel; ½ inch (12mm) diameter plated steel axles; external (out of the airstream) blade-to-blade linkage.

b. Damper shall be Greenheck model MBD-15 or approved equal by Ruskin, Pottorff, Air Balance or American Warming and Ventilating.

C. Round Duct.

1. Round Blade:

a. Dampers shall consist of a 20 gauge (1mm) galvanized steel frame with 6 3/8 inch (162mm) depth; blades fabricated from 20 gauge (1mm) galvanized steel; /38 inch (10mm) square plated steel axles, acetal bearings.

b. Damper shall be Greenheck model MBDR-50 or approved equal by Ruskin, Pottorff. Air Balance or American Warming and Ventilating.

2.6 Volume Damper Hardware:

A. Rectangular Volume Dampers with standoff bracket for ductwork with external insulation- Ventlok 555 or approved equal by Young Regulator or Greenheck.

B. Round Volume Damper with standoff bracket for ductwork with external insulation - Ventlok 555 or approved equal by Young Regulator or Greenheck.

2.7 Access Doors, Ductwork:

A. General.

1. Hinged access doors in ductwork shall be provided before and after all coils and all fire or automatic dampers to allow complete access for maintenance. Doors shall be 12 inches by 12 inches or as large as duct size permits. Provide latches for fastening doors. Doors may be shop made or factory made.

2.8 Louvers - Stationary:

A. General.

1. Units shall be certified in accordance with AMCA Certified Rating Program for water penetration and air performance.

2. Louvers shall be of the stationary type and constructed of extruded aluminum finished as directed by the Architect.

B. Frames.

1. Units shall be 6" in depth and length and width as shown on the drawings.

2. Provide caulking slots.

C. Blades.

1. Blades shall be set at 37 degrees and approximately 5" on centers.

D. Miscellaneous.

1. Provide insect screens.

2. Provide extended sill.

E. Unit shall be manufactured by Ruskin ELF 6375DX or approved equal by American Warming and Ventilating, Airbalance, Louvers and Dampers, Greenheck or NCA or United Enertech.

2.9 Equipment Supports:

A. Equipment support curb shall be of 18 gauge galvanized construction with continuously welded corner seams and cant.

B. Provide a wood nailer and 18 gauge counter flashing.

C. Curb shall be 12" high suitable for installation on the intended type of roof and slope.

D. Unit to be Thycurb or approved equal by Pate or RPS.

2.10 Pipe Curb:

A. Pipe curb shall be of 18 gauge galvanized construction with continuously welded corner seams and cant. Curb interior shall be lined with 1 ½", 3 pcf rigid insulation.

B. Provide a wood nailer and 18 gauge counter flashing with integral pipe welded pipe penetration sleeves.

C. 90 degree curb cover shall be of .05 aluminum construction with continuously welded corner seams with a removable watertight cover.

D. Provide EPDM boots to seal pipe to sleeve penetrations complete with stainless steel clamps.

E. Curb shall be 12" high suitable for installation on the intended type of roof and slope.

F. Unit to be Thycurb or approved equal by Pate or RPS.

PART 3 - EXECUTION

3.1 General:

A. Duct sizes shown are net. Increase duct sizes as required to account for duct liner to maintain free area.

B. Install products in accordance with the manufacturer's recommendations.

3.2 Ductwork:

A. Fabricate and install all ducts and plenums in accordance with the ASHRAE Guide and the appropriate SMACNA Duct Manual.

B. Seal all duct joints with mastic duct sealer. Tape shall not be used for duct sealer.

C. Flex duct shall be limited to maximum of 4 linear feet.

D. Contractor shall review and coordinate the installation of the ductwork. No ductwork shall be fabricated prior to the contractor obtaining exact field dimensions of the building structure, including new and existing ceiling space conditions, architectural, mechanical, electrical, and structural obstructions, etc., which may affect the installation of the air distribution system. Notify the

Architect immediately upon any discrepancies.

E. Leak Testing of Ductwork.

1. Low Pressure System:

a. Test new ductwork for leaks by sealing openings and pressurizing system to that static pressure which the system will operate. Use test methods approved by Architect. Seal all joints as herein described. Leakage shall not exceed 3 percent of air flow specified at the system's nominal static pressure. Perform additional test as may be required by the Architect. **Random testing of low pressure ductwork, downstream of all terminal units shall be required if duct sealing appears inadequate.** Keep ducts free of audible leaks which are detectable in all finished spaces. Notify Testing and Balancing Contractor, who shall witness tests, at least 48 hours in advance of test. Refer to the duct construction schedule on the drawings for additional information.

F. Duct Cleaning:

1. Clean the inside of ductwork and casing of debris, dirt, and other foreign matter before any system's fans and filters are operated for any reason. After the equipment has been used temporarily for any purpose, i.e., adjusting, testing and ventilating, clean or renew (depending on type) filter media and clean ducts downstream from the filters which have handled unfiltered air. Additionally, clean exhaust and return ducts, which in the opinion of the Architect, have been handling excessive dirty air prior to acceptance of the system. Keep main duct risers capped with plastic or poly after duct testing to help maintain clean risers. Provide roll filter media at each open end duct to help maintain clean risers until project balancing begins.

3.3 Air Balance:

A. The air distribution system shall be tested, adjusted and balanced to the quantities indicated on the contract document.

B. The Contractor shall obtain the services of an independent test and balance agency that specializes in and whose business is limited to the testing and balancing of air conditioning systems. The agency selected shall be fully certified by the Associated Air Balance Council (AABC), or the National Environmental Balancing Bureau (NEBB). The agency shall submit qualifications to the Engineer for approval prior to commencing any work on this project. All final reports shall be signed by an AABC Test and Balance Engineer or a NEBB Certified Supervisor and shall include an official stamp.

C. Testing and balancing shall be performed in complete accordance with current AABC National Standards for Field Measurement and Instrumentation, or NEBB

Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems applicable to air distribution.

D. Instruments used for testing and balancing of air systems must have been calibrated within a period of six months and checked for accuracy prior to start of work. Provide a list of instruments used on the project to include all serial and model numbers and calibration dates.

E. Six (6) copies of the complete test report shall be submitted to Engineer prior to final acceptance of the project.

F. The approved balancing agency shall monitor job progress during installation phase of contract to assure dampers, etc. are installed as shown or specified.

G. The Contractor shall submit name of the test and balance agency to the Architect and Consulting Mechanical Engineer for approval within thirty (30) days after receipt of construction contract by the air conditioning contractor. If the Contractor fails to submit the name of the selected test and balance agency with the above prescribed period, the Consulting Mechanical Engineer may select the certified AABC or NEBB agency of his choice and Contractor must then insure purchase order for this work as directed and assume all costs.

H. The Contractor shall demonstrate a minimum of 5% random sampling to the Engineer/Owner during the system demonstrations. Demonstrations shall confirm the air balance report readings.

(END OF SECTION)

PART 1 - GENERAL

1.1 Work Included:

A. Ceiling Exhaust Fan.

B. Inline Exhaust Fan.

1.2 Related Work:

A. Section 15850 - Ductwork.

B. Section 15900 - ATC.

C. Division 16 - Electrical.

1.3 Quality Assurance:

A. All fans shall bear AMCA seal for air and sound.

B. All fans shall be UL labeled.

1.4 Submittals:

A. Submit shop drawings.

B. Submit installation instructions.

C. Submit fan curves or AMCA certified performance table.

PART 2 - PRODUCTS

2.1 General:

A. Provide fans as scheduled on the Drawings.

2.2 Ceiling Exhaust Fan:

A. Provide a ceiling exhaust fan with steel housing, BDD, disconnect, centrifugal blower, fan speed controller, ½" acoustic insulation and integral grille.

B. Unit to be Soler & Palau or approved equal by Acme, Greenheck or Cook

2.3 Inline Exhaust Fan:

A. Provide an inline exhaust fan with steel housing, disconnect, BDD, centrifugal

blower, fan speed controller, ½" acoustic insulation and suspension package.

B. Unit to be Soler & Palau or approved equal by Acme, Greenheck or Cook.

2.4 Roof Cap:

A. Roof cap shall be constructed of heavy gauge aluminum construction and designed for fresh air intake and exhaust.

B. Roof cap shall be provided with aluminum curb and aluminum bird screen.

C. Roof cap shall be Soler & Palau model RCXII or approved equal by Cook, Greenheck, PennBarry or Acme.

PART 3 - EXECUTION

3.1 Installation:

A. Install fans in accordance with the manufacturer's recommendations.

(END OF SECTION)

PART 1 - GENERAL

1.1 Work Included:

A. Single Zone VAV Air Handling Unit.

B. Dedicated Outdoor Air Unit.

1.2 Related Work:

A. Section 15850 - Ductwork.

B. Section 15904 – Interoperable Facility Management Control System

C. Section 15400 - Plumbing.

D. Division 16 - Electrical.

1.3 Submittals:

A. Submit shop drawings and product data.

B. Submit manufacturer's installation instructions.

C. Submit manufacturer's descriptive literature, operating instructions and maintenance and repair data.

1.4 Warranty:

A. Provide an additional 4 year unconditional parts warranty on compressors.

B. Provide an additional 9 year unconditional parts warranty on the heat exchanger.

PART 2 - PRODUCTS

2.1 Manufacturer:

A. Units shall be products of a manufacturer who provides local service personnel from factory representative, franchised dealer or certified maintenance service shop.

2.2 Single Zone VAV Air Handling Unit (AHU-1)

A. Provide factory fabricated cabinet type air handling units as manufactured by York, Carrier, Trane, or Daikin Applied.

B. Unit shall be of double-wall construction. Casing shall be a minimum two-inch

construction with 18 gauge exterior and 24 gauge solid galvanized interior. Casings shall be completely sealed on both interior and exterior.

C. Insulation shall be two inch with 1.5 pound density. All connecting channels and supports shall be insulated to prevent thru metal conductance. Insulation shall meet all requirements of NFPA-90A.

D. Unit shall be complete as indicated on the drawings with mixed air plenum, filter section, drain pan, preheat coil, cooling coil, reheat coil, and fan section. Unit shall be provided with drain pan in both fan and coil sections.

E. Provide Class 2 or Class 1 filter media per U.L. 900 and as required by local codes.

F. Filter types, efficiencies, and nominal depths shall be as follows:

1. Flat filters – 2" 30% pleated.
2. Angled filters –2" 30% pleated filters.
3. Rigid filters –12" rigid filters with efficiencies of 60-65% (MERV 11).

    a. Provide a pre- filter rack in rigid filter segments. Pre- filters shall have 2" throwaway filters.

G. Provide a flush mounted, factory installed magnahelic differential pressure gage on the drive side of unit to measure pressure drop across filters. Manufacturer shall provide fully functional gauges, complete with tubing.

H. Fan section shall be constructed of mill galvanized steel and shall include one double-inlet, double width centrifugal fan having non-overloading horsepower characteristic, backwardly-curved single-thickness, airfoil blades with constantly rising pressure characteristics and heavy gauge housing with structural steel supports.

I. Wheels and scrolls shall be steel painted with a baked enamel finish or galvanized steel.

J. Fan and motor shall be integrally mounted on welded steel channel base with fan and base having one coat of primer paint. Internally mounted motor shall be factory-mounted on slide rails having two adjusting nuts, with access to motor, drive and bearings provided by hinged access door in the end panels. Bearings shall be foot-mounted on structural steel framework integral with housing, base and cabinet roof, and shall be pillow-block type with minimum life of 200,000 hours at maximum operating conditions, including belt tension for the class of fan furnished. Fan shall be statically and dynamically balanced in the factory and given final testing with motor and drive in place.

K. Motor shall be furnished by unit manufacturer in accordance with Section 15010. Provide multiple-belt drives sized for 1.5 times the fan motor horsepower. For motors over 20 H.P., drives shall be of the fixed pitch type, with one sheave change provided as required for final air balance.

L. Fans shall be provided with scroll access doors, scroll drains, inlet screens and an OSHA approved fan drive guard with provision for RPM measurement without removing the guard.

M. Provide extended lubrication lines from fan bearing to unit casing at access side, mounted and prepacked with grease at the factory. Lubrication lines to be plastic hose or metal tubing connected to the bearing with a Zerk fitting on the unit casing.

N. Provide UL or ETL listed VFDs and associated components, as scheduled and shown on drawings. VFDs shall comply with applicable provisions of the National Electric Code. F. Provide 2 contactor VFD bypass with fused disconnect.

O. Mount VFDs in a dedicated NEMA 1 compartment located on the primary access side of its associated fan section and wire VFD to motor, unless otherwise indicated on drawings. E. After unit installation, VFD shall be started and programmed by a factory trained and employed service technician.

P. Provide VFD with harmonic distortion feedback protection:
1. Equivalent 5% impedance input line reactor
2. Integral RFI/EMI filtering to meet EMC EN61800-3 for First Environment

Q. Provide VFD with a user interface with the following features:

1. 30 Character multi-lingual alphanumeric display
2. Parameter set-up and operating data
3. Display data shall include:
4. output frequency (Hz)
5. speed (RPM)
6. motor current
7. calculated % motor torque
8. calculated motor power (kW)
9. DC bus voltage
10. output voltage
11. heat sink temperature
12. elapsed time meter (re-settable)
13. kWh (re-settable)
14. input / output terminal monitor

15. PID actual value (feedback) & error
16. fault text
17. warning text
18. scalable process variable display

R. Provide VFD with the following protection circuits:
1. over current
2. ground fault
3. over voltage
4. under voltage
5. over temperature
6. input power loss of phase
7. loss of reference/feedback
8. adjustable current limit regulator

S. VFD shall be UL 508C approved for electronic motor overload (12t).

T. Provide high input transient protection and surge suppression

1. 4 MOVs ahead of diode bridge
2. 120 Joule rated 1600V diode module
3. Compliant with UL 1449 / ANSI 61.4

U. Provide the following communication features:

1. Two programmable analog inputs
2. Six programmable digital inputs
3. Two programmable analog output
4. Three programmable digital relay outputs
5. Modbus RTU Communications protocol
6. Adjustable filters on analog inputs and outputs
7. Input speed signals, including 4-20 mA and 0-10 VDC
8. Accel/Decel contacts (floating point control)
9. Auto restart (customer selectable and adjustable)
10. Start/Stop options shall include 2 wire (dry contact closure), 3 wire (momentary contacts), application of input power, and application of reference signal (PID sleep/wake-up)
11. Integrated control interface for Siemens FLN, Johnson N2, Modbus RTU, or BACnet MS/TP or LONworks over RS-485.

V. Provide VFD with the following functions:

1. Premagnetization on start
2. DC braking/hold at stop
3. Ramp or coast to stop
4. Seven preset speeds

5. Three critical frequency lockout bands
6. Start function shall include ramp, flying start, automatic torque boost, and automatic torque boost with flying start

W. Draw-thru, cooling coil section shall be minimum 28" deep in direction of air flow furnished with a minimum 24” access door. Furnish troughs and downspouts, where required for coil banks more than one high. Coils shall slide into unit through removable end panel.

X. Cooling coils shall be of the sizes and capacities as scheduled on the drawings. All coils shall be ARI rated in accordance with standard 410-72.

Y. Tube shall be copper tubing, minimum 5/8" O.D. and shall have 0.025 inch minimum wall thickness. Fins shall be aluminum plate fin type, and shall be spaced not closer than 10 per inch. Fins shall be expanded on tubing to provide a permanent mechanical bond. Tube headers shall be brass, bronze, or copper with air vent and drain tappings. Provide Type 304 stainless steel casings and supports.

Z. Coils shall be air tested under water at 315 psig and shall be guaranteed for 200 psig working pressure. Coils shall be certified in accordance with ARI standard 410-72.

AA. Coils shall be same end connection and shall be circuited to achieve the pressure drops scheduled.

BB. Drain pan shall be provided under coil and fan sections. Pan shall be constructed of welded galvanized steel with a bitumastic coating, or stainless steel. The bottom of the pan shall be insulated with 1", 3 PCF fiberglass insulation protected underneath by a galvanized steel sheet. Galvanized drain pans shall have a stainless steel liner, minimum 22 gauge, type 304 stainless steel.

CC. Hot water heating coils shall be constructed as described for cooling coils, but may have 16 gauge galvanized steel casing.

DD. Unit shall be finished with unpainted mill galvanized casing mounted over channel bases or drain pans fabricated of welded steel coated on the external surface with ZIPCOR or equivalent zinc chromate, iron oxide, phenolic resin paint which dries to a semi-gloss finish.

EE. Access door in fan section shall be full sized, duct wall construction having fiberglass insulation sandwiched between inner and outer panels, gasketed to provide positive seal and complete with hinges and quick-opening handle with locking latch. Provide access doors in coil section of similar construction.

FF. Provide internal vibration isolation and flexible connection inside the unit for

complete fan isolation from the unit casing. Vibration isolation shall conform to requirements as specified in Section 15050, Basic Materials and Methods.

2.3 Dedicated Outdoor Air Unit (DOAS-1)

A. Product Specification

1. The unit shall be a packaged static-plate energy recovery ventilator with recovery bypass, heating and cooling coil as manufactured by RenewAire, or approved equal.

B. Quality Assurance

1. The energy recovery core performance ratings shall be certified by ARI under its Standard 1060 for Energy Recovery Ventilators. Products not currently ARI-Certified will not be accepted.

2. Unit shall be Listed under UL 1812, Standard for Ducted Air to Air Heat Exchangers.

3. The energy recovery core shall meet NFPA 90A and 908 requirements for flame spread, not to exceed 25, and smoke generation, not to exceed 50, through an on going testing and verification program using UL Standard 723.

4. The core shall be warranted to be free of manufacturing defects and to retain its functional characteristics, under circumstances of normal use, for a period of ten years from the date of purchase. Balance of Unit shall be warranted to be free of manufacturing defects and to retain its functional characteristics, under circumstances of normal use, for a period of two years from the date of purchase.

C. Energy Transfer

1. The energy recovery core shall be capable of transferring both sensible and latent energy between air streams. Latent energy transfer shall be accomplished through molecular transport by hydroscopic resin.

D. Passive Frost Control

1. The energy recovery core shall perform without the occurrence of condensation or frosting under normal operating conditions defined as outside temperatures above -10°F and inside relative humidity below 40%. Occasional extreme conditions shall not affect the usual function or performance of the energy recovery core.

E. Positive Air stream Separation

1. Exhaust and fresh airstreams shall at all times travel in separate passages, and airstreams shall not mix. The exhaust air transfer ratio (EATR) of the energy recovery component shall be ARl-1060 certified as 0% at balanced pressure.

F. Laminar Flow

1. Airflow through the energy recovery core shall be laminar, avoiding deposition of particulates on the interior of the exchange plate material.

G. Isolation Dampers

1. Isolation dampers shall be AMCA-certified Class 1or Class 1A to demonstrate leakage of less than 4 SCFM/ft2 at 1.0" H20 static pressure difference (forward flow), thus satisfying requirements of ASHRAE 90.1- 2007 Section 6.4.3.4.3. Dampers shall be equipped with replaceable EPDM blade seals and stainless steel compression jamb seals. Dampers shall be controlled to be fully open before blowers begin operation, and to be fully closed whenever ventilation is not called for.

H. Energy Recovery Bypass

1. Energy recovery shall be bypassed by means of a face- and-bypass damper located in the Outside Air stream. Bypass section of damper shall be AMCA-certified Class 1or Class 1A to demonstrate leakage of less than 4 SCFM/ft2 at 1.0 in. w.g. static pressure difference. Both sections of damper shall be equipped with replaceable EPDM blade seals and stainless steel compression jamb seals. Damper shall be controlled by a differential enthalpy controller and an adjustable low- limit control.

I. Construction

1. The energy recovery core shall be of static plate, cross-flow construction, with no moving parts.

2. The unit cabinet shall be constructed of galvanized, 20-gauge steel, with lapped comers.

3. All unit cabinet panels shall be insulated to a minimum R-value of 4.3 (hrtt2·°F/BTU).

4. All compartments shall be fully lined with 24-gauge minimum

galvanized steel (G90).

5. Entire unit shall display no greater than 220 SCFM leakage from outside to inside of cabinet when depressurized to -2.0".

6. All unit cabinet panels shall display deflection no greater than U120 when unit is depressurized to -2.0" relative to ambient.

7. The exhaust and fresh air streams shall both be protected by MERV 8 rated, 2 inch pleated, disposable filters positioned before the energy recovery core.

8. Unit shall be provided on a 10-guage base rail with provisions for placement by fork lift and capable of supporting unit when supported at four designated mounting points with base rail deflection no greater than 0.13".

9. The unit shall have single-point power connection.

10. Motors shall be NEMA-Premium efficiency, Totally Enclosed Fan-Cooled (TEFC), with inverter-rated construction.

11. Flange components shall be provided suitable for connection of ductwork.

12. Motors shall be controlled by individual Variable Frequency Drives, each of which shall be additionally protected by fuses contained in the unit electrical enclosure.

13. The keypads of the Variable Frequency Drives shall be accessible by means of removable access panels while the unit is running, without exposure of internal wiring or connections. Air leakage through the access panels while open shall not exceed 60SCFM under any operating conditions.

14. Unit compartments containing high voltage shall be accessible through a door which cannot be opened until the unit's primary load switch is turned off to disconnect all power downstream of that switch.

15. Static pressure measurement ports shall be provided along with charts such that both airflows across the energy recovery core can be measured during unit operation, in energy recovery or bypass modes, with an uncertainty less than 10%.

16. Internal operating logic shall be provided by stand- alone relays, temperature controllers, and enthalpy controllers. Proprietary software

and programmable logic controllers shall not be used.

17. Provide unit with roof curb.

18. Unit shall be integrated with Variable Refrigerant Flow Heat Pumps Systems control.

PART 3 - EXECUTION

3.1 General:

A. Install equipment in accordance with the manufacturer's recommendations.

3.2 Filters:

A. Contractor shall provide temporary filters during testing phase. A clean set of filters shall be installed at substantial completion and spare set shall be turned over at this time.

(END OF SECTION)

PART 1 - GENERAL

1.1 Work Included:

A. Variable Refrigerant Flow Zoning (VRFZ) Simultaneous Heat Pump.

1.2 Related Work:

A. Section 15850 - Ductwork.

B. Section 15400 - Plumbing.

C. Division 16 - Electrical.

1.3 Submittals:

A. Submit shop drawings and product data.

B. Submit manufacturer's installation instructions.

C. Submit manufacturer's descriptive literature, operating instructions and maintenance and repair data.

1.4 Warranty:

A. Provide an additional 4 year unconditional parts warranty on compressors.

B. Provide an additional 9 year unconditional parts warranty on the heat exchanger.

PART 2 - PRODUCTS

2.1 Manufacturer:

A. Units shall be products of a manufacturer who provides local service personnel from factory representative, franchised dealer or certified maintenance service shop.

2.2 Variable Refrigerant Flow Zoning (VRFZ) Simultaneous Heat Pump:

A. System Description.

1. The variable capacity, heat pump heat recovery air conditioning system shall be a Mitsubishi Electric CITY MULTI VRFZ (Variable Refrigerant Flow Zoning) or approved equal by Daikin, Sanyo or LG.

2. The simultaneous system shall consist of a outdoor unit, branch controller, multiple indoor units and M-NET DDC (Direct Digital Controls). Each

indoor unit or group of indoor units shall be capable of operating in any mode independently of other indoor units or groups. System shall be capable of changing mode (cooling to heating, heating to cooling) with no interruption to system operation. Each indoor unit or group of indoor units shall be independently controlled.

3. The changeover system shall consist of outdoor unit, multiple indoor units and M-NET DDC (Direct Digital Controls).

B. Quality Assurance.

1. The units shall be listed by Electrical Laboratories (ETL) and bear the ETL label.

2. All wiring shall be in accordance with the National Electrical Code (N.E.C.).

3. The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).

4. A full charge of R-410A for the condensing unit only shall be provided in the condensing unit.

C. Delivery, Storage and Handling.

1. Unit shall be stored and handled according to the manufacturer's recommendation.

D. Warranty.

1. The units shall be covered by the manufacturer's limited warranty for a period of two (2) years from date of installation.

a. If the systems are:

(1) Designed by a certified VRFZ System Designer,
(2) Installed by a contractor that has successfully completed the factory VRFZ three day service course, (online or teleconference certification is not acceptable), AND
(3) Verified with a completed commissioning report submitted to and approved by the manufacturer, then the units shall be covered by an extended manufacturer's limited warranty for a period of five (5) years from date of installation.

b. In addition the compressor shall have a manufacturer's limited warranty for a period of seven (7) years from date of installation.

c. If, during this period, any part should fail to function properly due

to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer.

E. Manufacturer shall have a minimum of ten years of HVAC experience in the U.S. market.

F. All manufacturer technical and service manuals must be readily available for download by any local contractor should emergency service be required. Registering and sign-in requirements which may delay emergency service reference are not allowed.

G. The system shall be installed by a contractor with extensive VRFZ install and service training. The mandatory contractor service and install training should be performed by the manufacturer.

H. Products.

1. Simultaneous Outdoor Unit.

a. General: The outdoor units shall be equipped with multiple circuit boards that interface to the controls system and shall perform all functions necessary for operation. Each outdoor unit module shall be completely factory assembled, piped and wired and run tested at the factory.

(1) All units requiring a factory supplied twinning kits shall be piped together in the field, without the need for equalizing line(s). If an alternate manufacturer is selected, any additional material, cost, and labor to install additional lines shall be incurred by the contractor.
(2) Outdoor unit shall have a sound rating no higher than 60 dB(A) individually or 63 dB(A) twinned. Units shall have a sound rating no higher than 50 dB(A) individually or 53 dB(A) twinned while in night mode operation. If an alternate manufacturer is selected, any additional material, cost, and labor to meet published sound levels shall be incurred by the contractor.
(3) All refrigerant lines shall be insulated.
(4) There shall be no more than 3 branch circuit controllers connected to any one outdoor unit.
(5) Outdoor unit shall be able to connect to up to 50 indoor units depending upon model.
(6) The outdoor unit shall have an accumulator with refrigerant level sensors and controls.
(7) The outdoor unit shall have a high pressure safety switch, over-current protection, crankcase heater and DC bus protection.
(8) The outdoor unit shall have the ability to operate with a maximum height difference of 164 feet and have total

refrigerant tubing length of 1804-2625 feet. The greatest length is not to exceed 541 feet between outdoor unit and the indoor units without the need for line size changes or traps.

(9) The outdoor unit shall be capable of operating in heating mode down to -4°F ambient temperature or cooling mode down to 23°F ambient temperature, without additional low ambient controls. If an alternate manufacturer is selected, any additional material, cost, and labor to meet low ambient operating condition and performance shall be incurred by the contractor.

(10) The outdoor unit shall not cease operation in any mode based solely on outdoor ambient temperature.

(11) The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.

(12) Unit must defrost all circuits simultaneously in order to resume full heating more quickly. Partial defrost which may extend "no or reduced heating" periods shall not be allowed. Unit must continue heating operation in defrost mode.

b. Unit Cabinet:

(1) The casing(s) shall be fabricated of galvanized steel, bonderized and finished.

c. Fan:

(1) Each outdoor unit module shall be furnished with one direct drive, variable speed propeller type fan. The fan shall be factory set for operation under 0 in. WG external static pressure, but capable of normal operation under 0.24 in. WG external static pressure via dipswitch.

(2) All fan motors shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.

(3) All fan motors shall be mounted for quiet operation.

(4) All fans shall be provided with a raised guard to prevent contact with moving parts.

(5) The outdoor unit shall have vertical discharge airflow.

(6) System shall have condenser fans capable of removing snow build-up or provide **snow control sensor** to cycle the condenser fans in the event of snow accumulation to reduce snow buildup on the top of the unit.

d. Refrigerant:

(1) R410A refrigerant shall be required for outdoor unit

systems.

e. Coil:

(1) The outdoor coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.
(2) The coil fins shall have a factory applied corrosion resistant blue-fin finish.
(3) The coil shall be protected with an integral metal guard.
(4) Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.

f. Compressor:

(1) Each outdoor unit module shall be equipped with one inverter driven scroll hermetic compressor at a minimum.
(2) A crankcase heater(s) shall be factory mounted on the compressor(s).
(3) The outdoor unit compressor shall have an inverter to modulate capacity. The capacity shall be completely variable with a turndown of 19%-8% of rated capacity, depending upon unit size.
(4) The compressor will be equipped with an internal thermal overload.
(5) The compressor shall be mounted to avoid the transmission of vibration.
(6) Prior to bidding, manufacturers requiring equalization must submit oil line sizing calculations specific to each system and module placement for this project.

g. Electrical:

(1) The outdoor unit electrical power shall be 460 volts, 3-phase, 60 hertz.
(2) The outdoor unit shall be controlled by integral microprocessors.
(3) The control circuit between the indoor units, BC Controller and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

2. Branch Circuit Controllers.

a. General:

(1) The BCC (Branch Circuit Controllers) shall be specifically used with R410A simultaneous systems. These units shall be equipped with a circuit board that interfaces to the controls system and shall perform all functions necessary

for operation. The unit shall have a galvanized steel finish. The BCC shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory. This unit shall be mounted indoors, with access and service clearance provided for each controller.

b. BCC Unit Cabinet:

(1) The casing shall be fabricated of galvanized steel.
(2) Each cabinet shall house a liquid-gas separator and multiple refrigeration control valves.
(3) The unit shall house two tube-in-tube heat exchangers.

c. Refrigerant.

(1) R410A refrigerant shall be required.

d. Refrigerant valves:

(1) The unit shall be furnished with multiple branch circuits which can individually accommodate up to 54,000 BTUH and up to three indoor units. Branches may be twinned to allow more than 54,000 BTUH.
(2) Each branch shall have multiple two-position valves to control refrigerant flow.
(3) Service **shut-off valves** shall be field-provided/installed for each branch to allow service to any indoor unit without field interruption to overall system operation.
(4) Linear electronic expansion valves shall be used to control the variable refrigerant flow.

e. Integral Drain Pan:

(1) An integral condensate pan and drain shall be provided.

f. Electrical:

(1) The unit electrical power shall be 208/230 volts, 1 phase, 60 hertz.
(2) The BC Controller shall be controlled by integral microprocessors.
(3) The control circuit between the indoor units and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded (as required) cable to provide total integration of the system.

3. High Static Option Ceiling – Concealed Ducted Indoor Unit.

a. General:

(1) The unit shall be a ceiling concealed ducted indoor fan coil that mounts above the ceiling with a fixed rear return and a horizontal discharge supply, and shall have a modulating linear expansion device. unit shall be used with the simultaneous or changeover outdoor unit. High Static Option models shall feature external static pressure settings up 0.80 in. WG. Units shall have the ability to control supplemental heat via connector CN24 and a 12 VDC output.

b. Indoor Unit:

(1) The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

c. Unit Cabinet:

(1) The cabinet shall be ceiling-concealed, ducted.
(2) The cabinet panel shall have provisions for a field installed filtered outside air intake.

d. Fan:

(1) The indoor unit fan shall be an assembly with one or two Sirocco fan(s) direct driven by a single motor.
(2) The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
(3) The indoor unit shall have a ducted air outlet system and ducted return air system.

e. Filter:

(1) Return air shall be filtered by a field-supplied filter.
(2) Provide a rear return filter box with MERV 8.

f. Coil:

(1) The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
(2) The tubing shall have inner grooves for high efficiency heat exchange.
(3) All tube joints shall be brazed with phos-copper or silver

alloy.

(4) The coils shall be pressure tested at the factory.

(5) A condensate pan and drain shall be provided under the coil.

(6) The condensate shall be gravity drained from the fan coil.

(7) Both refrigerant lines to the indoor units shall be insulated.

g. Electrical:

(1) The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.

h. Controls:

(1) This unit shall use controls provided by the outdoor unit manufacture to perform functions necessary to operate the system.

4. Controls:

a. General:

(1) The Controls Network (CN) shall be capable of supporting remote controllers, schedule timers, system controllers, centralized controllers, an integrated web based interface, graphical user workstation, and system integration to Building Management Systems LonWorks®.

b. Electrical Characteristics:

(1) The CMCN shall operate at 24VDC. Controller power and communications shall be via a common non-polar communications bus.

(2) The controls shall be compatible with LonWorks and the BAS system. The **LonWorks interface** shall provide, as a minimum, the following functionality for each fan coil unit:

(a) On/Off
(b) Setpoint (both heating & cooling)
(c) Mode of operation
(d) Fan Speed
(e) Indoor temperature
(f) Local prohibit (on/off)
(g) Local prohibit (mode)
(h) Local prohibit (setpoint)
(i) Thermostat off
(j) Filter sign
(k) Thermo “on/off” state
(l) Model size

(m) Alarm state
(n) Error code

(3) Wiring:

(a) Control wiring shall be installed in a system daisy chain configuration from indoor unit to ME remote controller to indoor unit, to the BC controller (main and subs, if applicable) and to the outdoor unit. Control wiring to remote controllers shall be run from the indoor unit terminal block to the controller associated with that unit.
(b) Control wiring for schedule timers, system controllers, and centralized controllers shall be installed in a daisy chain configuration from outdoor unit to outdoor unit, to system controllers, to the power supply.
(c) Control wiring for the Deluxe MA, Simple MA, and Wireless MA remote controllers shall be from the remote controller to the first associated indoor unit (TB-15) then to the remaining associated indoor units (TB-15) in a daisy chain configuration.
(d) The AG-150A, G-50A and GB-50A system controller shall be capable of being networked with other AG-150A, G-50A and GB-50A system controllers for web based control.

(4) Wiring type:

(a) Wiring shall be 2-conductor, twisted shielded pair (as required), stranded wire, as defined by the Design Tool AutoCAD output.
(b) Network wiring shall be CAT-5e with RJ-45 connection.

c. Controls Network.

(1) The Controls Network (CN) consists of remote controllers, schedule timers, system controllers, centralized controllers, and/or integrated web based interface communicating over a high-speed communication bus. The Controls Network shall support operation monitoring, scheduling, error email distribution, personal browsers, tenant billing, online maintenance support, and integration with Building Management Systems (BMS) using either LonWorks® or BACnet® interfaces. The below figure illustrates a sample CN System Configuration.

d. CN: Remote Controllers.

(1) The Simple MA Remote Controller (PAC-YT53CRAU) shall be capable of controlling up to 16 indoor units (defined as 1 group). The Remote Controller shall be compact in size, approximately 3" x 5" and have limited user functionality. The Remote Controller supports temperature display selection of Fahrenheit or Celsius. The Remote Controller shall allow the user to change on/off, mode (cool, heat, auto (R2/WR2-Series only), dry, setback (R2/WR2-Series only) and fan), temperature setting, and fan speed setting and airflow direction. The Remote Controller shall be able to limit the set temperature range from the Backlit Simple MA. The Remote controller shall be capable of night setback control with upper and lower set temperature settings. The room temperature shall be sensed at either the Remote Controller or the Indoor Unit dependent on the indoor unit dipswitch setting. The Remote Controller shall display a four-digit error code in the event of system abnormality/error.

(2) Room temperature shall be sensed at each fan coil unit by a plain wall-mount sensor. No display or setpoint adjustment shall be used at the sensor.

5. 4-Way Ceiling-Recessed Cassette Indoor Unit:

a. General:

(1) The PLFY-P**NCMU-ER4 shall be a four-way cassette style indoor unit that recesses into the ceiling with a ceiling grille. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

b. Unit Cabinet:

(1) The cabinet shall be a compact 22-7/16" wide x 22-7/16" deep so it will fit within a standard 24" square suspended ceiling grid.

(2) The cabinet panel shall have provisions for a field installed filtered outside air intake.

(3) Four-way grille shall be fixed to bottom of cabinet allowing two, three or four-way blow.

c. Fan:

(1) The indoor fan shall be an assembly with a turbo fan direct driven by a single motor.
(2) The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
(3) The indoor fan shall consist of three (3) speeds, Low, Mid, and High.
(4) The indoor unit shall have an adjustable air outlet system offering 4-way airflow, 3-way airflow, or 2-way airflow.
(5) The auto air swing vanes shall be capable of automatically swinging up and down for uniform air distribution.

d. Filter:

(1) Return air shall be filtered by means of a long-life washable filter.

e. Coil:

(1) The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
(2) The tubing shall have inner grooves for high efficiency heat exchange.
(3) All tube joints shall be brazed with phos-copper or silver alloy.
(4) The coils shall be pressure tested at the factory.
(5) A condensate pan and drain shall be provided under the coil.
(6) The unit shall be provided with an integral condensate lift mechanism that will be able to raise drain water 19-3/4" inches above the condensate pan.
(7) Both refrigerant lines to the PLFY indoor units shall be insulated.

f. Electrical:

(1) The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
(2) The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

g. Controls:

(1) This unit shall use controls provided by Mitsubishi Electric to perform functions necessary to operate the system.
(2) Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature

at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.

(3) Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.

(4) Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.

(5) Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

(6) Manufacturer to provide drain pan level sensor powered by a 20-year life lithium battery. Sensor shall require no external power for operation and shall have an audible indication of low battery condition.

(7) The drain pan sensor shall provide protection against drain pan overflow by sensing a high condensate level in the drain pan. Should this occur the control shuts down the indoor unit before an overflow can occur. A thermistor error code will be produced should the sensor activate indicating a fault which must be resolved before the unit re-starts.

6. Ceiling-Concealed Ducted Indoor Unit

a. General:

(1) The PEFY shall be a ceiling-concealed ducted indoor fan coil design that mounts above the ceiling with a 2-position, field adjustable return and a fixed horizontal discharge supply and shall have a modulating linear expansion device. The PEFY shall be used with the R2-Series outdoor unit and BC Controller, Y-Series outdoor unit, or S-Series outdoor unit. The PEFY shall support individual control using M-NET DDC controllers.

b. Indoor Unit.

(1) The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

c. Unit Cabinet:

(1) The unit shall be, ceiling-concealed, ducted.
(2) The cabinet panel shall have provisions for a field installed filtered outside air intake.

d. Fan:

(1) PEFY-NMAU models shall feature external static pressure settings from 0.14 to 0.60 in. WG.
(2) The indoor unit fan shall be an assembly with one or two Sirocco fan(s) direct driven by a single motor.
(3) The indoor fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings.
(4) The indoor fan shall consist of three (3) speeds, High, Mid, and Low plus the Auto-Fan function.
(5) The indoor unit shall have a ducted air outlet system and ducted return air system.

e. Filter:

(1) Return air shall be filtered by means of a standard factory installed return air filter.
(2) Optional return filter box (rear or bottom placement) with high-efficiency filter shall be available for all PEFY indoor units.

f. Coil:

(1) The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
(2) The tubing shall have inner grooves for high efficiency heat exchange.
(3) All tube joints shall be brazed with phos-copper or silver alloy.
(4) The coils shall be pressure tested at the factory.
(5) A condensate pan and drain shall be provided under the coil.
(6) The condensate shall be gravity drained from the fan coil.
(7) Both refrigerant lines to the PEFY indoor units shall be insulated.

g. Electrical:

(1) The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
(2) The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

h. Controls:

(1) This unit shall use controls provided by Mitsubishi Electric Cooling & Heating to perform functions necessary to operate the system. Please refer to Part 5 of this guide specification for details on controllers and other control options.

(2) Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.

(3) Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.

(4) Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.

(5) Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

(6) Manufacturer to provide drain pan level sensor powered by a 20-year life lithium battery. Sensor shall require no external power for operation and shall have an audible indication of low battery condition.

(7) The drain pan sensor shall provide protection against drain pan overflow by sensing a high condensate level in the drain pan. Should this occur the control shuts down the indoor unit before an overflow can occur. A thermistor error code will be produced should the sensor activate indicating a fault which must be resolved before the unit re-starts.

7. Low Profile Ceiling-Concealed Ducted Indoor Unit

a. General:

(1) The PEFY-NMSU (Low Profile) unit shall be a ceiling-concealed ducted indoor fan coil that mounts above the ceiling with a rear return and a fixed horizontal discharge supply and shall have a modulating linear expansion device. The PEFY-NMSU shall be used with the R2-Series outdoor unit and BC Controller, Y-Series outdoor unit, or S-Series outdoor unit. The PEFY-NMSU shall support individual control using M-NET DDC controllers. PEFY (Low Profile) models shall have an extremely compact profile (7-7/8”) which requires minimal ceiling space. PEFY-NMSU models shall feature external static pressure settings up to 0.20 in. WG. Units shall have the ability to

control supplemental heat via connector CN24 and a 12 VDC output.

b. Indoor Unit.

(1) The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

c. Unit Cabinet:

(1) The cabinet shall be space saving, low profile, ceiling-concealed ducted.
(2) The cabinet panel shall have provisions for a field installed filtered outside air intake.

d. Fan:

(1) The indoor unit fan shall be an assembly with one Sirocco fan direct driven by a single motor.
(2) The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
(3) The indoor fan shall consist of three (3) speeds, High, Mid, and Low.
(4) The indoor unit shall have a ducted air outlet system and ducted return air system.

e. Filter:

(1) Return air shall be filtered by means of a standard factory installed return air filter.

f. Coil:

(1) The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
(2) The tubing shall have inner grooves for high efficiency heat exchange.
(3) All tube joints shall be brazed with phos-copper or silver alloy.
(4) The coils shall be pressure tested at the factory.
(5) A condensate pan and drain shall be provided under the coil.
(6) The unit shall be provided with an integral condensate lift

mechanism able to raise drain water 21 inches above the condensate pan.

(7) Both refrigerant lines to the PEFY indoor units shall be insulated.

g. Electrical:

(1) The unit electrical power shall be 208/230 volts, 1 phase, 60 hertz.

(2) The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

h. Controls:

(1) This unit shall use controls provided by Mitsubishi Electric Cooling & Heating to perform functions necessary to operate the system. Please refer to Part 5 of this guide specification for details on controllers and other control options.

(2) Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.

(3) Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.

(4) Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.

(5) Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

(6) Manufacturer to provide drain pan level sensor powered by a 20-year life lithium battery. Sensor shall require no external power for operation and shall have an audible indication of low battery condition.

(7) The drain pan sensor shall provide protection against drain pan overflow by sensing a high condensate level in the drain pan. Should this occur the control shuts down the indoor unit before an overflow can occur. A thermistor error code will be produced should the sensor activate indicating a fault which must be resolved before the unit re-starts.

8. Alternate High Static Option, Ceiling-Concealed Ducted Indoor Unit

a. General:

(1) The PEFY-NMH(S)U (Alternate High Static Option) unit shall be a ceiling concealed ducted indoor fan coil that mounts above the ceiling with a fixed rear return and a horizontal discharge supply, and shall have a modulating linear expansion device. The PEFY-NMH(S)U shall be used with the R2-Series outdoor unit and BC Controller, Y-Series outdoor unit, or S-Series outdoor unit. The PEFY-NMH(S)U shall support individual control using M-NET DDC controllers. PEFY-NMH(S)U models shall feature external static pressure settings up 1.00 in. WG. Units shall have the ability to control supplemental heat via connector CN24 or CN4F and a 12 VDC output.

b. Indoor Unit.

(1) The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

c. Unit Cabinet:

(1) The cabinet shall be ceiling-concealed, ducted.
(2) The cabinet panel shall have provisions for a field installed filtered outside air intake.

d. Fan:

(1) The indoor unit fan shall be an assembly with one or two Sirocco fan(s) direct driven by a single motor.
(2) The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
(3) The indoor unit shall have a ducted air outlet system and ducted return air system.

e. Filter:

(1) Return air shall be filtered by a field-supplied filter.
(2) Optional rear return filter box with long-life filter shall available for all PEFY-NMH(S)U-E indoor units.

f. Coil:

(1) The indoor coil shall be of nonferrous construction with

smooth plate fins on copper tubing.

(2) The tubing shall have inner grooves for high efficiency heat exchange.

(3) All tube joints shall be brazed with phos-copper or silver alloy.

(4) The coils shall be pressure tested at the factory.

(5) A condensate pan and drain shall be provided under the coil.

(6) The condensate shall be gravity drained from the fan coil.

(7) Both refrigerant lines to the PEFY indoor units shall be insulated.

g. Electrical:

(1) The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.

(2) The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

h. Controls:

(1) This unit shall use controls provided by Mitsubishi Electric to perform functions necessary to operate the system. Please refer to Part 5 of this guide specification for details on controllers and other control options.

(2) Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.

(3) Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.

(4) Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.

(5) Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

(6) Manufacturer to provide drain pan level sensor powered by a 20-year life lithium battery. Sensor shall require no external power for operation and shall have an audible indication of low battery condition.

(7) The drain pan sensor shall provide protection against drain pan overflow by sensing a high condensate level in the drain pan. Should this occur the control shuts down the indoor unit before an overflow can occur. A thermistor error code will be produced should the sensor activate

indicating a fault which must be resolved before the unit re-starts.

PART 3 - EXECUTION

3.1 General:

A. Install equipment in accordance with the manufacturer's recommendations.

3.2 Rooftop Units:

A. Mount unit on a factory-built curb with weather tight flashing.

3.3 Variable Refrigerant Flow Zoning (VRFZ):

A. System shall installed by a factory certified installer. Prior to the VRFZ equipment submittal the contractor shall submit certificate of certified personal installing the VRFZ system.

B. Provide factory approved refrigerant piping schematic for approval prior to fabrication.

3.4 Filters:

A. Contractor shall provide temporary filters during testing phase. A clean set of filters shall be installed at substantial completion and spare set shall be turned over at this time.

(END OF SECTION)

PART 1 - GENERAL

1.1 Work Included:

A. Diffusers.

B. Registers.

C. Grilles.

1.2 Related Work:

A. Section 15850 - Ductwork.

1.3 Submittals:

A. Submit product data and shop drawings covering each item together with a schedule of outlets.

1.4 Quality Assurance:

A. Rate outlets in accordance with ADC standards.

B. Outlets shall have a maximum noise level of NC35.

PART 2 - PRODUCTS

2.1 General:

A. Supply outlets shall be complete with anti-smudge frames.

B. Provide plaster frames for outlets located on plaster surfaces.

2.2 Diffusers:

A. Ceiling (Rect.).

1. Diffuser to be of steel construction, finished in white enamel with snap in direction cores with damper and grid.

2. Unit to be square or rectangular.

3. Unit to be Titus or approved equal by Carnes, Anemostat, Krueger, E.H. Price Tuttle & Bailey or Metal Aire.

B. Ceiling (Perforated).

1. Diffuser to be of steel construction, finished in white enamel with one piece, demountable face.

2. Perforations to be 3/16" holes 1/4" on staggered centers.

3. Unit to be Titus PAS or approved equal by Carnes, Krueger, E.H. Price, Anemostat or Metal Aire.

2.3 Registers:

A. Supply (Double Deflection).

1. Registers to be of steel construction, finished in white enamel.

2. Double deflection with horizontal face bars.

3. Unit with integral dampers.

4. Unit to be Titus or approved equal by Metal Aire, Anemostat, Krueger, E.H. Price, or Tuttle & Bailey.

B. Return.

1. Register to be of steel construction, finished on white enamel.

2. Horizontal 35 degree deflected face bars on ¾" spacing.

3. Unit with integral damper.

4. Unit to be Titus or approved equal by Carnes, Anemostat, Krueger, E.H. Price, Tuttle and Bailey or Metal Aire.

C. Exhaust.

1. Register to be of aluminum construction, finish on white enamel.

2. Horizontal 35 degree deflected face bars on ¾" spacing.

3. Unit with integral damper.

4. Unit to be Titus 350F or approved equal by Carnes, Anemostat, Krueger, E.H. Price or Metal Aire.

5.

2.4 Linear Diffusers:

A. Diffuser shall be extruded aluminum with flanged frames, ½" slots and 180 degree pattern adjustment vanes.

B. Finish shall be selected by the Architect.

C. Units shall be Titus or approved equal by Krueger, Anemostat, Carnes, E.H. Price, Tuttle and Bailey or Metal Aire.

2.5 Exhaust Grilles:

A. Grilles shall be aluminum, finish on white enamel.

B. Horizontal 35 degree deflected face bars on ¾" spacing.

C. Units shall be Titus or approved equal by Krueger, Anemostat, E.H. Price, Carnes or Metal Aire.

2.6 Ceiling Grille:

A. Return.

1. Register to be of steel construction, finished on white enamel.

2. Horizontal deflected face bars on 2/3" spacing.

3. Unit to be Titus or approved equal by Carnes, Anemostat, Krueger, E.H. Price, Tuttle and Bailey or Metal Aire.

2.7 T-Bar Slot Diffusers:

A. Diffuser shall be 2-way, 2-slot type with insulated plenums (see Section 15180, Insulation).

B. Units shall provide suitable air discharge patterns to accommodate tenant allowance established under this contract.

2.8 Manufacturer:

A. Manufacturer named items are for standard of reference and do not necessarily limit supply to the named manufacturer. Items of the same physical size, function and performance by the approved equal manufacturers are acceptable.

PART 3 - EXECUTION

3.1 Installation:

A. Install items in accordance with the manufacturer's printed instructions.

B. Paint ductwork, visible behind air outlets, matt black.

(END OF SECTION)

PART 1 - GENERAL

1.1 Scope of Services:

A. Prepare and submit to the owner's representative a written commissioning plan establishing our authority within the scope of the project and identify the responsibility of each trade affected by the commissioning process.

B. Attend periodic construction progress meetings and perform unscheduled walks through the building to observe and keep abreast of mechanical systems installation progress. Our presence at meetings and in the building will be for our own benefit in preparing to commission the building and shall in no way be construed as superseding the authority of the project design engineers.

C. Be present to observe the start up of equipment; i.e.: converter, pumps, air handling units etc. which are supervised and certified by the equipment manufacturer's agent. Witness the start up of the Variable Refrigerant Flow Systems, Dedicated Outdoor Air Unit and a representative sample of individual units such as VRF Air Handling Units to verify that the equipment operations have been certified by the equipment manufacturer's representatives and are operating in accordance with contract documents.

D. Witness piping pressure system tests, flushing and cleaning. Review the submittal data of the chemical water treatment vendor and subsequent treatment installation.

E. Check a representative sampling of the air duct systems, plenums, coils, and filters for cleanliness, damage or leakage.

F. Review the submittal data furnished by the Testing, adjusting and Balancing (TAB) agency for qualifications, instrumentation calibration, and TAB agenda. Visit the project periodically during testing, adjusting and balancing of the air and water systems to witness the actual work being performed. Review the certified reports submitted by the TAB agency and recommend acceptance when appropriate.

G. Review the submittal data furnished by the vibration testing agency for qualifications, instrumentation calibration, and testing agenda. Visit the project periodically during noise and vibration testing to witness the actual work being performed. Review the certified reports submitted by the testing agency and recommend acceptance when appropriate.

H. Periodically observe the installation of the Automatic Temperature Controls (ATC) and Building Automation System (BAS). Verify the calibration of a representative sampling of sampling devices. Witness the operation of all air handling units and exercise their respective control sequences including safeties. Observe the operation and controlling sequences of all central system piping,

isolation, changeover and modulating control valves.

I. Require that heating, ventilating and air conditioning commissioning be performed while the central plant is in operation i.e.: commissioning of the heating system will be performed during the heating season and commissioning of the cooling system will be performed during the cooling season.

J. Attend mechanical contractor instructional meetings concerning the Heating, Ventilation and Air Conditioning Systems with the owner's operating personnel.

K. Review contractor prepared operating and maintenance manuals, As Built drawings, and all certifications required for submission by project specifications. Our recommendations for approval, when appropriate, will be forwarded to the owner.

L. Furnish a written report and recommend acceptance of the Heating, Ventilation and Air Conditioning Systems upon satisfactorily completing the commissioning process.

(END OF SECTION)

SECTION 15904 - INTEROPERABLE FACILITY MANAGEMENT CONTROL SYSTEM

PART 1 - GENERAL

1.1 Overview:

A. Furnish all labor, materials, equipment, and service necessary for a complete and operating temperature control system, utilizing Direct Digital Controls, pneumatic/electronic interfaces and actuation devices, as shown on the drawings and as described herein. Drawings are diagrammatic only. Equipment and labor not specifically referred to herein or on the plans, that are required to meet the functional intent, shall be provided without additional cost to the Owner. Performance and capabilities are based on the Siebe Environmental Controls Facility Management System.

1.2 Installation:

A. All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the regular employment of the temperature control system manufacturer or its exclusive factory authorized installing contracting field office (representative). The installing office shall have a minimum of five years of installation experience with the manufacturer and shall provide documentation in submittal package verifying longevity of the installing company's relationship with the manufacturer. Supervision, calibration and checkout of the system shall be by the employees of the local exclusive factory authorized temperature control contracting field office (branch or representative).

1.3 Control Wiring:

A. All electrical control wiring and power wiring to the control panels shall be the responsibility of the FMCS contractor.

B. The electrical contractor (Div. 16) shall furnish all power wiring to electrical starters and motors.

C. All wiring shall be in accordance with the Project Electrical Specifications Division 16.

1.4 Pneumatic Tubing:

A. Pneumatic control air lines shall be hard drawn copper tubing where a run is exposed, with either hard drawn or annealed tubing used where concealed. Runs shall be parallel to or at right angles to the structure and only tool made bends will be acceptable. Special FR (Fire Retardant) tubing may be run in covered raceways. Run outs from raceways to the control devices shall not exceed three feet. Main and branch lines above dropped ceilings and in other concealed but accessible locations may be FR tubing, provided that it is run parallel to or at right

angles to the structure, properly supported and installed in a neat and workmanlike manner.

B. Identify each item, mounted on the face of a control panel, with an engraved nameplate (1/4" high engraved letters minimum). Identify each item of control equipment (except room sensors and thermostats), with stamped tape, firmly attached to equipment (1/4" high letters minimum).

C. Thermostats or sensors mounted on outside walls shall be mounted on 1" minimum thickness, rigid fiberglass insulating base (or equal).

D. All thermostat bulbs in water lines shall be installed in separable wells, packed with heat conductive compound.

1.5 Unacceptable Bids:

A. Bids by wholesalers, contractors or franchised dealers or any other firm whose principal business is not that of manufacturing or installing automatic temperature control systems shall not be acceptable. Bid documents that are not complete in their response to these documents or take exception to any of the capabilities defined within these documents will be rejected.

1.6 Shop Drawings/Submittals:

A. Eight copies of shop drawings of the entire control system shall be submitted and shall consist of a complete list of equipment and materials, including manufacturers catalog data sheets and installation instructions. Shop drawings shall also contain complete wiring and schematic diagrams, software descriptions, calculations, and any other details required to demonstrate that the system has been coordinated and will properly function as a system. Terminal identification for all control wiring shall be shown on the shop drawings. A complete written Sequence of Operation as well as a hard copy graphical depiction of the application control programs shall also be included with the submittal package.

B. Upon completion of the work, provide a complete set of drawings and application software on magnetic floppy disk media. Drawings shall be provided as AutoCAD or ViSiO compatible files.

1.7 Materials:

A. All materials and equipment used shall be standard components, of regular manufacture for this application. All systems and components shall have been thoroughly tested and proven in actual use. Siebe Environmental Controls (SEC) is the basis of the system design. Products manufactured by other companies shall be considered equal if all other requirements of the specifications, drawings and plans are met and the supplier is pre-qualified by the owners representative and the consulting engineer, at least 10 days prior to the bid. Acceptability will be by addendum only. Exceptions to the specification will qualify the bid as

unacceptable.

1.8 Temperature Control Air Compressor:

A. A duplex air compressor system (two compressors mounted on one tank) shall be furnished and installed by the temperature control contractor. Air compressor system shall be sized to fit the pneumatic control system, to insure no more than 33% run time. The tank shall be sized for a maximum of 6 starts per hour. An automatic alternator shall be connected to the motors and pressure switches, in a 'lead-lag' manner, and shall alternate compressor operation after each on-off cycle. Alternator shall be further connected to energize the 'lag' operation after each on-off cycle. Alternator shall be further connected to energize the 'lag' compressor at the setting of the lower pressure switch if the "lead" compressor fails or is disabled for service. Air compressor system shall include a refrigerated air dryer sized for the capacity of the air compressor. Accessories such as filters, pressure regulators, valves, spring isolators, automatic tank drain etc. shall also be furnished for a complete operating system.

1.9 Warranty:

A. The temperature contractor shall provide a one-year warranty that will commence from the point of the project’s beneficial use by the Owner.

B. The temperature control contractor's office shall be within a 30-mile radius of the job site.

C. The contractor shall respond to the job site emergency calls within a reasonable amount of time during normal working hours.

1.10 Software License Agreement:

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

1.11 Specification Compliance Review:

A. The temperature control system/BAS contractor shall supply, a paragraph by paragraph specification compliance report. The report shall indicate for each numbered paragraph, how the contractor meets the criteria of the paragraph. The following format must be utilized in completing the compliance report:

B. Comply - without exception.

C. Qualify - meet the functional intent. For each paragraph, the contractor shall identify all differences in specific functions stated in the given paragraph and

provide a description of what is excluded or how the qualifying system will meet the function specified.

D. Does not comply – cannot meet specified function.

1.12 Agency and Code Approvals:

A. All products of the BAS shall be provided with the following agency approvals. With the submittal documents, verification that the approvals exist for all submitted products, shall be provided. Systems or products not currently offering the following approvals are not acceptable:

B. UL-916; Energy Management Systems
C. ULC; UL - Canadian Standards Association
D. FCC, Part 15, Subpart J, Class A Computing Devices

E. All products shall be labeled with the appropriate approval markings. System installation shall comply with NFPA, NEMA, Local and National codes.

F. The FMCS manufacturer shall provide documentation supporting compliance with ISO-9001 certification mark from applicable registrar.

PART 2 - PRODUCTS

2.1 Facility Management Control System:

A. General.

1. The Facility Management Control System (FMCS) shall be comprised of a network of interoperable, stand-alone digital controllers. All controllers and software within FMCS shall be Year 2000 compliant and shall be supported by compliance documentation from the manufacturer.

2.2 Specification Nomenclature:

FMCS	Facility Management Control System
SDC	Standalone Digital Controller
IDC	Interoperable Digital Controller
ILC	Interoperable LONMARK Controller
LIDC	Lighting Interface Digital Controller
GDC	Gateway Digital Controller
GP	Graphical Programmer
HMI	Human Machine Interface
PAC	Personnel Access Controller
GUI	Graphical User Interface

PART 3 - EXECUTION

3.1 Open, Interoperable, Integrated Architectures:

A. Network.

1. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system. The FMCS requires the incorporation of LonWorks Technologies using Free Topology Transceivers (FTT-10), and specific conformance to the LONMARK Interoperability Association's v3.0 Physical and logical Layer guidelines in all unitary, terminal unit and other devices.

2. LonTalk communications protocol will be used on the communication network between FMCS controllers and other LonWorks devices to assure interoperability between all devices within the network.

3. The FMCS shall support the direct integration of standard and non-standard communicating systems. At a minimum, the FMCS shall deliver connectivity at the Lon, IP, and HMI levels through standard offerings. The FMCS shall offer as a standard available solution, a minimum of 300 individual communicating interfaces to 3rd party products.

4. The FMCS shall provide a standard available test kit for development of additional interfaces by others, in addition to the FMCS manufacturer.

5. The FMCS shall provide compliance with the ASHRAE standard 135-P for BACnet interoperability with all devices within the FMCS.

6. The FMCS shall provide a high speed Network Interface that shall plug directly into the SDC which supports one of the following types of communication standards between SDCs:

a. Ethernet.

(1) The Network Interface shall employ Carrier Sense Multiple Access/Collision Detect (CSMA/CD) contention type protocol, which adheres to the industry standard format IEEE 802.3. The content of messages shall be the manufacturer's standard. The Network Interface shall be fully Internet Protocol (IP) compliant allowing connection to currently installed IEEE 802.3 compliant Ethernet Networks.

(2) The Network Interface shall directly support connectivity to a variety of cabling types. As a minimum provide the following connectivity: 10Base2 (ThinNet RG-58 A/U Coaxial cabling with BNC connectors), 10BaseT (Twisted-Pair RJ-45 terminated UTP cabling).

b. Echelon.

(1) The FMCS shall employ LonTalk communications utilizing the LonWorks Neuron chip, which conforms to the International Standards Organization's (ISO) seven layer Open Systems Interconnect (OSI) network protocol model. The content of messages shall be the manufacturer's standard. The Neuron chip and a transformer-isolated transceiver shall provide for 1.25 Mbps communications over Category 4 Unshielded Twisted Pair (UTP) cabling.

(2) To facilitate facility expansion or to support large Wide Area Networks (WANs) the Network Interface shall directly support a minimum of 4 logical networks using the same physical network (Ethernet or Echelon). Each logical network shall support a minimum of 30 SDCs.

(3) The ability to support bi-directional access to remote SDCs shall be supported by a single point of connection. The ability to monitor and edit system data shall be provided via the SDC remote communications connection. Connection via the HMI, the GP as well as a standard VT-100 terminal interface shall be provided. Support for solicited as well as unsolicited communications is a requirement.

(4) There shall be no power wiring, in excess of 30 Vac rms voltage, run in conduit with communications trunk wiring. In cases where power or signal wiring is run in conduit with trunk wiring, all communications trunk wiring and power wiring shall be run using separate twisted shielded pairs (24awg) with the shields grounded in accordance with the manufacturer's wiring practices.

B. Standalone Digital Controllers (SDC).

1. General.

a. The SDC controllers shall permit the simultaneous operation of all control, communication facilities management and operator interface software, as programmed by the Contractor or User. Modification of the on-board SDC controller database shall be performed on-line using the built-in interface. Systems that require the SDC to be removed from service while DDC control sequences are modified shall not be acceptable.

b. SDC controllers shall utilize true floating-point arithmetic capabilities. To accommodate totalization of large totalized values, SDCs with reporting capability shall support the

calculation, accumulation and display of values within the range of +/-10 to the 10th power. The SDC shall employ a multi-tasking, multi-user operating system.

c. All programming defining the functions to be performed by the SDC, including but not limited to application programs and point database within each SDC shall be protected from loss due to power failure for a minimum of six months. Systems not providing non-volatile memory shall provide a system rechargeable battery backup system sufficient to provide protection for the specified 6 month period.

d. SDC controllers shall be equipped with a minimum of two operator service ports for the connection of serial devices such as the GP, HMI, modems, printers, etc. Connection of a service device, to a service port, shall not cause the SDC controller to lose communications with its peers or other networked device controllers. The SDC shall be able to route alarms, trends, and reports to any serial device connected to the network. This shall also include the auto dialing to remote locations. The SDC shall be capable of dialing out to a minimum of ten remote locations for the annunciation of alarms. Alarms shall include the time, date, and alarm condition, in addition to a user-defined detailed message detailing the condition.

e. The SDC shall provide Alarming, point trending and Energy report generation capabilities. Alarming points shall be uniquely definable, with multiple alarms assignable to a single point. Such alarms shall be provided with a unique 80-character message. Systems utilizing an alarm messages library, shall describe the size of the library and verify how all alarming within the SDC will be guaranteed unique 80 character messages.

f. The quantities of trended point values shall be limited only by total controller memory space. If necessary, a SDC may be dedicated fully to a trending task, allowing all controller memory to be available for the trend storage. Each unique trend report shall contain a minimum of 4 different points and a minimum of 128 samples per point. Trending frequency for each report shall be operator definable from a sample once a second to a sample once every 24 hours. Trend reports shall be internally formatted by the SDC and shall be reportable directly to a serial printer, a VT-100 display terminal, a CCS, CHS or any other device capable of receiving a formatted ASCII data file.

g. The energy reports shall not be limited in quantities only by available memory within the GDC. Each Energy report shall be fully formatted and reportable to a serial printer, a VT-100 display

terminal, a CCS, a CHS or any other device capable of receiving a formatted ASCII data file. As a minimum, each Energy report shall provide a daily report and a monthly report with summary information such as outside air temperature, outside air humidity, total energy consumed and degree-day calculations.

h. The SDC controller shall provide a built-in operator interface, which consists of an alphanumeric LCD display of 4 lines x 20 characters, and a multi-function keyboard. Devices without such built-in displays shall provide a permanently connected HMI as described elsewhere in this specification, one per SDC.

i. The SDC shall provide for logical grouping of network variables and allow for viewing and editing of system parameters. Logical grouping menus shall allow for detailed descriptions of system variables of a minimum of 20 characters.

j. The SDC shall communicate via the FMCS Network Interfaces to the enterprise LAN, whether dedicated or common. The SDC shall provide communications connectivity to the LonWorks bus and shall support any LONMARK/LonWorks compliant devices.

k. The SDC shall provide connectivity to the currently marketed FMCS solutions offered by the manufacturer. The SDC shall be interoperable these FMCS offerings for scheduling, global data sharing, Energy Demand Limiting, alarming, optimized start/stop, and systems integrations for all other data within the entire FMCS. In addition, the SDC shall provide connectivity to existing DDC controllers currently marketed by the manufacturer.

l. The SDC shall be compliant with the current and previously marketed HMIs of the manufacturer, and shall be capable of full bi-directional communications through the LAN, with previously manufactured SDC controllers sold for the last ten years by the manufacturer.

C. Interoperable Lonmark Controllers (ILC).

1. General.

a. Controls shall be microprocessor based Interoperable LONMARK Controllers (ILC), bearing the applicable LONMARK interoperability logo on each product delivered. ILCs shall be provided for Unit Ventilators, Fan Coils, Heat Pumps, VAV Terminal Boxes and other applications as shown on the drawings. ILCs shall be based on the Echelon Neuron 3150 microprocessor working from software program memory which is physically located in the ILC. The application control program shall be

resident within the same enclosure as the input/output circuitry, which translates the sensor signals.

b. To simplify controls and mechanical service troubleshooting, the ILC shall be mounted directly in the control compartment of the unitary system. The ILC shall be provided with a sheet metal or polymeric enclosure that is constructed of material allowing for the direct mounting within the primary air stream, as defined by UL-465. The direct mounting shall allow all controls maintenance and troubleshooting to be made while at the unitary equipment.

c. The ILCs shall communicate with the SDC at a baud rate of not less than 78.8K baud. The ILC shall provide LED indication of communication and controller performance to the technician, without cover removal.

d. The ILCs shall be fully supported and communicate with any and all GUI(s) on the bus.

2. ILC Sensor.

a. The ILC Sensor shall connect directly to the ILC and shall not utilize any of the I/O points of the controller. The ILC Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive. The ILC Sensor shall provide a communications jack for connection to the LON communication trunk to which the ILC controller is connected. The ILC Sensor, the connected controller, and all other devices on the LON bus shall be accessible by the Graphical Programming tool.

b. The ILC Sensor shall be supplied in the following variations:

(1) Tamper-resistant (no display).
(2) Tamper-resistant with tenant override.
(3) Basic user functions (LCD display and setpoint adjustment and tenant override).
(4) Full user functions (LCD display and network-variable access and tenant override).
(5) ASHRAE 95 compliance (LCD display and sub-base functionality).

c. The ILC Sensor shall be provided in a modular configuration that allows for the rough in of all wiring without the presence of the electronics or esthetic covering. The ILC Sensor shall allow for the customization of the color on the esthetic covering as a standard offering. User interface with the ILC Sensor shall be provided as a configurable function by the FMCS, and shall offer password protection for access to network variable editing.

Multiple network variables shall be accessible and editable by the ILC Sensor. Icons shall be utilized to represent sensor and controller function status, affording independence from a single language for use interface.

3. ILC Functionality.

a. The ILC shall provide a –40 to 140 degree Fahrenheit ambient operating temperature range. The ILC shall be provided in a modular configuration that allows for the rough in of all wiring without the presence of any of the ILC electronics. ILC devices that require the electronics to be present at the time of wiring, will require an additional controller to be provided for every 10 devices on the drawings, to allow for the preconfiguration and storing for service purposes.

b. All input/output signals shall be directly hardwired to the ILC. For all non-VAV terminal applications, a minimum of two input points of the ILC shall employ a universal configuration that allows for flexibility in application ranging from dry contact, resistive, to voltage/current sourced inputs. If universal points are not available, a minimum of two input points (each) of the dry contact, resistive and analog voltage/current types must be provided on every controller. The outputs of the ILC shall be of the relay and universal analog form. All digital outputs shall be relay type. ILC devices utilizing non-relay outputs shall provide an interface relay for all points. All analog outputs shall be programmable for their start points and span to accommodate the control devices. Configuration of all I/O points shall be accomplished without physical hardware jumpers, switches or settings. Troubleshooting of input/output signals shall be easily executed with the Graphical Programming tool (GP) or a volt-ohm meter (VOM). All I/O points shall be utilized by the local ILC or shall be available as I/O points for other controllers throughout the network.

c. All ILCs shall be fully application programmable and shall at all times maintain their LONMARK certification. Controllers offering application selection only (non-programmable), require a 10% spare point capacity to be provided for all applications. All control sequences within or programmed into the ILC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.

d. The ILC shall be provided with the ability to interface with the Graphical Programming tool. The interface port shall be provided at the wall sensor or within the unitary equipment, as specified on the plans. The interface port shall allow the GP to have full functionality as described in GP section of this specification.

Through the connected controller all ILC devices on the LON bus shall be accessible by the Graphical Programming tool.

e. Mechanical equipment manufacturers desiring to provide ILC type controls as factory mounted equipment, shall provide a separate bid for their products less all controls, actuators, valve assemblies and sensors, which are specified to be provided by the FMCS contractor.

4. ILC – VAV Controller Functionality.

a. Controls shall be microprocessor based Pressure Independent Variable Air Volume Digital Controllers, as shown in the drawings. The VAV ILC shall be a single integrated package consisting of a microprocessor, power supply, damper actuator, differential pressure transducer, field terminations, and application software. An alternate model shall be offered that allows for direct connectivity to an external actuator for those applications that employ a non-butterfly style damper configuration. All input/output signals shall be directly hardwired to the VAV ILC controller. The internal actuator shall employ a manual override that allows for powered or non-powered adjustment of the damper position. In all cases, the controller shall automatically resume proper operation following the return of power to, or control by the ILC. Programming, configuring and/or troubleshooting of input/output signals shall be easily executed through the ILC sensor or GP tool connected at the wall sensor location.

b. The VAV ILC control algorithms shall be designed to limit the frequency of damper repositioning, to assure a minimum 10-year life from all components. The VAV ILC shall provide internal differential pressure transducer for pressure independent applications with an accuracy of ± 5 %. Flows through transducers requiring filter maintenance are not acceptable. The VAV ILC shall provide zone control accuracy equal to or better than +/- 1 degree Fahrenheit. Systems providing control accuracy's greater than +/- 1 degrees Fahrenheit are not acceptable. With the submittal package, contractor shall provide performance data that verifies control accuracy of the VAV ILC.

c. All input/output signals shall be directly hardwired to the VAV ILC. A minimum of one input point of the VAV ILC shall employ a universal configuration that allows for flexibility in application ranging from dry contact, resistive, to voltage/current sourced inputs. If a universal point is not available, a minimum of one input point (each) of the dry contact, resistive and analog voltage/current types must be provided on every controller. The outputs of the ILC shall be of the relay and universal analog form.

All digital outputs shall be relay type. ILC devices utilizing non-relay outputs shall provide an interface relay for all points. All analog outputs shall be programmable for their start points and span to accommodate the control devices. Configuration of all I/O points shall be accomplished without physical hardware jumpers, switches or settings. Troubleshooting of input/output signals shall be easily executed with the Graphical Programming tool or a volt-ohm meter (VOM). All I/O points shall be utilized by the local ILC or shall be available as I/O points for other controllers throughout the network.

d. The FMCS contractor shall provide VAV ILC to the VAV box manufacturer, for factory mounting. The VAV terminal unit supplier shall include in its price all costs for mounting of VAV ILC controller, connection of actuator to damper shaft, wiring of device power, wiring of VAV ILC to fan (fan powered terminal) and wiring to electric reheat coils or reheat valve actuator as specified on drawing.

e. The VAV terminal manufacturer shall provide a multi-point, averaging, differential pressure sensor mounted on the inlet to each VAV box. The VAV terminal unit manufacturer shall supply a line to low voltage transformer, of sufficient capacity, to power the VAV ILC plus all reheat valves and/or contactors and fan circuits associated with the VAV terminal and actuator assemblies. The FMCS contractor shall provide all reheat control valves to the mechanical contractor for mounting and piping. The FMCS contractor shall provide and install all wiring between the valve and VAV ILC controller and between the room sensor and the VAV ILC controller.

5. ILC VAV - Air Balancing.

a. Through the portable GP tool, the VAV ILC shall support a fully prompted Air Balance sequence. The GP tool shall, when connected through the wall sensor, access the connected VAV ILC unit. The air balance sequence shall step the balancing contractor through the checkout and calibration of the VAV ILC. Upon completion of the balancing sequence, the flow values presented by the VAV ILC shall match those observed by the balancing contractor's measurement equipment. Additionally, upon completion of the air balance, the SDC shall automatically archive the balance settings for future use if the controller were to require replacement. Systems not able to provide a formatted air balance GP tool shall provide an individual full time during the Air-balancing process to assure full balance compliance.

D. Interoperable Digital Controllers (IDC).

1. General.

a. Controls shall be microprocessor based Interoperable LonWorks Digital Controllers (IDC), providing interoperability with all LONMARK and LonWorks devices. IDCs shall be provided for any equipment applications as required, as shown on the drawings. IDCs shall be based on the Echelon Neuron Hosted microprocessor architecture, working from software program memory that is physically located in the IDC. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals.

b. All IDCs shall be fully application programmable utilizing graphical objects. All control sequences programmed into the IDC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained. Systems that only allow selection of sequences from a library or table are not acceptable.

c. The IDC shall be provided with the ability to interface with the Graphical Programming tool. The interface port shall allow the GP to have full functionality as described in GP section of this specification. Through the interface port all IDC devices on the LON bus shall be accessible by the Graphical Programming tool.

d. The IDCs shall communicate with the SDC at a baud rate of not less than 78.8K baud. The IDC shall have as a minimum ambient operating temperature range of 32 to 122 degrees Fahrenheit.

e. The IDC shall be fully supported by the Graphical User Interface (GUI).

f. All input/output signals shall be directly hardwired to the IDC. All controllers shall employ a universal input configuration that allows for flexibility in application ranging from dry contact, resistive, to voltage/current-sourced inputs. If universal points are not available, a minimum of one spare input point (each) of the dry contact, resistive and analog voltage/current types must be provided for each input point utilized. IDC devices shall provide digital and analog output types and quantities consistent with the requirements of the application requirements. Troubleshooting of input/output signals shall be easily executed with the Graphical Programming tool or a volt-ohm meter (VOM). All I/O points shall be utilized by the local ILC or shall be available as I/O points for other controllers throughout the network.

g. To simplify controls and mechanical service troubleshooting, the

IDC shall be mounted directly in or on the control compartment of the air handling system. The IDC shall be provided in a NEMA 1 enclosure to accommodate direct mounting on the equipment to be controlled. The IDC shall be constructed in a modular orientation such that service of the failed components can be done quickly and easily. The modular construction should limit the quantities of printed circuit boards to a maximum of two. All logic, control system, power supply and input/output circuitry shall be contained on a single plug-in circuit board. All wiring terminations shall be made to serviceable connections allowing controller reconfiguration without the removal of any terminated wires. This shall allow all controls maintenance and troubleshooting to be made while at the air handling unit. The IDC shall be directly wired to sensory devices, staging relays or modulating valves for heating and cooling.

h. The FMCS contractor shall provide and field install all IDCs specified under this section. Mechanical equipment manufacturers desiring to provide IDC type controls as factory mounted equipment, shall provide a separate bid for their products less all controls, actuators, valve assemblies and sensors, which are specified to be provided by the BAS/Temperature control contractor.

3.2 Graphical User Interface (GUI):

A. The Graphical User Interface shall reside on the LonWorks communication bus to allow the operator to view, configure, and edit values from multiple controllers on the bus. The GUI shall be completely programmable and shall be wall or panel mounted. Operator interface shall be via a touch screen display with ASHRAE standard user-definable graphical icons associated with any displayed variable. Variables such as alarms, trends, setpoints, analog, and digital values may be displayed and/or edited using the GUI.

B. Multiple GUI's shall be capable of residing on the communications bus and shall be capable of displaying common and/or unique parameters of the system controllers. The GUI shall be menu based displaying a minimum of 16 menus, and 256 unique system parameters.

C. Each GUI shall be password protected and provide for a minimum of three unique passwords. All data residing in the GUI shall be stored in EEPROM non-volatile memory, which is not dependent upon the presence of a battery, to be retained. GUI's that do not have EEPROM shall provide a minimum 6-month battery back up, or dedicated UPS for each GUI.

3.3 Graphical Programmer (GP):

A. A Graphical Programmer's utility tool shall be provided. The utility shall reside

on a portable laptop 200 MegHz Pentium-based computer with a minimum of 64Meg of ram. The computer shall include a PCC-10 network interface card to allow for direct connection to the Lon bus. Alternately, or in addition to, the GP tool can reside on the primary HMI platform when direct LONMARK connectivity is made through the HMI. The GP is a graphical object-oriented Visio-based drawing tool that provides an intuitive interface for network design integrating LonWorks capabilities into Windows NT based applications. These functions shall include Network Management services such as device installation, device configuration, diagnostics, maintenance, and defining network data connections between system controllers, know as "binding." All ILCs and IDCs shall be programmed using the GP. The utility shall be capable of downloading application programs to all of the devices within the FMCS.

3.4 Gateway Digital Controller (GDC):

A. Gateway Digital Controllers (GDCs) shall be provided for the purpose of integrating microprocessor based, communicating, direct digital control systems from vendors other than the primary, selected controls manufacturer, that do not comply with the open, interoperability requirements of this specification. GDCs shall work from software program memory that is physically located in the GDC. All communications interface control programs shall be resident within the GDC. All GDCs shall exist at the LAN level with the SDCs and HMIs. The GDCs shall support the protocol interface driver tool defined in the FMCS section of this specification. FMCS' that do not offer GDCs and the protocol driver tool kit, shall not be acceptable.

B. The FMCS contractor shall provide and field install all GDCs specified under this section. Any interface requirement beyond a two wire communications wire link, shall be provided by the equipment manufacturer supplying the non-open, non-interoperable microprocessor based, communicating, direct digital controllers, unless specifically defined otherwise in these specification documents.

3.5 Human Machine Interface (HMI):

A. Human Machine Interface Hardware - the HMI shall include as a minimum:

1. This HMI computer shall be a Pentium II (450mhz) computer with MS NT 4.0 operating system. (Operating systems that provide only foreground/background operation, or are based on concurrent DOS, are unacceptable and will be rejected.)

2. The system shall come standard with at least 256K RAM disk cache and 128 megabytes of system RAM.

3. High Resolution Color Monitor: Provide HMI with a 19" non-interlaced 72 Hz .28 dot pitch Super VGA (1024 X 780 resolution) color monitor and driver. Video card shall have 4 megabyte of video RAM.

4. A 1.44 megabyte 3.5” floppy drive and a 6.0 GIG 10 millisecond average access time hard disk drive.

5. High quality bus or serial mouse. The HMI shall also be provided with a 104 key keyboard. Either mouse or keyboard shall be able to be utilized interchangeably for operator interface.

6. A 56K baud phone/fax modem.

7. One (1) parallel printer: Epson LX-300, 80 column 160 cps tractor feed, for reports, alarms and exception messages.

8. A built-in read/write CD-ROM, for the purpose of manually and automatically backing up fixed system data, shall be provided.

9. Provide HMI to HMI communications via an IEEE 802.3 10/100 Mbps Ethernet Network Adapter. The Ethernet adapter shall support early token release for improved efficiency.

B. Human Machine Interface Software – the HMI shall include as a minimum:

1. The HMI shall be a 32 bit, object oriented application that is interoperable with all 16 and 32 bit non-FMCS applications. System shall support MS NT 4.0 long file name designations. Systems not utilizing a 32 bit, object oriented structure are not acceptable. The ability to develop displays and presentations in multiple screen resolutions shall be provided. This feature affords the ability to incorporate the FMCS HMI into the existing network independent of the hardware currently installed.

2. The HMI shall be completely icon driven, multi-tasking and employing a graphical operating environment that allows the operator to perform virtually all functions through the mouse, without dependence on the keyboard to do operator functions. Up to 16 applications may collect data dynamically and simultaneously from the SDCs without HMI speed degradation. The HMI shall have the ability to allow the passing of data freely to MS Windows applications that incorporate the use of Dynamic Data Exchange.

3. Provide a modem and software for remote access into the HMI in a bi-directional fashion with remote SDCs. Up to 250 locations shall be addressable by the HMI.

4. The HMI, through its LAN connectivity, shall support the following standard Net BIOS network configurations; Ethernet, Novell, Token-Ring, ARCNET, Serial and TCP/IP.

5. The HMI shall be utilized for real-time access to all integrated systems on the LAN as well as for information management. Information

management shall mean the manipulation of all real time or archived system information, via spreadsheets, databases, etc. Complete file management and data transfer (such as copying, moving or transferring files) automatically and manually shall be provided via Dynamic Data Exchange. An inherent knowledge by the operator of the "operating system" shall not be required for the daily operation of this system.

6. The HMI shall be capable of true multi-tasking capabilities. The User shall be able to use other non-related programs in the HMI while still running all HMI applications with no interruptions, including the use of real time data in other applications. The HMI shall allow spreadsheet programs to gather data from the SDCs dynamically, while monitoring Display Frames.

7. Active-X COM objects shall be supported to allow for easy system tailoring and customization. Systems not supporting Active-X Controls shall provide a full definition of how the operator can customize the presentation of the system.

8. The HMI shall support OLE and OPC interface conventions allowing for the integration of non-FMCS applications into the HMI.

9. The HMI must support the Standard Query Language (SQL) component of the Open Database Connectivity (ODBC) standard. Utilities that extend the power and functionality of the SQL component are desirable. Definition of these ODBC extensions is required. Systems that do not extend the ODBC standard shall define how system expansion will be supported.

10. This HMI shall provide an easy method of menuing for system access. Any and all HMI programs, MS Windows or NT programs shall be accessible only through this HMI menuing system. Systems that require the use of MS Windows 95 explorer and/or X-Tree format, as the shell or entry point to other programs, shall be rejected.

11. This menuing program shall utilize dynamic push buttons. Each pushbutton shall be user configurable to allow access to any of the HMIs applications. A push-button shall display a user selectable ICON and text describing visually the linked application. The dynamic push button shall be capable of launching an application or a specific file. As an example, a push-button may be configured to take a User to a Dynamic Graphic screen for a Particular Zone in a building or launch a non-FMCS business application.

12. Predefined graphical wizards shall be provided to simplify the introduction of the HMIs operating system to the user. Systems not providing standard wizards shall include a minimum of 80 hours of specific HMI training with the base bid.

13. System shall provide a scripting language that allows the operator to define customized sequences and FMCS control functions. As a minimum, the scripting language shall provide simulation, prototyping and background calculating capabilities. Systems that do not provide a user definable, powerful scripting language shall not be acceptable.

14. The HMI shall be capable of connecting to the Internet via a Browser application to allow access to FMCS dynamic data from a remote Internet access point. Systems that do not allow for Internet access and connectivity, via the HMI, shall provide as a minimum, 10 additional client access packages for remote connectivity.

15. System shall automatically re-launch the HMI applications following a power failure reset of the hardware, with no operator intervention required. Multiple servers shall be supported with full time system performance monitoring and the ability to restore system functionality by automatically selecting a new server, upon failure of the primary server, without operator intervention. In addition, monitoring of GDC connectivity points shall be provided on an automatic basis, allowing for automatic redirection of bus connectivity upon reported failure.

C. HMI System Security:

1. System Security shall be on an application by application basis. System Administrator shall setup and define access privileges per user, per application and per setpoint levels. The Users shall be assigned discrete password names an codes, both of which must be entered in order to have access to any particular application or function within the system. Access privileges shall also be assignable for entry into the standard MS Windows NT or array of applications such as File Manager, Task Manager or others. A minimum of 10,000 levels of assignable access must be provided. Systems not supporting this level of customization and flexibility for system security must define delivered capabilities, and may not be accessible.

D. HMI Display Frames:

1. The Dynamic Graphic portion of this HMI shall allow the operator to access any system information via a “system penetration” method. “System penetration” shall allow the operator to penetrate into the facility until the detailed color graphic display of a specific area of the facility is represented. All system travel shall be 100% accessible via the mouse, no keyboard commands shall be necessary to edit dynamic data.

2. The ability to import background images for the display frames shall include as a minimum, photos, digital images, bitmaps and standard image formats. Systems that utilize a proprietary background image format are

not acceptable.

3. As a minimum, a graphic display shall be provided for the overall site, for each subsystem within the site and for all individual locations associated with each subsystem. All graphics shall be logically linked to allow the operator to traverse through the overall system and at any time return immediately to the associated subsystem, or overall site plan, via a graphic element.

4. The system shall allow for the easy development and editing of dynamic graphics. Wizards shall be utilized to assist the operator with their manipulation of the graphic system. The operator shall be able to, through a single mouse function, select between the dynamic display mode and the graphic edit mode for the currently viewed graphic frame, assuming appropriate access level is provided to the operator. Systems requiring multiple mouse or operator keyboard commands to enter the graphic edit mode are not desirable and require thorough definition of steps involved to accomplish function.

5. Animation of system data shall be provided via graphic elements on the display frames. Standard graphic element library shall be provided to assist the operator with their implementation. The ability to define and add new animated graphic elements shall be provided. As a minimum, the ability to move, size, draw, arrange, align, layer, space, rotate, invert, duplicate, cut, copy, paste, erase any animated element shall be provided. System parameters and setpoints shall be assignable and modifiable by the animated graphic elements, relieving the need for keyboard commands for system manipulation.

6. The ability to simultaneously display a dynamic X/Y Chart of selected points, shall be provided. The chart shall be an element of the graphic display and shall automatically update with the display data. The chart shall allow for dynamic manipulation to modify the range, rate, and timeframe of view, in both a real-time as well as historical configuration. A minimum of 4 values shall be included on any chart display element. There shall not be a limit to the quantity of chart elements displayed on a graphic frame. Trace colors and X values shall be User configurable. Systems not providing this capability are required to provide an equivalent charting package with the HMI offering.

7. Full on-line system documentation shall be provided. It shall not be necessary to maintain printed copies of user or programming manuals. Context sensitive help files shall be provided for all applications within the FMCS area of the HMI. The ability to update on-line documentation must be provided via electronic updates, definition of update procedure shall be provided.

8. By pointing and clicking on any individual graphic element, the following

shall be available for display or modification, but not be limited to the current value or state may be edited. A self-prompting pop-up window shall be displayed providing the ability to modify the selected point value. Instructions assisting the operator in their use of the pop-up window shall be provided.

9. The ability to provide graphically displayed global scheduling and editing functions shall be provided. The ability to link these functions to the associated equipment or zone frames shall be a standard feature. A calendar shall be provided for display and modification of the SDC time clock functions. The User shall be able to view a daily, weekly, monthly, annual, special or holiday schedule from a defined display frame. A list of served areas shall be displayed on the same screen, this list shall be displayed at all times, pull down menus or other means of accessing these areas shall not be acceptable. The user shall only have to click on a served area to view its time clock schedule.

E. HMI Alarming:

1. The HMI shall provide, as standard, alarm annunciation of system data. On every display frame, the ability to view, acknowledge, delete and manipulate real-time and historical alarms shall be provided. The ability to provide a unique and custom alarm display for every display frame shall be provided. The ability to continuously or upon request, view the alarm display, shall be provided.

2. Alarm conditions shall be capable of invoking, as a minimum; a display frame, response instruction display, an audible annunciator, full conversation instructions, visual real-time video display, and any executable file.

3. Alarm logging shall be provided in a user definable configuration. All alarms shall be displayed and/or routed as follows, as a minimum; HMI display frame, local printer, server printer, client printer, logged to file, and archived in standard format for information management. Alarm groupings shall be hierarchical in nature allowing up to 8 alarm groups and 16 sub-groups. The HMI shall not possess any limits on the quantity of alarms that can be logged, including historical data archiving. Systems possessing limits must define the restrictions and may not be acceptable.

4. Alarm provider shall provide up to 999 alarm priorities with up to 5 alarm color changes, per priority, according to alarm status.

F. HMI Trending:

1. The HMI shall automatically perform time based, user defined, periodic collection of real time point data. The data shall be presented as an X/Y Chart in the Display Frame. The data shall be stored and archived in a file

format that allows for the manipulation and utilization of the data by third party applications.

2. A dynamic trend shall be defined as a group of at least 4 data points, with a circular buffer of 2000 data points. A historical trend shall be defined as a group of at least 8 data points, with the sampled points limited only by archival disk space. Sampling rates shall be user selectable from instantaneous (one per second) to once a week. Collection of data shall be user selectable to start and stop on a specific time and date. There shall be no limit to the number of X/Y Charts within a Display Frame.

3. X/Y Charting and column and row reporting shall be an integral part of the HMI. All points shall be chartable or reportable. Analytical data shall be displayed for any of the selected points in a clearly displayed X/Y Chart. This analytical data shall consist of at least the following: Average Mean, Standard Deviation, Simple Average, Current Value, Cycle Length, Cycle High and Cycle Low.

4. X/Y Charting shall provide for the following chart manipulation: display, zoom, scroll, centering, pen legend and export to Excel, Text via Dynamic Data Exchange.

G. HMI Reporting:

1. The report section of the HMI shall be the window to the HMIs database for all solicited and unsolicited data collected and shall provide for an easy means of reporting and information management. The HMI shall provide daily, weekly, monthly scheduling of reports or intervals custom to the needs of the user. The report generator shall allow an operator to easily and quickly define the contents of a report as well as define a print time and date. Information contained in the reports, as a minimum, shall be derived from alarm history and trend data.

2. The operator shall be able to compile reports by user, company/department, time and date period, point or points, with the ability to print a combination report. The combination report option shall allow the operator to define any or all of the information types to be reported, within one compilation, sorted by the above definitions and displayed, archived and/or printed. A report definition shall be able to be printed once or printed on a time and date schedule with a cover page that automatically identifies the operator, the time and date, and the parameters by which the report was compiled.

3.6 Sequence of Operations:

A. VAV Air Handling Units.

1. Refer to Automatic Temperature Control diagrams on drawings for

requirements.

B. Heating Hot Water System

1. Refer to Automatic Temperature Control diagrams on drawings for requirements.

C. Variable Refrigerant Flow System Heat Pump Units

1. General: Heat Pumps shall be equipped with a self contained control package.

2. Heat Pumps shall be provided with an interface to provide communication with the FMCS.

3. Through the LonWorks interface, the FMCS shall be able to enable and disable the AHU, adjust temperature set-point, and monitor status.

4. Occupied: Supply fan shall be energized and run continuously.

5. Upon a fall in space temperature below set-point (adjustable), as sensed by the space temperature sensor, the heat pump shall be indexed to heating mode.

6. Upon a rise in space temperature above set-point (adjustable), as sensed by the space temperature sensor, the heat pump shall be indexed to cooling mode.

7. Unoccupied: The supply fan shall be de-energized.

8. Upon space temperature decreasing below night setback temperature setpoint (55°F) (adjustable), the unit shall be energized in the heating mode and operate until the space temperature reaches 57°F (adjustable).

9. Safety: The FMCS shall provide duct supply air temperature sensors. If supply air temperature exceeds the parameters for the supply air temperature set-point (adjustable), and an alarm shall be initialized.

10. The units shall be interlocked with the applicable DOAS unit.

11. Dedicated Outside Air System (DOAS)

a. System shall operate to maintain a discharge temperature of 72 degrees Fahrenheit (adjustable).

(END OF SECTION)