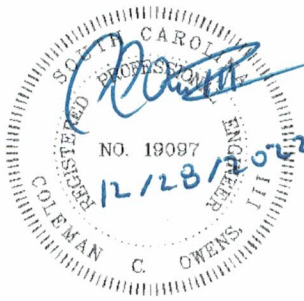
DIVISION NO. 15 – MECHANICAL



SECTION 15010 – GENERAL MECHANICAL

PART ONE – GENERAL:

1.01 SCOPE:

A. The General Conditions and Special Conditions are a part of these specifications.

B. Drawings and specifications are complementary each to the other and what is called for by either shall be as binding as if called for by both.

C. Provide all supervision, labor, material, equipment, machinery, plant and any other items necessary for a complete, safe and quietly operating mechanical system.

D. Examine other drawings and specifications and bring to the attention of the Architect prior to bid time any omissions or discrepancies in this Division.

1.02 CODES, RULES, PERMITS, FEES, APPLICABLE PROVISIONS:

A. The Contractor shall comply with all local, municipal and state laws and the latest revision of the regulations of the National Electric Code, the International Building Code, the International Plumbing Code, the International Gas Code and the International Mechanical Code, in the performance of his work wherever these laws and regulations may apply.

B. The Contractor shall give all required notices, obtain necessary permits and pay all required fees.

C. Deliver to Engineer, permit and licenses, including certificates from local and state health departments approving complete sanitary and water systems. Furnish certificates from fire department approving fire protection system and equipment.

D. Before and/or at completion of work, the Engineer shall cause to be made any and all tests which he may consider necessary. Should it develop during tests that the work is defective and does not comply with these specifications, such changes as are necessary shall be made to put the work in proper condition and the expense of such subsequent tests shall be borne by this Contractor.

E. The following requirements are supplementary to the tests specified for individual equipment and/or systems in this section of these specifications:

1. Concealed or insulated work shall remain uncovered until required tests have been completed, but in the event that the project construction requires it, the Contractor shall make arrangements for tests on portions of the work involved as the project progresses.

2. The Engineer shall be notified in advance of all tests and shall be represented at such tests. The cost of labor, material, instruments, etc., required for tests shall be borne by the Contractor, except where specified elsewhere.

3. Acceptance tests for operation and performance as specified and/or required for all equipment and systems shall be in the presence of the Architect, a representative of the Owner, as well as representatives of agencies having jurisdiction, upon completion of the work.

1.03 DRAWINGS:

A. Project Drawings: The Drawings accompanying this specification are generally diagrammatic and do not show all details of bolts, nuts, connections and the like, required for the complete system and do not indicate the exact location of piping, fixtures, equipment, etc., unless definitely dimensioned or noted. While these drawings shall be followed as closely as possible, all dimensions shall be checked at the building and any necessary changes shall be made in accord with structural and architectural conditions, equipment to be installed or with the work of the different trades, without any additional cost to the Owner and as directed by the Architect. The drawings and specifications are complimentary to the other and what is called for by one shall be as binding as if called for by both. Any component item under this contract shall be furnished and installed by the Contractor without extra charge.

1.04 EXAMINATION OF CONDITIONS:

A. It is understood and agreed that the Contractor has, by careful examination, satisfied as to the nature and location of the work, the conformation of the ground, the character, quality and quantity of the materials to be encountered, the general and local conditions and all other matters which can affect the work under this contract.

1.05 COORDINATION/COORDINATION DRAWINGS:

A. Coordinate work with other trades to avoid interference and establish necessary space requirements and tie-ins for each trade.

B. Prior to starting installation, furnish to the General Contractor and all Subcontractors concerned, copies of approved shop drawings showing location of equipment, piping, etc.

C. Schedule periodic meetings with other trades before and during installation to avoid conflicts and assure that pipes and equipment are installed in the best manner, taking into consideration head-room, maintenance, appearance and replacement.

D. The mechanical contractor shall produce either AutoCAD or Revit coordination drawings including the mechanical, electrical, plumbing, and fire sprinkler systems to be installed in order to avoid installation conflicts during construction. Coordination meetings shall be held after completion of these drawings to resolve potential installation conflicts. Additionally, a REVIT 3-dimensional drawing of the proposed mechanical room (M100/M101) piping and equipment layout shall be generated and

submitted to the engineer for approval prior to any pipe or equipment installation in the main mechanical room. This drawing shall include all equipment to be installed in this space. Any mechanical equipment, ductwork, or associated appurtenance that is installed prior to receiving written coordination drawing approval from the engineer is subject to removal and replacement of all installed material at the contractor's expense. This relates to coordination and installation deficiencies with respect to the requirements of the contract documents as identified by the engineer.

END OF SECTION 15010

SECTION 15040 – GENERAL COMPLETION

PART ONE – GENERAL:

1.01 GENERAL REQUIREMENTS FOR INSTALLATION:

A. Piping, fixtures, equipment, etc. shall be located to avoid interference with structural and architectural conditions or with the work of different trades. Provide off-sets where necessary to avoid footings, piers, columns, beams, windows, piping, electrical fixtures and other systems, etc. Specifically inform the General Contractor as to the correct size and location of all chases, openings, supports, sleeves, etc. required for the system. Furnish and install sleeves, inserts, bolts, etc. and all arrange for the cutting of walls, floors, roofs, etc. and the proper closing of all openings. Cutting of construction, where unavoidable, must be done by the General Contractor but shall be paid for by this Contractor. No part of the building may be broken out, cut, burned or permanently removed without the approval of the Owner and Engineer.

PART TWO – PRODUCTS:

2.01 WORKMANSHIP AND MATERIALS:

A. Workmanship shall be of the best quality and none but competent mechanics skilled in their trades shall be employed. The Contractor shall furnish the services of an experienced superintendent who will be constantly in charge of the erection of the work until completed and accepted.

B. Unless otherwise hereinafter specified, all materials and equipment shall be new, of best grade and as listed in printed catalogs of the manufacturer. Each article of its kind shall be the standard products of a single manufacturer.

C. The Architect shall have the right to accept or reject material, equipment and/or workmanship and determine when the Contractor has complied with the requirements herein specified. Where departures from indicated arrangements are required, written approval for such changes shall be obtained from Architect's representative.

D. All manufactured materials shall be delivered and stored in their original containers. Equipment shall be clearly marked or stamped with the manufacturer's name and rating.

E. All material and equipment used on this project shall be stored in a weatherproof bonded warehouse. Contractor shall submit insurance certificate to the Architect prior to storing any materials or equipment. No equipment, materials or roof-top heat pumps used on this project shall be stored outside exposed to the weather. Before final payment can be made, a

notarized statement with the material invoiced to the Owner must be furnished to the Engineer.

2.02 DIVISION OF WORK:

A. Coordinate all opening locations with General Contractor, see paragraph 2.04.

B. This Contractor shall furnish roof curbs and caps. Curbs and caps to be installed and flashed by the General Contractor, unless otherwise noted.

C. Furnish door grilles to General Contractor for installation.

D. Refer to the Electrical and Control Sections of this specification. The Electrical Subcontractor shall provide all wiring except:

1. Temperature Control Wiring
2. Equipment Control Wiring
3. Interlock Wiring

The Electrical Subcontractor shall furnish all power wiring complete from power source to motor or equipment junction box, including power wiring through starters. Electrical Subcontractor shall install all starters not factory mounted on equipment. The Mechanical Subcontractor shall, regardless of voltage, provide all temperature control wiring for equipment provided under this Division. The Mechanical Subcontractor shall furnish all starters and contactors to the Electrical Subcontractor and shall provide and be responsible for over-load heaters in all starters furnished. Over-loads shall be provided in each ungrounded conductor.

2.03 FINISHES:

A. Finishes for all water coolers, grilles, registers, diffusers, room fan coil units, room air conditioning units, louvers and any other item exposed to view shall be selected by Architect and shall be equivalent to baked enamel. Submit color charts along with submittal data.

2.04 OPENINGS – CUTTING, REPAIRING:

A. This Contractor shall cooperate with the work to be done under the other sections in providing information as to openings required in walls, slabs and footings for all piping and equipment, including sleeves, where required.

B. All drilling, cutting and patching required for the performance of work under this Section shall be performed by the General Contractor and the cost thereof shall be borne by this Contractor.

C. Holes in Concrete: Sleeves shall be furnished, accurately located and installed in for before pouring of concrete. This Contractor shall pay all

additional costs for cutting of holes as the result of the incorrect location of sleeves. All holes through existing concrete shall be either core drilled or saw cut. All holes required shall have the approval of the Structural Engineer prior to cutting or drilling. All penetrations shall be grouted all around with cement.

2.05 EXCAVATION AND BACKFILL:

A. General: The Contractor shall do all excavating and backfilling necessary to receive the work shown on the drawings.

Excavations shall be made to the proper depth and the trenches shall be graded uniformly to provide a solid bearing along the entire length of the pipe. Bell holes shall be provided in trenches at the joints in hub and spigot pipe to facilitate caulking and so that piping will not be supported in hubs. All trenches shall be excavated so that pipes will have at least six (6) inches clearance on each side. Pipes in fill or loose sand shall have trench bottom tamped to 95% maximum density compaction prior to laying pipe.

B. Dewatering and Shoring: Pumps shall be furnished as required to keep trenches dry during the laying and jointing of the mains. Provide shoring where required, maintaining trenches against settlement until final acceptance.

C. Backfilling: Do not fill any trenches until all piping has been inspected. After the work is installed, tested, inspected and approved, the trenches shall be refilled in six (6) inch layers with clean, damp earth, with each layer thoroughly tamped before proceeding with additional layers. Remove from site all excess earth, rock and other debris resulting from excavation and backfill work.

2.06 NAMEPLATES:

A. On all manufactured equipment, provide engraved plastic nameplates as manufactured by Seton Nameplate Co., Columbia-Engravers, International Nameplate Co. or equal. Unless otherwise noted, nameplates shall be 1/16” thick plastic with white letters on a black background. Attach nameplates with two (2) round-head chrome plated screws.

B. Unless otherwise noted, letters identifying equipment in equipment rooms to be ½” high. All other letters shall be 1/8” high. Hand lettering, under typing tape, embossed letters on plastic, etc. will not be acceptable.

C. Provide additional nameplates for mechanical equipment that is suspended above lay in/accessible ceilings. Nameplates shall be located directly below suspended equipment and attached to the ceiling gird (not tiles) to indicate approximate location of equipment.

2.07 CLEANING EQUIPMENT AND MATERIALS:

A. Provide for the safety and good condition of all materials and equipment until final acceptance by the Owner. Protect all materials and equipment from damage. Provide adequate and proper storage facilities during the progress of the work. Special care shall be taken to provide for bearings, open connections, pipe coils, pumps and similar equipment.

B. All fixtures, piping, finished surfaces and equipment shall have all grease, adhesive labels and foreign materials removed.

C. All piping shall be drained and flushed to remove grease and foreign matter. Pressure regulating assemblies, traps, flush valves and similar items shall be thoroughly cleaned. Remove and thoroughly clean and reinstall all strainer screens after the system has been in operation for ten (10) days.

2.08 CLEANING UP:

A. Remove from the premises all unused material and debris resulting from the performance of work under this section.

2.09 DAMAGES:

A. Cost of repairing damage to building, building contents and site during the construction and guarantee period resulting from this work including damage to ceilings or walls is a part of this contract.

2.10 FINISHED PLANS:

A. As-Build Drawings: Upon completion of work, the Contractor shall furnish and deliver to the Owner two (2) sets of as-built drawings to correspond in size to the tracings, showing among other things, layouts of utility systems and functional systems (such as air distribution, water, storm drainage and sanitary sewer). All pertinent dimensions and elevations of buried work shall be given.

2.11 INSTRUCTIONS:

A. Provide a hard-back, three-ring file folder containing all warranties, catalog data and the manufacturer's recommendations and the frequency with which each is to be done. Each sheet shall be initialed by the manufacturer's agent as being correct. Provide columns on each sheet so that they may be dated by maintenance personnel when each individual function is performed. Contractor shall furnish a typed maintenance manual in hard-back, three-ring binder explaining all maintenance functions. The Contractor shall instruct and demonstrate each maintenance function to the Owner's Representative. The Owner's Representative shall in turn, sign the maintenance sheets indicating his/her understanding of the instructions. Coordinate all equipment start-ups with the Owner so that they may be present.

B. The Contractor shall instruct the Owner's Representative in complete detail as to the proper operation of the overall system. Advise the Owner as to where to order common replacement items. Deliver to the Owner, the manufacturer's agent's name, address and telephone number of each piece of equipment.

C. The Contractor shall provide a complete listing of filter sizes and counts of all mechanical equipment to Owner's Representative.

2.12 GUARANTEE:

The Contractor agrees:

A. Contractor shall correct defects in workmanship materials, controls and operation of the system for a period of 1 year from the date of substantial completion and acceptance of work. Any equipment/material installed by the contractor replaced during the first-year warranty period shall be guaranteed for an additional year starting from the date of replacement. A manufacturer 5-year parts and labor warranty shall be provided for all HVAC equipment that utilizes a compressor or compressors. This warranty shall cover the entire refrigeration system including the refrigerant. The manufacturer's warranty certificate shall be included in the contractor's closeout documents provided at the completion of the project.

B. That the systems installed will safely, quietly and efficiently perform their respective functions in accordance with the design.

C. To service completely the systems for a period of one (1) year.

This work shall include: Adjustment of belts and drives, care of cooling towers (where applicable), complete oiling and greasing of mechanical equipment and labor for changing of air filters. Replacement filters will be furnished by the Owner. Contractor is responsible for providing and changing filters with the frequency as deemed necessary by the engineer and/or commissioning agent during the building construction. All HVAC units that are operated during construction shall have MERV 8 Minimum construction filters. Final Operating filters shall be MERV 8 minimum. Additionally, contractor shall protect all ductwork and mechanical equipment openings with construction quality sheet plastic to prevent construction dust/debris from entering into air or water moving equipment. All equipment, pipe, ductwork or related appurtenances fouled by construction debris shall be removed and replaced. Ventilation air units shall not be used to dehumidify the building during construction activities. VAU's shall only be operated after final cleaning of the building.

END OF SECTION 15040

SECTION 15050 – BASIC MATERIALS AND METHODS

PART ONE – GENERAL:

1.01 APPROVALS AND SUBSTITUTIONS:

A. All requests for substitutions shall be submitted so as to be received by the Engineer at least ten (10) days before bid date and must be approved before award of contract.

B. Contract prices shall be based on material and equipment as specified, unless written approval is obtained for any deviations. Requests for substitutions before bid date may be submitted by Contractors or by Equipment Manufacturer's Representatives.

C. Requests for approvals shall be submitted in the form of a letter (with one [1] copy minimum) on a letterhead of submitting firm, along with a self-addressed stamped return envelope. Letter shall be addressed to the Engineer and referenced to this project. Faxed requests are not acceptable.

D. If there are no deviations between the items submitted and the plans and specifications then the submittal letter should contain the statement, "Items are in accordance with plans and specifications with no deviations." An item with deviations from the plans and specifications may be submitted for approval consideration. Letter should then state, "Item submitted is in accordance with plans and specifications, except for the following deviations." Deviations should then be listed in itemized form.

E. Items approved shall not be construed as authorizing deviations from the plans and specifications. Contractor shall be responsible for verifying all dimensions with available space conditions with provisions for proper access, maintenance and part replacement and for coordination with other trades – electrical, plumbing, structural, etc. for proper services and construction requirements.

F. Where such approved deviations require a different quality and arrangement of ductwork, piping, wiring, conduit and equipment from that specified of indicated on the drawings, the Subcontractor shall furnish and install any such ductwork, piping, structural supports, insulation, controllers, motors, starters, electrical wiring and conduit and any other additional equipment required by the system at no additional cost to the Owner.

PART TWO – PRODUCTS AND EXECUTION:

2.01 MANUFACTURER'S INSTRUCTIONS:

A. Prior to purchasing equipment, procure product manufacturer's application, installation and operating instructions for use in conjunction with the system design drawings and specifications during construction. If there is any conflict between the manufacturer's publications and the design drawings and specifications, immediately notify the Engineer in writing. Upon notification by the Engineer, proceed in accordance with his/her instructions.

2.02 SHOP DRAWINGS:

A. The Subcontractor shall submit for approval detailed shop drawings of all equipment and all material required to complete the project and no material or equipment may be delivered to the job site or installed until the Subcontractor has in his possession the approved shop drawings for the particular material or equipment. The shop drawings shall be complete as described herein. The Subcontractor shall furnish the number of copies required by the General Contractor and Special Conditions of the contract but in no case less than six (6) copies. Shop drawings shall be submitted in appropriately sized 3-ring binders. Submittals shall be comprehensive and include all equipment/products to be provided. Partial submittals will be disapproved.

B. Prior to delivery of any material to the job site and sufficiently in advance of requirements to allow Architect ample time for checking, submit for approval detailed dimensional drawings or cuts showing construction, size, arrangement, operating clearances, performance characteristics and capacity. Each item of equipment proposed shall be a standard catalog product of an established manufacturer and of equal quality, finish and durability to that specified.

C. Samples, drawings, specifications and/or catalogs submitted for approval shall be properly labeled indicating specific service for which material or equipment is to be used, section and article number of specifications governing, Contractor's name and name of project.

D. Catalogs, pamphlets or other documents submitted to describe items on which approval is being requested shall be specific and identification in catalog, pamphlet, etc. of each item submitted shall be clearly made in ink. Data of a general nature will not be accepted.

E. Approval by the Architect and/or Engineer of shop drawings for any material, apparatus, devices and layouts shall not relieve this Contractor from the responsibility of furnishing same of proper dimension, size, quantity, quality and all performance characteristics to efficiently perform the requirements and intent of the contract documents.

   In addition, approval shall not relieve this Contractor from responsibility for errors of any sort on the shop drawings. If the shop drawings deviate from the contract documents, this Contractor shall advise the Architect and/or Engineer of the deviations in writing accompanying the shop drawings, including the reasons for deviations.

F. Failure of the Subcontractor to submit shop drawings in ample time for checking shall not entitle him/her to an extension on contract time and no claim for extension by reason of such default will be allowed.

END OF SECTION 15050

SECTION 15400 – PLUMBING

PART ONE - GENERAL:

1.01 APPLICABLE PROVISIONS:

A. General and Special Conditions are a part of this Section of the specifications and shall be consulted in detail for information pertaining to the work under this Section. Conditions of Sections 15010, 15040, and 15050 shall be a part of this Section also. Provide seismic support for plumbing systems per specification section 15890.

B. Drawings and specifications are complementary, and what is called for by either shall be as binding as if called for by both.

C. Contractor shall provide complete submittal to comply with Specification Section 15050, Paragraph 2.02. Partial submittals will be disapproved.

1.02 SCOPE:

A. Provide all plant, labor, equipment, material, and operations required for the installation of a complete, safe, and quietly operating sanitary system in accordance with specifications and drawings and subject to terms and conditions of the contract.

B. All permit, and inspection fees shall be included in this contract. All tap, meter, and impact fees are not to be included.

1.03 QUALITY ASSURANCE:

A. Before construction of project starts, check locations and inverts of existing and proposed pipes, sewers, and mains. Review other drawings for project; check grades, elevations, location of structural elements, locations and sizes of chases, type and methods of existing and new construction of floors, walls, partitions, etc. Report to Architect before start of construction any unsatisfactory condition or conflict between plumbing and other trades. No extra charge will be approved after start of construction for work resulting from failure to follow these instructions.

B. Unless otherwise shown, piping to be installed concealed, straight without sags or pockets, and graded for drainage. Cut pipe ends square and ream; before assembly, clean of all dirt, scale, and chips. Solder joints according to fittings manufacturer's recommendations. Apply pipe compound to external threads only. Run cold water pipe at least 12 inches away from the source of heat. Make adequate provision for expansion and contraction of pipes.

C. Liability for damages to buildings, contents of buildings, or site property during construction and guarantee period resulting from workmanship, materials or equipment supplied under this specification is a part of this contract.

D. Plumbing Contractor shall coordinate the location of all drain lines below slab with the General Contractor. The Plumbing Contractor shall install drain lines to avoid all column footings, grade beams, and pile caps. Sleeve all pipes thru walls or footings. Piping

under footings shall also be sleeved.

E. Plumbing Contractor shall patch solid or pour concrete for any foundation block removed or broken out for the installation of this work.

1.04 PROTECTION OF FIXTURES, EQUIPMENT, AND MATERIALS:

A. Protect against theft and damage.

B. Protect pipe openings and drains by plugs or caps. Clear all stoppages.

C. Protect finish on all fixtures and chrome trim during construction and cleanup. Avoid any exposure to acid fumes on the chrome.

1.05. SOLDER:

A. Any pipe, solder, or flux used shall be "lead free". The Federal Safe Drinking Water Act defines "lead free" as: "less than 0.2 percent lead in solder and flux, and less than 8.0 percent lead in pipes and fittings." See Section 15405, 1.01, F.4 for allowed products.

1.06 LAYOUT:

A. The Contractor shall make layout drawings for work that is to be installed under this Division of the Contract. The Contractor shall be responsible for all dimensions and space conditions. The Contractor shall coordinate his work with that of all trades. Particular care shall be exercised over lay-in and gypsum board ceilings, location of sleeves, and fixture spacing

B. All work and testing of piping above ceiling areas shall be completed before installation of ceiling tile or carpet.

1.07 PAINTING:

A. Clean and prepare exposed un-plated metal surfaces for painting. Pickle galvanized surfaces.

B. Except for asphalt-coated metal, apply two coats of oil paint for all exposed un-plated metal surfaces. Apply to exposed asphalt-coated metal surface two coats of paint manufactured for application to this type surface. Colors shall be selected by Architect.

C. Size insulation jackets that are in exposed locations and apply two coats of oil paint of colors selected by Architect.

D. Touch up factory finish on heaters, burners, pumps, etc. to match; sand, prime and cover all scratches or rust.

1.08 EQUIPMENT FOUNDATIONS:

A. Set all floor mounted equipment on 6" high concrete pads reinforced with 6 x 6, 10/10

Mesh. Pads shall be approximately 6" larger than equipment base and have 1" x 1" chamfer on all edges. Pads to have carborundum brick rubbed finish. Surface finish shall be uniformly smooth. All water heaters shall be provided with a 16 gauge, galvanized steel drain pan with welded watertight seams. Drain pan shall be provided with a ¾" ball valve and piped to funnel drain. See water heater schedule.

B. See detail on plans.

1.09 CONSTRUCTION WATER:

A. Install temporary water service to supply water for construction purposes. Plumbing Contractor shall locate and maintain two hosebibs at locations directed on site by General Contractor.

B. At completion of project, Plumbing Contractor shall remove all temporary lines, valves, meter, hosebibs, etc. This is to be done prior to fine grading around the building.

C. Connect to existing line beyond existing meter pit, on site as directed. Coordinate the connection with the Owner on site.

1.10 WATER SERVICE:

A. Connect to the existing water main at location indicated on drawings. New piping shall be type "K" copper below grade.

B. Backflow preventer shall be furnished and installed as indicated on drawing.

1.11 ACCESS DOOR AND PANELS:

A. Furnish to General Contractor factory fabricated doors and panels for installation at all places where specialties, valves, equipment, shock arrestors, etc., are inaccessible. Access means to be of adequate size for intended service and of approved manufacture, finish and type. Instruct General Contractor where to install access means and check for proper location. Panels installed in fire-rated ceiling or wall shall have same hourly fire ratings.

B. Access doors to be a minimum 14 gauge steel, in prime coat, with concealed hinges and flush key operated locking device. Doors shall be furnished to suit specific building construction. Size to suit specific requirements (minimum size of 12" x 12"). Submit shop drawings for approval.

C. Note the Water Piping Plans for some locations in suspended gypsum ceiling and/or chase walls of the gang toilets.

D. See detail of hose reel piping. Access panel required at check valve location in wall of kitchen at each reel location.

1.12 INSTALLATION PROCEDURE:

A. Prior to starting installation, furnish to the General Contractor and all Sub-Contractors concerned copies of approved shop drawings showing location of equipment, piping, etc.

B. Schedule meetings with other trades before and during installation to avoid conflicts and assure that pipes and equipment are installed in the best manner, taking into consideration head-room, maintenance, appearance, and replacement.

1.13 TESTS:

A. Leak test hot and cold water pipes at 150 psi hydrostatic pressure before covering. Block off equipment and accessories not designed for test pressure.

B. Test entire drainage and venting system by plugging all necessary openings and filling system with water to the level of the top of the highest vent stack. Not less than 10 feet of water pressure will be acceptable.

C. Notify Architect/Engineer 24 hours in advance of all planned tests so Representative may be present.

D. Contractor shall test the entire drainage and vent system by means of a “smoke test” at the time of final inspection. Contractor shall use the manhole at front entry and grease trap where applicable as means to introduce ”smoke” into DWV system.

E. At project completion, all below slab/grade drained and waste piping shall be video recorded to verify proper grade and installation. Video shall be turned over to the district maintenance department as part of the project closeout documentation.

F. Contractor shall get dimensions of actual location of all underground piping on as-built plans and provide photo graphed documentation of installation in trenches prior to back filling. A minimum of 2 dimensions from building reference points shall be provided and inverts indicated.

END OF SECTION 15400

SECTION 15401 – DRAIN, WASTE AND VENT PIPING

PART ONE - PRODUCTS:

1.01 SOIL, WASTE, DRAIN, AND VENT PIPING:

A. Run horizontal pipe, graded uniformly, not less than 1/4" per foot for pipes 2" and smaller, and 1/8" per foot for larger pipes unless otherwise noted on drawings. Offset piping as required to pass obstacles.

B. Change size by reducing fittings. Change direction by 45 degrees wyes and long-sweep bends. Use short-sweep bends only with written approval. No horizontal pipe to be drilled, tapped, or welded. Saddle hubs and bands, tapped tees, and crosses will not be approved.

C. Unless otherwise noted, soil, waste and drain piping to be service weight bell and spigot cast iron. All piping shall be asphalt coated. "No-Hub" may be used above ground only. Pipe shall be from Charlotte, AB&I, or Tyler Foundry Company.

D. Building drain shall be run as indicated on floor plans. See Civil Plans for connections.

E. Materials to conform with Tables 702.1, 702.2, 702.3, "International Plumbing Code", and/or local plumbing code. If a conflict exists between codes, the most stringent shall apply.

F. No-hub pipe may be used above grade for soil, waste, drain, condensate, roof drain, overflow drain, and/or vent piping.

G. Contractor shall install long sweep quarter bends at vent and condensate drain locations in any fire rated wall. Any no hub band installed in a fire rated assembly shall be covered by a UL rated “collar” to match rating of the wall.

H. Lavatory and sink drain "arms" shall be DWV copper. Waste arms serving urinals shall be Schedule 40 threaded red brass pipe with threaded red brass fittings.

I. Vent piping above slab may be no-hub cast iron, Schedule 40 galvanized steel, or DWV copper. All DWV pipe and fittings shall be made in the USA.

J. Condensate and storm drain bell and spigot cast iron piping, below grade or outside building, shall be service weight cast iron with drainage pattern fittings. Pipe shall be handled, installed, bedded, and backfilled per manufacturer’s printed recommendations.

K. Plastic, PVC, or copper flanges shall not be used on urinals.

L. Joints and Connections:

1. Joints in bell and spigot or between such pipe and threaded pipes or caulking ferrules to be "push" joint with compression gaskets of neoprene with approved lubricant. Material shall be Ty-Seal, Charlotte-Seal, or prior approved equal.

2. Screwed joints to be American Standard Taper Pipe Thread.

3. No-hub pipe and fittings shall be coupled with heavy duty neoprene sleeve and stainless steel band couplings. Couplings shall be "Husky White SD2000" by Anaheim, "Clamp-All" 80 lb. bands, Mission “Heavy-Duty” blue couplings, or Proflow “yellow" heavy duty bands by Ideal. Charlotte and Wade “Wide Body” couplings are not approved.

4. Join earthenware fixtures to soil pipe by brass floor flange wiped or iron floor flange connection caulked gas and water tight. Gasket fixture to flange with graphited ring, not with putty or rubber gasket.

5. Joints at floor drains, and cleanouts shall be packed with white oakum, filled with a single pour of molten lead not less than 1" deep, and caulked.

6. Joints in acid waste pipe and drainage fittings shall be made with factory approved heat fusion methods below grade and mechanical joints above slab.

END OF SECTION 15401

SECTION 15404-FLOOR DRAINS, CLEANOUTS, FLASHING & SLEEVES

PART ONE – GENERAL:

1.01 PIPE CLEANOUTS:

A. Install cleanouts at the base of each stack, not over 50 feet in horizontal 3" inch lines, at 75 feet in 4-inch lines, at turns greater than 45 degrees, and where shown. This applies outside as well as in the building. Extend outside cleanouts to surface. See detail on drawings for pad. All threaded parts of the assembly shall be metal.

B. Cleanouts, in general, to be pipe size up to 4 inches; not less than 4 inches for larger pipes. Cleanouts to be heavy brass ferrules and heavy brass plug with raised nut. Except as specified, cleanouts in walls or floors on grade to be extended flush and fitted with heavy polished brass plug with recessed socket. Cleanouts are listed in Schedule on plans. Products shall be by Zurn, Josam, Wade, or Smith.

C. Cleanouts shall be lead caulked into cast iron soil pipe to provide rigid joints. Extend lead joints past first horizontal fitting. In the event underground piping is specified or value engineering to be PVC, connect to the cast iron with a “double hub” section of pipe with lead and oakum joints. This applies inside as well as outside building. Any "loose" cleanouts or pads shall be reworked. Do not install no-hub band below grade to attach cleanout.

D. All interior cleanouts shall be provided with "vandal-proof" screws. At completion of project, furnish to Owner one "tool" to operate each size screw on project.

E. All cleanouts installed in an area to receive Dex-O-Tex flooring shall have an integral wide flange. See Architectural Finish Schedule.

1.02 FLASHING:

A. Where pipes pass through roof, flash as recommended by the manufacturer of the roofing system. Metal roofs shall have Dektite Model #1 or #3 enclosing the pipe and extending 8" in all directions. Equal flashing assembly shall be by Custom Curb or Portals Plus, Inc. Built up or shingle roofs shall have 4 pound lead boot flashings. Turn lead down into the vent pipe. Furnish lead flashing as specified on plans. Deliver to Roofer for installation prior to start of roofing work.

B. Vent pipes shall extend a minimum of 12" above roof.

C. Provide support for vent stacks at roof with U bolts and uni-strut or angle installed between roof purlins, truss, or bar joist.

1.03 FLOOR DRAINS:

A. Unless indicated otherwise, floor drains shall be three-inch minimum size and shall be

cast iron with Nikaloy brass suitable strainer. Furnish clamping collars where membranes are used - otherwise all drains shall have integral seepage pan. Drains are scheduled on plans. All threaded parts of the assembly shall be metal. All drains shall be furnished with caulk outlets. Products shall be by Zurn, Josam, Wade, or Smith.

B. Drains shall be provided with cast iron deep seal P-traps. All drain, trap outlets, and piping to connection into trunk line shall be lead caulked into cast iron soil pipe for rigidity. In the event underground piping is specified or value engineered to be PVC, connect to the cast iron with a “double hub” section of pipe with lead and oakum joints. Any "drains" found to be "loose" shall be reworked prior to pouring floor.

C. Do not block-out for drains; pour into floor slab. Recess drains in large areas 3/4" below finish floor. Floor slope by General Contractor. Drains in small areas or under servicing counters, or equipment shall be flush with finish floor.

D. Do not use no-hub bands to install any floor drain that is in the ground floor slab.

E. Drains shall be equipped with "vandal-proof" screws in strainer tops. Provide Owner with "tool" for each size screw at completion of job.

F. Drains located in areas with Dex-O-Tex floor finish shall have wide flange cast integrally with drain body or a steel plate welded to drain body. Drains with a sheet metal flange are not acceptable.

G. See Note #9 for drains that required trap primer (1/2") connections. All trap primers shall be by drainage connection, no connection to the domestic water piping. Do not install any device above ceiling for this purpose.

1.04 PIPE SLEEVES AND ESCUTCHEONS:

A. Where pipes pass through masonry construction, install sleeves sized to allow 1/2 inch clearance entirely around the passing pipe and insulation. Install sleeves during construction of walls, ceilings, and floors. Extend vertical sleeves a minimum of one inch above finished floor. Install sleeves in a water proof manner. Caulk with packing and waterproof plastic compound. Sleeves in bearing walls and floors shall be made of Schedule 40 steel pipe. Sleeves on other masonry walls shall be made of steel pipe or sections of cast iron pipe. Sleeves shall be flush with each side of masonry wall.

B. Install chromium plated steel escutcheons where pipes and conduit pass through finished walls and ceilings. Install chromium plated cast brass escutcheons where pipes and conduits pass through finished floors.

C. See details for fireproofing of pipes through sleeves in firewalls and floors. Extend insulation on all pipes through fire walls or floors. Contractor shall use a "UL" assembly without substitution. See hourly rating noted on each sheet of plans to identify firewalls.

D. All copper lines shall be sleeved where whey pass through concrete or block.

1.05 FIXTURE CARRIERS

A. Wall hung fixtures shall be supported on wall plate hangers with rectangular steel tube legs bolted to the floor slab. Use of pipe supports is not allowed.

B. Carriers shall be manufactured by Smith, Wade, Zurn, Josam, Watts or MIFAB.

1.06 TRAP PRIMERS

A. Floor Drains noted to have trap primer connection shall have ½" IPS threaded connection. Route ½" soft copper from floor drain up in wall at fixture indicated. Cover copper piping below slab and in block with slip on vinyl jacket.

B. Trap primer shall connect to P-trap of fixture. See note 9 on plans. Do not connect to water lines.

C. Trap primer shall be model #2698 1 1/2" Chrome by J.R. Smith or equals by Zurn.

D. Primer tube shall be ½" chrome plated copper with compression fitting or stainless steel flex hose of the exact length to go from trap to wall without undue sag.

END OF SECTION 15404

SECTION 15405-DOMESTIC WATER PIPING

PART ONE – GENERAL:

1.01 HOT AND COLD WATER PIPING:

A. Unless otherwise indicated, run concealed, pitched to assure venting along drainage. Valve main water service near entry and valve all submains and branches as indicated on plans. Install drain valve at low point in domestic water riser room and check valves in cold water to mixing fittings where tempered water is valved. Handles of below grade valves shall be within 12" of surface of finish grade.

B. Pipe outside building to be run at least 30" below finished grade. Pipe inside building shall be at least 8" below finished slab. All copper pipes below grade shall be protected with two coats of black asphaltum. Hang pipes from structural system. In areas with ceiling, the pipe shall be concealed. Install all supplemental galvanized steel angles or uni-strut needed to provide proper support for pipe hangers at specified hanger spacing.

C. Unless otherwise required, branches to small fixtures to be 1/2" ID for single fixture and 3/4" ID for two fixtures; 1" ID or larger to single flush valve. All pipe sizes indicated are "nominal" pipe size.

D. Hot and cold water piping to be hard drawn copper; type "L" above ground; type "K" underground; soldered wrought copper fittings. Provide soft drawn copper for below slab work in kitchen and first floor lab classrooms with island fixtures to eliminate joints below floor. All domestic water piping and fittings shall be manufactured by Cerro Tube and Nibco respectively.

E. Tables 303 and 603, "Materials" for Plumbing Installation of the International Plumbing Code applies.

F. Joints and connections:

1. Screwed; American Standard Taper Thread with non-toxic compound on male threads only.

2. Use hard solder (nickel and silver) capable of withstanding water at 200 psi and 250 degrees F. Use soldering nipples or couplings between screwed and soldered pipe and fittings.

3. Final connections at equipment, heaters, valves, pump, etc., to be by unions. Unions shall match material of adjacent pipes. Where pipe materials change, install EPCO insulating unions, or "Clearflow" fittings by Perfection Corp.

4. Contractor shall use 95.6%/4%/0.4% Tin, Copper and Silver "Silvabrite" 100 or Taramet “Sterling” Solder. Solder shall be lead, nickel and antimony fre. The use of 50/50 solder is not allowed.

G. Contractor shall hang or support water lines in chases and isolate copper lines from the cast iron stacks, hangers, chair carriers, etc.

H. Contractor shall provide support in stud walls for water supply to each fixture or hosebib equal to "Holdrite" #108-26 copper plated 24 gauge steel bracket. Solder pipe to bracket. Screw brackets to studs.

I. Contractor shall isolate all copper water lines from contact with concrete, block or mortar.

J. Contractor shall stop and seal insulation within wall. Do not allow insulation to penetrate face of block or gypsum board.

K. Contractor shall solder 8" long “L” shaped copper strap to each hosebib or fixture supply in block walls and anchor it into cell of block work filled with mortar mix. Loose supply piping will not be accepted.

L. Contractor shall provide solid metal stud blocking in stud walls for flush valve standoff brackets.

1.02 AIR CHAMBERS:

A. Install vertically at each hot and cold supply for each fixture on the project including but not limited to water closets, urinals, sinks, lavatories, showers, electric water coolers, eye washes, etc. Chambers shall be one pipe size larger than branch supply size and not less than 18" high and shall be in addition to water hammer arrestors as located on plans and specified below. Where necessary to avoid obstructions, offset chambers within the wall. Chambers shall be insulated the same as pipe and shall not be in contact with any ferrous metal. Provide additional support in wall and insulate.

B. See detail on plans. Do not install air chambers above ceiling. Chamber may be made up using ¾” and 1” pre-made 18” long tubing sections by Sioux Chief.

1.03 WATER HAMMER ARRESTORS:

A. Water hammer arrestors (i.e. shock arrestors, shocks, etc.) shall be constructed entirely of stainless steel treaded nipple compression chamber and bellows. Units shall be pre-charged and permanently sealed at the factory.

B. Units shall be sized: A, B, C, D, E or F and certified by the Plumbing and Drainage Institute (PDI).

C. Locate units as indicated on plans for each quick closing valve and flush valve or group of flush valves. See kitchen equipment piping details. Provide access door for each unit located in a chase or above a hard ceiling. Water hammer arrestors shall be provided as indicated on the plans in addition to air chambers as specified above.

D. Units shall be installed in a vertical position and be accessible for replacement.

E. Contractor shall furnish and install type “A” shock arrestor at each wall hydrant location.

F. Water hammer arrestors shall be manufactured or marketed under one of the following name brands: J.R. Smith, Wade, Josam, Zurn, Wade, or Watts.

1.04 WALL HYDRANT:

A. 3/4" hose thread, cast bronze, non-freeze, auto self-draining, box hydrant with integral vacuum breaker, hinged latching cast cover, loose key operator, length to suit wall thickness (12" min. length). Locate with aid of other drawings to avoid storm leaders, exterior electrical outlets, etc. Cover shall be nickel bronze and have “water” on door.

B. Contractor shall anchor piping within wall cavity, protect finish of hydrant, isolate copper from masonry, and align face of hydrant box to be flush and square with finish wall surface.

C. Hydrants shall be Zurn #1320-NB, Josam #71000, Smith #5519-NB, or equals by MIFAB, Watts, or Woodford.

D. Box hydrants , where indicated, shall be Zurn #1360-6, 3/4" hose thread, cast bronze, non-freeze, with flush hinged locking cover, polished nickel bronze scoriated face, bronze casing, 3' depth of bury, 24" x 24" x 6" thick concrete collar around each box. Box and collar to be flush with finish grade. Equals by Wade, Smith, Woodford or Mifab.

E. Roof hydrants, where indicated shall be Woodford model RHY2, non-freeze complete with all necessary mounting hardware, hydrant support and two-degree shim for pitch adjustment. Hydrant shall feature repair-in-place technology. Equals by Zurn, Wade, Smith or MIfab.

F. Twin-temp hydrants, where indicated, shall be Smith #5560-NB-QT-H ¾” hose thread, vacuum breaker, cast box with nickel bronze finish, hinged cover with cylinder lock, non-freeze loose key operator for hot and cold inlets, quarter turn on valves, length to suit wall thickness. Provide check valves in hot and cold water supplies. Equals by Zurn or Wade.

G. Control box for water supply for can wash, where indicated, shall be Smith model #3380 type 304 stainless steel box with hinged door with cylinder lock, integral screw driver stops on ½” hot and cold supplies, atmospheric vacuum breaker, all types “L” copper tubing. Box shall have flange for recess into masonry wall construction. Equals by Zurn or Wade.

1.05 HOSEBIB:

A. Locate as shown on plans by symbol "HB" or note.

B. Mount 16" above floor.

C. Provide 3/4" H.P.T. vacuum breaker in matching finish.

D. Unit shall be Model #387 polished chromium plated by Chicago Faucet, or equal by T&S, Bradley, or Mifab #9241.

1.06 VACUUM BREAKERS:

A. Unless otherwise specified, each interior and exterior hosebib and faucet having hose

threads, and not equipped with a built-in vacuum breaker, shall be equipped with Nidel 3/4" HD vacuum breaker of finish to match hosebib or faucet. Equals by Watts or Wilkins.

B. At each location of connection to a piece of equipment that may have continuous pressure on the line, install a Watts #7C or equal. These are required at hose reels, food pulpers, and other locations that may have a submerged inlet that is under pressure.

1.07 VALVES:

A. Valves shall have the name or trademark of the manufacturers and the working pressure stamped or cast on the valve body. Valves shall be of one manufacturer listed below or prior approved in addendums. Valves found to be not as specified shall be removed.

B. All valves in each system, except for special types shall be the product of a single manufacturer.

C. All valves installed in horizontal lines shall be installed with the stems horizontal or above. Valve handwheels shall be oriented, when installed, to provide maximum accessibility for operation.

D. All valves that require packing shall be designed and constructed such that they can be packed under pressure.

E. Valve handwheels shall be malleable iron (except where specifically specified otherwise).

F. Domestic Water System:

1. Gate valve 4" in size and larger shall be iron body, bronze trim, non-rising stem, solid wedge, flange ends, and 200 psi W.O.G. Valve shall be Nibco F-619.

2. Ball valves 3" in size and smaller shall have bronze body, non-rising stem, solid ball, and solder ends for 200 pound W.O.G. Valves shall be: Apollo #70-100 or equal by Nibco 585-70, T or S.

3. Check valves 3" in size and smaller shall be horizontal swing type with bronze body, composition disc, and solder ends for 200 pound W.O.G. Valves shall be:

Crane	No. 1342
Hammond	IB941
Stockham	B-309
Nibco	S-413-W

4. Globe valves 2" in size and smaller shall have bronze body, rising stem, composition disc, and solder ends for 200 pound W.O.G. Valves shall be:

Crane	No. 1310
Hammond	IB423
Stockham	B-14-T

Nibco	S-211-W

5. Hose End Drain Valves shall be 3/4" in size with bronze body, non-rising stem, solid wedge, threaded inlet, and hose outlet with cap and chain for 200 pound W.O.G. Valves shall be:

Crane	No. 451
Jenkins	372
Kennedy	31
Nibco	T-585-70-HC

1.08 INSULATION:

A. After testing, clean pipes and fittings. Insulation shall be installed by factory authorized and trained personnel or Subcontractor.

B. Insulate all piping above slab with Certain-Teed 500 degrees Snap-On ASJ/SSL pipe insulation. Do not install fiberglass in locations that are not protected from the weather. Equals by Owens Corning Fiberglass SSL 1, Knauf, or Micr-Lok by Mansville are acceptable. Install factory “butt joint” strips and mastic to all ells and tees.

Hot Water and Hot Water Recirculation - 1" Thick for pipes 1 ½” and smaller
Hot Water - 2" Thick for pipes 2" and larger
Cold Water - 1/2" Thick

C. Insulate all fittings except unions with fiberglass inserts, to equal thickness of adjacent pipe insulation and finish with PVC fitting covers sealed as recommended by manufacturer. PVC covers shall be plenum rated and have a flame spread of 25 or less and a smoke development of 50 or less meeting requirements of NFPA 90A.

D. Insulate above grade lines and fittings which convey water from coolers, ice chest, and air conditioners with 3/4" thick closed cell elastomeric insulation (Armaflex, Rubatex, or Halstead). Seal joints with manufacturer's recommended glue. Do not split insulation or use tape.

E. Insulate all underground hot water and hot water recirculating lines and fittings with 1-1/2" thick Pittsburgh Corning Foamglas. Finish with cut back asphalt (Foster 60-25 or approved equal) reinforced with glass or nylon open weave cloth.

F. For pipe inside block cavity, Contractor shall install Armstrong #AP Armaflex self-sealing 1/2" thick closed cell elastomeric insulation on pipes up through 6" in diameter, and 1/2" thick closed cell flexible elastomeric block insulation sheet material for pipes larger than 6".

G. Insulation shall be continuous thru sleeves at each fire rated wall or floor. See details. Do not “cut back” insulation at sleeves.

H. Foam plastic insulation is not acceptable.

1.09 CAST IRON ACCESS BOXES:

A. Cover valves below grade with Charlotte Pipe & Foundry Co., Style UTL-286 boxes, or equals. Set cover flush with finished grade and valve handle not over 12” below.

1.10 STERILIZATION OF HOT AND COLD WATER SYSTEM:

A. Sterilize with a solution containing not less than fifty (50) parts per million of available chlorine. Use sodium hypochlorite solution conforming to Federal Specification OB-441A, Grade D. Solution to remain in system for twenty-four (24) hours, opening and closing all valves several times. After sterilization, flush with clean water until chlorine is not greater than 0.2 parts per million.

B. Have a minimum of two (2) samples from most remote part of system taken 24 hours apart and tested by an independent testing laboratory approved by the State Health Department. Deliver certificates of approval to Architect. All laboratory fees are to be included in the Plumbing contract. The Contractor will be responsible for preventing use of water from systems for human consumption until tested and approved. Should any of the reports prove unfavorable, the entire disinfection and sampling process shall be repeated.

NOTE: Certificates indicating negative results of coliform and non-coliform growth must be procured before building can be accepted or occupied.

END OF SECTION 15405

SECTION 15406 – HANGERS, SUPPORTS AND FIRE STOPPING

PART ONE – GENERAL:

1.01 PIPE SUPPORTS:

A. Perforated strap hangers, chains, or wire will not be permitted on the job.

B. Support horizontal ferrous piping where run above ground with galvanized split ring hangers, turnbuckles and threaded rods, as manufactured by Grinnell Co., PHD Manufacturing, Michigan Hanger Co., or B-Line Systems. Hangers to be securely fastened to structure and spaced not over 5 feet apart for cast iron pipes and 8 feet apart for other ferrous pipes. Locate hangers as close to hubs or bands as possible. Hangers shall be equal to Michigan Hanger Co. #401.

C. Support horizontal copper piping where run above ground and all insulated pipe by means of oversize hangers with integral factory installed insulation shields. Hangers shall be spaced not over 6 feet apart for 1-1/2" and smaller pipes, and not over 8 feet apart for 2" and larger pipes. Insulation shall be continuous through the hangers. Hangers shall be equal to M-Co. #403 or PHD #455.

D. Support horizontal “plastic” acid waste piping by means of PHD #450 V clevis hanger and #450T support trough. Provide hangers on each side of trough joints, 10' length.

E. Furnish and install intermediate or supplementary steel required for proper support of piping and installation of hangers. Group parallel runs of pipe and support by common angle hangers of adequate dimensions.

F. Where pipe smaller than 1" is installed along the face of the wall, install Grinnell #153 hanger flange and CT-138R split-ring tubing hanger. Bolt to wall with lag screws, or toggle bolts. Contractor shall cut and seal pipe insulation around each hanger.

G. Where indicated and detailed on plans, support all domestic water lines in corridors on galvanized angle iron frames. Frames shall be bolted to block walls or through bolted to metal studs with oversized fender washers. Detail indicates the maximum size required. Submit shop drawing from a Registered Seismic Engineer for each condition for any condition of lesser number of lines, smaller diameter pipes, smaller angle or thinner angle iron. Frames shall be welded, drilled, cleaned and then hot dipped galvanized.

H. Provide seismic cable braces on drain, waste, vent, water, gas, and or specialty piping as noted on detail.

I. See details for fireproofing of pipes and pipe sleeves in firewalls and floors. Extend insulation on all pipes through pipe sleeve in firewalls or floors. Contractor shall use an “UL” assembly without substitution. See hourly rating noted on each plan to identify firewalls. All pipe penetrations of fire rated walls or floors (except coredrilled floors) shall have a schedule 40 steel sleeve.

END OF SECTION 15406

SECTION 15416 – NATURAL GAS PIPING

1.01 GAS SYSTEM:

A. Provide a system of gas piping including connection to the service. See notes and detail on plans. Regulators, and piping shall be by this Contractor.

B. Connect to each gas consuming appliance and outlet. Install gas cock and union ahead of each connection. All work and materials shall meet local requirements and comply with the International Gas Code. Contractor shall provide letter of certification to the Engineer that gas system has been installed and tested per the Gas Code.

C. Interior above grade pipe 2 ½" and smaller shall be Type A53 Schedule 40 black steel with screwed malleable iron fittings. Exterior above grade piping 2 ½" and smaller shall be Type A53 Schedule 40 galvanized steel with screwed malleable iron fittings. Gas piping 3" and larger shall be welded Type A53 Schedule 40 with welded fittings. Pipe shall be either black steel or galvanized as specified previously for threaded pipe. Weld joints and fittings on galvanized pipe shall be cold galvanized after fabrication. All gas piping and fittings shall be made in the USA.

D. All below grade gas piping shall be high density polyethylene (HDPE) piping. Piping shall be as manufactured Performance Pipe, DRISCOPIPE 8100 series, HDPE gas distribution pipe or prior approved equal HDPE product. All pipe and fittings shall be manufactured in accordance with ASTM D2513. Pipe and fitting shall be joined by heat fusion in accordance with the manufacturer's instructions.

E. Pipe below slab on grade shall be Schedule 40 black steel within conduit. Conduit shall be Schedule 40 galvanized steel. Conduit shall be connected together and sealed gas tight. See plans for gas vents, conduit details, and special notes. Conduit shall be sized to allow removal of gas piping with last elbow in place. No gas piping shall be installed in such a manner that it can not be removed for replacement.

F. Leak test all pipe before concealment and connection as required by local authority (or at 150 psig) and deliver certificate of approval, in triplicate, to Architect. Notify Engineer 24 hours prior to test so a Representative may be present during test.

G. Leak test completed system after installation of all fittings, valves, trim, etc., are in place and before any use by Owner. Test pressure shall be 4 psig and shall be scheduled so Owner, State Fire Marshall, Architect, and Engineer, as well as Contractor, may have a Representative present. Test shall be a minimum of 20 minutes.

H. Provide ten-foot ground rod at tank location. Bond gas line to ground rod and to main domestic cold-water line with bare #6 copper wire. Route wire through 1/2" EMT.

I. Tanks shall be ASME labeled, size as noted on plans, furnish and install as indicated. Bolt saddles to pad provided if above grade installation. Bury tank with hold down pad, straps, and special coating for underground installation. See plan for regulators. Install plug valve at each tank. See detail.

J. Plumbing Contractor shall include the cost of the fuel to fill each tank and arrange for filling at time of installation. Tanks shall be full at Substantial Completion of the project.

K. Valves:

1. Plug valves shall be bronze body and plug, threaded ends, and square head for 125-pound W.O.G. Valves shall be: Crane No. 250, Walworth No. 554.

2. Lubricated plug valves shall be factory lubricated and sealed and shall be rated for natural gas.

3. Provide one box end wrench to the Owner for each size and type of valve head.

4. Ball valves shall have bronze body, brass stem, chrome plated brass ball and reinforced teflon seat, threaded ends and rated 600-pound W.O.G. Valves shall be: Apollo 70-100.

L. Provide union, ball valve, and flex hose rated for natural gas at connection to each appliance or equipment. See notes on kitchen plan and equipment schedule.

M. Provide type “B” vents from gas heaters thru roof, see detail.

END OF SECTION 15416

SECTION 15417- INSTANTANEOUS WATER HEATER

1.01 INSTATANEOUS WATER HEATER:

A. General - Water heater shall be as Intellihot or prior approved equal. See schedule for model numbers, capacities, and fuel types. Heater shall operate at a minimum of 94% thermal efficiency and meet the requirements of ASHRAE 90.1.

B. Construction - Water heater shall be completely factory packaged consisting of one heater with 1,000,000 BTUH input.

C. Assembly- Shall be insulated, enamel steel jackets, mounted on steel skids, and ETL approved.

D. Burners - Each water heater shall have a combination burner for natural and LP gas. Selection made by a switch.

E. Heat Exchanger - Each heater shall be provided with a single pass heat exchanger made of 316 L stainless steel, ASME stamped and carry a 10-year non-prorated warranty without any restrictions as to constantly flowing water through the exchanger.

F. Controls - Failure of any one heater shall not shut the entire system down. Should there be a failure of any heater, the outlet temperature shall remain the same, requiring that no water flow through the failed heater. Work load of each heater shall be equal. Outlet temperature shall be within +/- 2° F set point. Maximum efficiency is accomplished by immediately heating incoming cold water beginning with a flow of 0.5 gpm and an input of 30,000 BTUH. Turn down shall be 25:1. Heater shall operate at full capacity even with a gas pressure of only 2.5" Install round double wall type "B' gas vent piping thru roof as manufactured by Metalbestos or approved equal with size per manufacturer's requirements and the IFGC. See detail. Heater shall be set up to deliver 180 degree water for kitchen dishmachine. See detail.

G. Factory Monitoring - For two years manufacturer shall monitor the operation of the water heater and provide at no cost any parts or controls that may be required.

H. Start-up - Start up shall be provided by factory trained person who is employed by the manufacturer or manufacturer's representative.

I. Accessories - Provide recirculation pump model B &G PL-36B or equal by Grundfos, ¾" bronze body, control by Aquastat. Control wiring shall be by the plumber and shall comply with section 16010 and 15904 of the specifications. Provide bronze fittings and/or Dielectric unions at connections to heater per manufacturer's literature. Provide condensate dilution kit.

END OF SECTION 15417

SECTION 15424 – CONDENSATE DRAINAGE

1.01 CONDENSATE DRAINAGE:

A. Work Included:

1. Furnish all labor, materials, equipment, and plant required for the complete installation of all piping, hangers, insulation, catch basins, traps, sleeves, firestopping, etc., to route condensate from air handlers to the exterior.

B. Products:

1. Condensate piping above slab shall be no-hub cast iron and below slab shall be bell and spigot cast iron as specified for soil, waste, and drain piping with drainage fittings. All piping shall be made in the USA.

2. Drain piping from P & T valves shall be Type "L" copper with wrought copper fittings.

C. Executions:

1. All condensate and P & T piping shall be installed at a minimum uniform grade of 1% unless otherwise noted.

2. Provide riser clamps at each floor.

3. Condensate piping shall be installed as specified for soil, waste, and drain piping.

4. P & T drain piping shall be installed as specified for domestic water piping.

5. See "Insulation" section of this Specification for work included.

6. See notes on plans.

1.02 INSULATION:

A. After testing, clean pipes and fittings. Insulation shall be installed by factory authorized and trained personnel or Subcontractor.

B. Insulation shall be as follows: Condensate - 3/4" Thick

C. Insulate all fittings except unions with fiberglass inserts, to equal thickness of adjacent pipe insulation and finish with PVC fitting covers sealed as recommended by manufacturer. Where piping runs through an air plenum, PVC covers shall have a flame spread of 25 or less and a smoke development of 50 or less meeting requirements of NFPA 90A.

D. Insulate above grade lines and fittings which convey water from coolers, ice chest, and air conditioners with 3/4" thick closed cell electrometric insulation (Armaflex, Rubatex, or Halstead). Seal joints with manufacturer's recommended coating. Do not split insulation

or use tape.

E. For pipe inside block cavity, Contractor shall install Armstrong #AP Armaflex self-sealing 1/2" thick closed cell elastomeric insulation on pipes up through 6" in diameter, and 1/2" thick closed cell flexible elastomeric block insulation sheet material for pipes larger than 6".

F. Insulation shall be continuous thru sleeves at each fire rated wall or floor. See details. Do not “cut back” insulation at sleeves.

G. Foam plastic insulation is unacceptable.

H. See Section 15406 for hangers and firestopping.

END OF SECTION 15424

SECTION 15425 – PIPE IDENTIFICATION

PART ONE – GENERAL:

1.01 IDENTIFICATION OF PIPING:

A. General:

1. The following piping system shall be provided with identification as hereinafter specified:

PIPING SYSTEM	MARKER BACKGROUND COLOR	MARKER LETTERS
Domestic Cold Water Supply	Green	White
Domestic Hot Water Supply	Yellow	Black
Domestic Hot Water Circulation	Yellow	Black
Gas Piping	Yellow	Black

B. The legend and letter colors for the pipe marking system shall be in accordance with applicable provisions of ANSI Standard A13.1-1981.

C. Shop drawings submitted to the Architect/Engineer shall show complete details of the marking system, including colors and legends.

D. Marking System:

1. All piping that is accessible for maintenance operations (except piping in finished spaces) will be identified with semi-rigid plastic (not pressure-sensitive) identification markers.

2. Direction of flow arrows are to be included on each marker unless otherwise specified.

3. In conformance with "Scheme for the Identification of Piping System" (ANSI A13.1-1981), each marker must show:

a. Approved color coded background.
b. Proper color of legend in relation to background color.
c. Approved legend letter size.
d. Approved marker length.

4. Locations for pipe markers shall be as follows:

a. Adjust to each valve and fitting (except on plumbing fixtures and equipment).
b. At each pipe passage through wall, floor, and ceiling construction.
c. At each passage to underground.
d. On all horizontal pipe runs - marked every 25 feet.

5. Pipe marking shall be as follows:

a. SETMARK Type SNA markers on pipes 3/4" thru 5" (Snap On).
b. SETMARK Type STR markers on pipes 6" and larger (Snap On).
c. Pipe identification system shall be SETMARK outdoor grade plastic acrylic.
d. Pipe markers as manufactured by Seton Nameplate Co., New Haven, CT 06506 (1-800-243-6624) or approved equal. Equal products by Brady Corp. (1-800-635-7557).

6. For pipes under 3/4" O.D. (too small for color bands and legends), brass identification tags 1 1/2" in diameter with depressed 1/3" high black-filled letters above 1/2" black-filled numbers will be fastened securely at specified locations.

END OF SECTION 15425

SECTION 15615 – CLOSED CIRCUIT EVAPORATIVE COOLER

PART ONE – GENERAL:

1.01 Closed circuit evaporative cooler shall be factory assembled sectional, induced draft, counter flow design and shall meet all applicable requirements of ASHRAE 90.1 and IBC regulations for seismic loads of up to 1g and wind loads up to 145 PSF.

1.02 Evaporative coolers shall be as manufactured by Evapco ESW4 or full submittal prior approved equal by B.A.C. Prior approval package shall be submitted a minimum of 10 days prior to bid. Failure to provide prior approval submittal will result in B.A.C. being removed from the specifications by addendum. The mechanical contractor is responsible for all changes electrically, structurally or otherwise to provide alternate prior approved equipment.

1.03 QUALITY ASSURANCE

A. Verification of Performance:

1. The thermal performance shall be certified by the Cooling Technology Institute in accordance with CTI Certification Standard STD-201. Lacking such certification, a field acceptance test shall be conducted within the warranty period in accordance with CTI Acceptance Test Code ATC-105, by a Licensed CTI Thermal Testing Agency.

2. Unit Sound Performance ratings shall be tested according to CTI ATC-128 standard. Sound ratings shall not exceed specified ratings.

3. Unit shall meet or exceed energy efficiency per ASHRAE 90.1-2019.

B. Warranty: Submit a written warranty executed by the manufacturer, agreeing to repair or replace components of the unit that fail in materials and workmanship within the specified warranty period.

1. The Entire Unit shall have a manufacturer's comprehensive five (5) year parts and labor warranty against defects in materials and workmanship from substantial completion of the project and a 10 year warranty on the stainless steel heat exchanger.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide closed circuit coolers manufactured by one of the following:

1. EVAPCO Model ESW4 12-46L12-LF-C

2. Prior Approved Substitute – See section 1.02 above.

2.2 THERMAL PERFORMANCE

A. Each unit shall be capable to cool 500.0 GPM of water entering at 100.1° F leaving at 85.1° F at a design entering wet bulb of 80.0° F with a pressure drop across the coil not to exceed 2.55 psi.

2.3 IBC COMPLIANCE

A. The structure of this product shall be designed, analyzed, and constructed in accordance with the wind and seismic load requirements of the following: 2009 IBC, 2012 IBC, 2015 IBC, 2018 IBC, ASCE/SEI 7-05, ASCE/SEI 7-10, ASCE/SEI 7-16, NFPA 5000. For Importance Factor (IP) = 1.5, SDS = 1.6 (@ z/h = 0) and P = 119 psf.

2.4 COMPONENTS

A. Description: Factory assembled and tested, induced draft counter flow closed circuit cooler complete with fan, coil, fill, louvers, accessories and rigging supports

B. Materials of Construction

1. All cold water basin components including vertical supports, air inlet louver frames and panels up to rigging seam shall be constructed of Type 304 Stainless Steel. All factory cold water basin seams shall be welded for water tight construction.

2. Casing and fan section, including channels and angle supports, shall be constructed of Type 304 stainless steel. Fan cowl and guard shall be constructed of Type 304 Stainless Steel. "Series 300" stainless steel will not be acceptable as equivalent to Type 304 Stainless Steel.

C. Fan(s):

1. Unit shall be provided with Super Low Sound Fan(s). Fan(s) shall be high efficiency axial propeller type with non-corrosive Fiber Reinforced Polyester (FRP) blade construction. Fan(s) shall be heavy duty and utilize a forward swept blade design for superior sound reduction. Each fan shall be dynamically balanced and installed in a closely fitted fan cowl with venturi air inlet for maximum fan efficiency.

D. Drift Eliminators

1. Drift eliminators shall be constructed entirely of Polyvinyl Chloride (PVC) in easily handled sections. Design shall incorporate three changes in air direction and limit the water carryover to a maximum of 0.001% of the recirculating water rate. Drift eliminators shall be self-extinguishing, have a flame spread of less than 25 under ASTM E84, and shall be resistant to rot, decay and biological attack.

E. Water Distribution System

1. Spray nozzles shall be precision molded ABS, large orifice spray nozzles utilizing fluidic technology for superior water distribution over the fill media. Nozzles shall be designed to minimize water distribution system maintenance. Spray header, branches, and riser shall be Schedule 40 Polyvinyl Chloride (PVC) for corrosion resistance.

F. Heat Transfer Media

1. Heat transfer coil shall be elliptical tubes Type 304 Stainless Steel, encased in stainless steel framework. The coil assembly shall be designed with sloping tubes for liquid drainage. Coil shall have design pressure of 300 psi and shall be in compliance with ASME/ANSI B31.5, Refrigeration Piping and Heat Transfer Components. The coil assembly shall be strength tested in accordance with ASME/ANSI B31.5 and subsequently leak tested using air under water.

G. Pump

1. Unit shall have EISA close-coupled centrifugal pump with mechanical seal. The pump shall be installed in a vertical position so that water will drain from the pump when the cold water basin is emptied. Pump motor shall be totally enclosed with protective canopy for outdoor operation.

H. Bleed-off

1. Unit shall have a waste water bleed line with a manual adjustable valve provided.

I. Air Inlet Louvers

1. The air inlet louvers shall be constructed from UV inhibited Polyvinyl Chloride (PVC) and incorporate a framed interlocking design that allows for easy removal of air inlet louvers for access to the entire basin area for maintenance. The air inlet louvers shall have a minimum of two changes in air direction and shall be of a non-planar design to prevent splash-out and block direct sunlight & debris from entering the basin. Air inlet louvers shall be self-extinguishing, have a flame spread of less than 25 under ASTM E84, and shall be resistant to rot, decay and biological attack.

J. Make up Float Valve Assembly

1. Make up float assembly shall be a mechanical brass valve with an adjustable plastic float.

K. Pan Strainer

1. Pan Strainer(s) shall be all Type 304 Stainless Steel construction with large area removable perforated screens.

L. Pipe Connection Type

1. Any connections provided with a Groove (GVD) or Beveled for Welding/Grooved (BFW/GVD) shall conform to standard groove specification (SGS).

2.5 MOTORS AND DRIVES

A. General requirements for motors are specified in Division 23 Section “Motors”

B. Fan Motor

1. Fan motor(s) shall be totally enclosed, ball bearing type electric motor(s) suitable for moist air service. Motor(s) are Premium Efficient, Class F insulated, 1.15 service factor design. Inverter rated per NEMA MG1 Part 31.4.4.2 and suitable for variable torque applications and constant torque speed range with properly sized and adjusted variable frequency drives. Variable frequency drives shall be provided by the controls contractor.

2. Fan motor(s) shall include strip-type space heaters with separate leads brought to the motor conduit box.

C. Fan Drive

1. The fan drive shall be multigroove, solid back V-belt type with QD tapered bushings designed for 150% of the motor nameplate power. The belt material shall be neoprene reinforced with polyester cord and specifically designed for evaporative equipment service. Fan sheave shall be aluminum alloy construction. Belt adjustment shall be accomplished from the exterior of the unit.

D. Fan Shaft

1. Fan shaft shall be solid, ground and polished steel. Exposed surface shall be coated with rust preventative.

E. Fan Shaft Bearings

1. Fan Shaft Bearings shall be heavy-duty, self-aligning ball type bearings with extended lubrication lines to grease fittings located on access door frame. Bearings shall be designed for a minimum L-10 life of 100,000 hours.

F. Vibration Switch

1. Unit shall be provided with a Vibration Cutout Switch, operating on 120 VAC feed, to protect the fan and drive assembly from damage in the event of excess vibration. Vibration switch shall be DPDT.

2.6 MAINTENANCE ACCESS

A. Fan Section

1. Access door shall be hinged and located in the fan section for fan drive and water distribution system access.

B. Basin Section

1. Framed removable louver panels shall be on all four (4) sides of the unit for pan and sump access.

C. Internal Working Platform

1. Internal working platform shall provide easy access to the fans, belts, motors, sheaves, bearings, all mechanical equipment and complete water distribution system. The fill shall be an acceptable means of accessing these components.

D. External Service Platform with Ladder

1. An external service platform compliant with OSHA shall be provided at the motor access door of the unit extending the full length of the access door. Each platform shall have at least a 36 in wide walking surface. The platforms shall have galvanized steel grating, supported by galvanized steel framework attached to the unit and surrounded by a handrail, knee rail and toe plate system that is compliant with OSHA. Mounting channels shall be the same material as the casing section (galvanized or stainless steel). A vertical ladder shall be provided from the base of the unit to the platform.

E. Motor Davit with Base

1. Unit shall be provided with mechanical external motor davit assembly which facilitates in removal of larger fan section components. Davit arm shall be constructed of aluminum and base shall be galvanized steel.

F. Louver Access Door

1. Hinged access door in louver shall be provided.

2.7 ACCESSORIES

A. Basin Heater Package

1. Cold water basin shall be fitted with Type 304 Stainless Steel element, electric immersion heater(s) with a separate thermostat and low water protection device. Heaters shall be selected to maintain +40° F pan water at 0 °F ambient temperature.

2. Electric immersion heater package shall include a factory-supplied NEMA 4x enclosure containing a magnetic contactor with 120 VAC control circuit, transformer, and main power disconnect. Control

package wired by others.

3. Provide two basin heater control packages to serve the four separate tower sections furnished to operate as one evaporative cooler. Each Basin heater packages shall be rated for 24KW total load and configured from the factory to serve two towers sections at 12 KW (2-6KW heaters) each. Coordinate interconnection of basin heaters and basin heater control panels with the electrical and controls contractors.

PART THREE – EXECUTION:

3.01 Cooler shall be provided with an external service platform with an integral ladder, vibration switches and electric sump heaters capable of maintaining the sump temperature at 40 degrees F down to 0 degrees F ambient temperature with the spray pumps and fans off.

3.02 A factory control panel shall be provided by the cooler manufacturer to control the basin heaters and spray pumps. Panel shall have single point power connections with voltage as indicated on the schedule. Panel shall be connected to the building energy management system to allow for EMS control of the pumps and heaters. Pan water immersion heater with built-in thermostat and low water cut off shall be factory installed. See section 2.7 for quantity of factory control panels and interconnection between tower sections. Each basin heater control package shall serve two tower sections.

3.03 Evaporative cooler shall be mounted on I-beam structural supports as shown on drawings. See mechanical plans and tower support details.

END OF SECTION 15615

SECTION 15621 – CONDENSING BOILER NATURAL GAS/FUEL OIL (DUAL FUEL)

PART ONE – GENERAL:

1.01 The hot water boiler shall be capable of 94% thermal efficiency per DOE / BTS 2000 and up to 99% efficient at low fire rates with low return water temperature. Boiler shall feature inward-fired burner technology with seamless modulation capable of 20 to 1 turndown with no minimum flowrate required. The complete packaged boiler with burner, controls and trim shall be UL approved. Boiler shall meet all applicable requirements of ASHRAE 90.1. Boiler shall be provided with a 5 year manufacturer's parts and labor warranty (entire unit) and a 10 year manufacturer's burner and heat exchanger parts warranty.

1.02 The unit shall have performance and output ratings as scheduled on plans. Boiler shall be capable of both natural gas and fuel oil operation as emergency backup, dual fuel.

1.03 Boiler shall be Patterson-Kelley P-K Mach or prior approved equal.

PART TWO – PRODUCTS:

2.01 Unit shall be assembled and wired with burner, controls, trim and skid type base installed at the factory. Unit shall be equipped with pre-mix, surface burner with proportional gas/air control and variable speed blower motor. Gas train shall meet UL795, FM and CSD-1 requirements. Unit shall have hot surface ignition system with electronic ignition control with pre and post purge. Electronic operating control shall include digital readout, firing cycle status lights and high limit temperature control with manual reset. Temperature and pressure gauges shall be provided on the supply outlet and the gas train shall be equipped with high and low gas pressure switches. Unit shall be dual fuel type capable of operation on both natural gas and fuel oil.

2.02 The pressure vessel shall consist of vertical fire tubes and steel boiler construction with a medium mass design. Vessel shall be ASME "H" stamped and provided with a 150 PSI design pressure with a 150 PSI relief valve. Condensing fire tubes shall be vertically oriented and coated with PVDF polymer. Economizer section shall be stainless steel. MODBUS controls shall be provided to interconnect multiple boilers and shall have a full color touch screen programmable user interface. Controller shall be Bacnet/LonWorks compatible and be connected to the building automation system. Entire boiler shall be provided with a 10 year parts and labor warranty.

2.03 Controls shall be 120V, 60 cycle single phase. Boiler shall be provided with the following options: Audible alarm for any failure, MODBUS connection cable, remote alarm relay, combustion air interlock, float-type low-water cutoff with blowdown, air vent valve, high and low water pressure safety switches, water flow switch, gas pressure gauge and UL approved vent cap for direct combustion air. Boiler shall be provided with integral step down transformer

to provide 120V controls. See boiler schedule for power supply voltage and phase.

PART THREE – EXECUTION:

3.01 BOILING OUT:

A. Before being placed in service, boiler shall be thoroughly boiled out for a period of 24 hours. The solution to be used in the boiler for the boiling out process shall consist of ten (10) pounds of trisodium phosphate per 100 gal. of water. Upon completion of boiling out, the boiler shall be thoroughly flushed out with potable water.

3.02 Emergency disconnect switch shall be provided on the wall near the boiler room entrance to allow rapid and complete shut down of the boiler in the event of an emergency.

3.03 The boiler manufacturer's representative shall start-up, adjust and test the boiler. The Owner's representative shall be instructed in the proper operation and maintenance of the boiler. The manufacturer shall submit a written start up report. A pre-start up check list shall be submitted with the product submittal for the contractor's use.

3.04 Install round double wall, Type 316 stainless steel type-B gas vent through roof as manufactured by Metal Bestos or approved equal. Size per manufacturer's requirements and the IFGC. See details.

END OF SECTION 15621

SECTION 15700 - PACKAGED HEAT PUMPS

PART ONE – GENERAL:

1.01 Unit shall be self-contained, roof mounted type consisting of filters, evaporators, fan and motor, electric heaters, outside air intake, cooling coil, condensate collector and drain, compressor, condenser fan and motor, inter-connecting refrigerant piping and factory installed controls with 24V remote control center. The units shall be designed in accordance with UL requirements, A.R.I. rated and meet all applicable requirements of ASHRAE 90.1.

1.02 Units shall be as manufactured by Trane or prior approved equal.

PART TWO – PRODUCTS:

2.01 UNIT CASING:

A. Cabinet: Galvanized steel phosphatized and finished with an air-dry paint coating with removable access panels. Structural members shall be 16 gauge with access doors and removable panels of minimum 20 gauge.

B. Units' cabinet surface shall be tested 500 hours in salt spray test in compliance with ASTM B117.

2.02 AIR FILTERS:

A. 2" pleated media filters shall mount integrally within the unit and shall be accessible through access panels.

2.03 MOTOR COMPRESSORS:

A. Motor compressors shall be manufacturer's standard spring mounted hermetic type fully serviceable on job location with five (5) year warranty.

2.04 FANS:

A. Fans shall be forward double width double inlet centrifugal type fan with self-aligning grease lubricated ball or sleeve bearings with permanent lubrication fittings. Fans shall have internal thermal overload protection.

2.05 ELECTRIC HEATERS:

A. Electric heaters shall be of the open coil type designed to fit within the unit. Heaters shall be complete with contactors, control transformer, automatic thermal high limit, manual reset high limit control, fan interlock, fuse block with fuse for each phase and disconnect. Heaters must be UL listed.

2.06 COILS:

A. Provide a thermal expansion valve for each refrigeration circuit. Factory pressure test at 450 psig and leak tested at 200 psig. Coils shall be configured with aluminum fin surface mechanically bonded to copper tubing coil.

2.07 REFRIGERATION SYSTEM:

A. Compressor(s): Provide compressors with direct drive operating at 3,600 rpm integral centrifugal oil pump, inlet dir separator, rolling element bearings, crankcase heater, completely enclosed compression chamber with no leakage paths. Provide suction cooled motor with over-temperature and over-current protection.

B. Compressor(s) shall be manufactured by the HVAC unit manufacturer.

C. Units shall have cooling capabilities down to 60 degrees F.

D. Provide with thermostatic temperature control in the compressor windings to protect against excessive temperatures-, high- and low-pressure conditions.

2.08 CONTROLS:

A. Units shall have factory wired controls including all components necessary for standard sequences of heating and cooling.

2.09 ACCESSORIES:

A. Unit shall come with factory outside air intake hood with bird screen and balancing and motorized dampers. Coordinate with Controls Specifications as applicable.

B. Provide factory coil guards and seacoast coatings for condenser coils.

C. Provide with energy recovery ventilation package and hot gas reheat where indicated on plans.

D. Units shall be provided with factory wired and mounted 120V GFCI convenience outlet.

2.10 WARRANTY:

A. Heat pumps shall be provided with a warranty of two (2) years for parts and labor plus an additional three (3) years parts and labor on the compressors.

PART THREE – EXECUTION:

3.01 Mount unit on structural aluminum or hot dipped galvanized seismic roof curb per Section 15890 with flashing assembly that complies with the National Roofing Contractors Association requirements. The roof curb on the top elevation must be true and level. Contractor shall provide supplemental steel to attach curb to structure as recommended by seismic curb manufacturer. See Seismic Specifications for product and design criteria.

3.02 Provide 1" Type "L"- hard copper P-trap assembly at each condensate drain connection with threaded cleanout plug. Depth of trap shall be sufficient for drainage with static pressure of unit.

END OF SECTION 15700

SECTION 15710-SPLIT SYSTEM HEAT PUMPS

PART ONE – GENERAL:

1.01 Units shall be provided complete with indoor and outdoor sections, refrigerant piping and factory installed controls. Systems shall be A.R.I. 210 and 270 rated, UL listed and meet all applicable requirements of ASHRAE 90.1.

1.02 Heat pump system shall be as manufactured by Trane or prior approved equal.

PART TWO – PRODUCTS:

2.01 INDOOR UNIT:

A. Indoor unit shall be constructed of galvanized steel with baked enamel finish properly reinforced for maximum rigidity and shall be internally insulated. Casing shall be sectionalized construction consisting of fan section, coil section, electric heater section, filter section as indicated and drain pan. Removable panels shall be furnished to provide access to internal parts and shall be gasketed to minimize leakage.

B. Evaporator coil shall be manufacturer's standard of sufficient size to provide the heating and/or cooling requirements as specified. Provide factory mounted non-bleed thermal expansion valve and low ambient cooling down to 30 degrees. Provide subcooling circuits(s). Refrigerant shall be R-410A.

C. Evaporator fan shall be centrifugal double inlet forward curve blade type and shall be variable speed. Fans shall be statically and dynamically balanced and shall have permanently lubricated bearings and shall be complete with built-in thermal overload protection.

D. Electric heaters shall be the open coil type designed to fit within the unit. Heater shall be complete with contactors, control transformers, automatic thermal high limit, fusible links for each heater circuit and fan interlock. Heaters shall be UL listed. Provide single point power.

2.02 OUTDOOR UNIT:

A. Outdoor unit shall be fabricated of heavy G-90-gauge galvanized steel with baked enamel finish for weatherproof installation and vertical air discharge. The unit shall be readily accessible for maintenance and shall be complete with all operating and safety controls ready for electrical connection. Units shall be provided with factory supplied louvered coil guards. Unit shall be provided with Seacoast coil protection.

B. Motor compressor shall be the unit manufacturer's standard for heat pump service. Provide factory-assembled and pre-wired units suitable for outdoor use consisting of cabinet, compressor(s), condensing coil and fan(s), integral subcooling circuit(s), internal thermal overload protection, suction line accumulator, filter drier, crankcase heaters, hard start capacitor, and controls. Provide expansion valve(s) and check valves for split system heat pump unit(s). Accessories shall be factory mounted. Provide heat pump condensing unit fully charged from the factory for up to 15 feet pf piping. Unit shall be designed to operate at temperatures as high as 115 F. Cooling capacities shall be matched with air handling unit that is ARI certified. The unit shall be UL listed.

C. Condenser fan shall be the propeller type arranged for vertical discharge. Fan shall be statically and dynamically balanced. Fan motor shall have permanently lubricated bearings and shall have built-in thermal overload protection.

D. Coils: Condenser coils shall be dipped and baked with Epoxy, Phenolic, or Heresite Seacoast coated copper fins and seamless copper tubing. Provide subcooling circuit(s).

E. Performance Ratings: Energy Efficiency Rating (SEER) not less than 13.00 SEER per ARI, as a matching system.

2.03 CONTROLS:

A. Units shall have factory wired controls, including all components necessary for standard sequences of heating and cooling. Provide controls in accordance with Controls Specification Sections.

PART THREE – EXECUTION:

3.01 OUTDOOR UNIT:

A. Mount unit with clearances as recommended by manufacturer. Provide vibration isolators of the cork and neoprene type under the outdoor unit. Securely mount unit with anchor bolts through isolators into support base.

3.02 INDOOR UNIT:

A. Support indoor unit on 2 ½" x 2 ¼" angle iron with four (4) spring type vibration isolators.

B. Provide four (4) 16-gauge galvanized steel straps of sufficient size to secure unit to angle supports.

C. Install indoor unit with manufacturer's required minimum clearances to all service panels.

3.03 INDOOR UNIT AUXILIARY DRAIN PAN:

A. Provide an auxiliary drain pan of 16-gauge galvanized steel a minimum 2" deep with all welded seams. Pan shall extend a minimum of 3" beyond unit casing on all sides. Provide a float switch in pan to de-energize unit if pan fills with condensate.

3.04 REFRIGERANT PIPING:

A. Refrigerant piping shall be type "ACR" hard nitrogenized copper with silver brazed joints and cleaned and capped wrought copper fittings installed in accordance with manufacturer's instructions. Refrigerant lines shall be sealed and charged with nitrogen after installation.

B. Contractor shall note the length of the refrigerant lines. The following items shall be provided as specified above and in accordance with the heat pump manufacturer's recommendations for "long line" applications as necessary:

1. Liquid and suction line sizing
2. Indoor and outdoor thermal expansion valves
3. Refrigerant charge by the "weigh-in" method
4. Oil return (only if required by manufacturer)
5. Crankcase heater, "hard start" gear and liquid filter/dryer accessories for heat pump units

3.05 CONDENSATE PIPING:

A. Condensate piping shall be type “L” hard copper full size of indoor unit connection 1” minimum with P-trap and cleanout tee with plug at trap. Route condensate drain as indicated.

3.06 INSULATION:

A. Insulation shall be provided on refrigerant suction and condensate piping. Insulation shall be ¾” thick “Rubatex” or “Armaflex.” Seal all joints with adhesive. Provide 1” thick “Rubatex” or “Armaflex” on refrigerant suction piping 1 ½” O.D. and larger. Insulation shall not be cut lengthwise to install. All exterior refrigerant piping shall be covered with 22-gauge aluminum or 24-gauge stainless steel jackets and banded 4’ on center.

B. All piping shall be hung with clevis type hangers complete with insulation saddles. Route liquid line above suction and tie wrap 4’ o.c. with 3/8” wide nylon straps without compressing insulation. Pipe hangers shall be as manufactured by Michigan Hanger Co., Grinnell or B-Line. Hangers equal to M-CO #403.

3.07 WARRANTY:

A. Contractor shall correct defects in workmanship materials, controls and operation of the system for a period of 1 year from the date of substantial completion and acceptance of work. Any equipment/material installed by the contractor replaced during the first-year warranty period shall be guaranteed for an additional year starting from the date of replacement. A manufacturers 1-year parts warranty shall be provided for all HVAC equipment that utilizes a compressor or compressors. An additional 4-year manufacturer’s parts warranty shall be included for the compressors only for a total of 5-years. All warranties shall begin after the date of substantial completion. For the first year, the mechanical contractor is responsible for all labor associated with the above-mentioned warranties. The manufacturer’s warranty certificate shall be included in the contractor’s closeout documents provided at the completion of the project.

3.08 INSTALLATION:

A. Heat pumps shall be installed in strict accordance with the manufacturer’s recommendations. Provide equipment startup by manufacturer’s personnel.

END OF SECTION 15710

SECTION 15713 - SPLIT SYSTEM HEAT PUMPS (DUCTLESS FAN-COIL)

PART ONE – GENERAL:

1.01 Units shall be provided complete with indoor and outdoor sections, refrigerant piping and factory installed controls. Systems shall be A.R.I. rated, UL listed and meet all applicable requirements of ASHRAE 90.1.

1.02 Heat pump system shall be as manufactured by Mitsubishi, Sanyo, or Daikin.

PART TWO – PRODUCTS:

2.01 INDOOR UNIT:

A. Indoor unit shall be self contained console type for wall or ceiling as indicated. Unit shall have supplemental electric heat and ventilation air connection.

B. Evaporator coil shall be manufacturer's standard of sufficient size to provide the heating and/or cooling requirements as specified and shall be complete with quick-attach fittings for pre-charge tubing as applicable.

C. Evaporator fan shall be statically and dynamically balanced and shall have permanently lubricated bearings and shall be complete with built-in thermal overload protection.

D. Electric heaters shall be the open coil type designed to fit within the unit. Heater shall be complete with contactors, control transformers, automatic thermal high limit, fusible links for each heater circuit and fan interlock. Heaters shall be UL listed.

2.02 OUTDOOR UNIT:

A. Outdoor unit shall be fabricated of heavy gauge galvanized steel with baked enamel finish for weatherproof installation and vertical air discharge. The unit shall be readily accessible for maintenance and shall be complete with all operating and safety controls ready for electrical connection. Units shall be provided with factory supplied coil guards and seacoast coil coating.

B. Motor compressor shall be the unit manufacturer's standard for heat pump service and shall be complete with internal thermal overload protection, crankcase heater and suction line accumulator.

C. Condenser fan shall be the propeller type arranged for vertical discharge. Fan shall be statically and dynamically balanced. Fan motor shall have permanently lubricated bearings and shall have built-in thermal overload protection.

D. Each outdoor unit shall be provided with filter-drier.

2.03 CONTROLS:

A. Units shall have factory wired controls, including all components necessary for standard sequences of heating and cooling.

PART THREE – EXECUTION:

3.01 OUTDOOR UNIT:

A. Mount unit with clearances as recommended by manufacturer. Provide vibration isolators of the cork and neoprene type under the outdoor unit. Securely mount unit with anchor bolts through isolators into support base. Provide factory coil guards.

3.02 REFRIGERANT PIPING:

A. Refrigerant piping shall be type “ACR” copper with silver brazed joints and cleaned and capped wrought copper fittings installed in accordance with manufacturer’s instructions.

3.03 CONDENSATE PIPING:

A. Condensate piping shall be type “L” hard copper full size of indoor unit connection 1” minimum with P-trap and cleanout tee with plug at trap. Route condensate drain as indicated.

3.04 INSULATION:

A. Insulation shall be provided on refrigerant suction and condensate piping. Insulation shall be ¾” thick “Rubatex” or “Armaflex.” Seal all joints with adhesive. Insulation shall not be cut lengthwise to install. All exterior refrigerant piping shall be covered with 22-gauge aluminum or 24-gauge stainless steel jacket.

B. All piping shall be hung with clevis type hangers complete with insulation saddles. Route liquid line above suction and tie wrap 4’ o.c. with 3/8” wide nylon straps without compressing insulation. Pipe hangers shall be as manufactured by Michigan Hanger Co., Grinnell or B-Line. Hangers equal to M-CO #403.

3.05 WARRANTY:

A. Heat pumps shall be provided with a warranty of two (2) years for parts and labor plus an additional three (3) years parts and labor on the compressors.

3.06 INSTALLATION:

A. Heat pumps shall be installed in strict accordance with the manufacturer’s recommendations.

END OF SECTION 15713

SECTION 15732

WALL HUNG PACKAGED HEAT PUMPS WITH ENERGY RECOVERY

PART ONE – GENERAL:

1.01 Units shall be provided complete and ready for operation with factory mounted controls and heat recovery ventilator assembly. Systems shall be A.R.I. rated, UL listed and meet all applicable requirements of ASHRAE 90.1.

1.02 Heat pumps shall be manufactured by Bard or prior approved equal.

PART TWO – PRODUCTS:

2.01 HEAT PUMPS:

A. Unit shall be constructed of galvanized steel with baked enamel finish properly reinforced for maximum rigidity and shall be internally insulated. Casing shall be sectionalized construction consisting of fan section, coil section, electric heater section, filter section as indicated and drain pan. Removable panels shall be furnished to provide access to internal parts and shall be gasketed to minimize leakage. Heat pumps shall have single point power entry and internal fused disconnect for entire unit.

B. Evaporator coil shall be manufacturer's standard with copper tubes and aluminum fins of sufficient size to provide the heating and/or cooling requirements as specified.

C. Evaporator fan shall be centrifugal double inlet forward curved blade type and shall be direct driven. Fans shall be statically and dynamically balanced and shall have permanently lubricated bearings and shall be complete with built-in thermal overload protection.

D. Electric heaters shall be the open coil type designed to fit within the unit. Heater shall be complete with contactors, control transformers, automatic thermal high limit, fusible links for each heater circuit and fan interlock. Heaters shall be UL listed.

E. Units shall be provided with factory installed energy recovery wheel assembly built into unit with an outside air capacity of up to 450 cfm. Outside air shall be controlled by a factory mounted relay(s) interlocked with the building control system which will close the outside air damper and de-energize the exhaust and outside air fans during unoccupied hours.

F. Units shall be provided with hot gas reheat humidity control.

G. Motor compressor shall be the unit manufacturer's standard for heat pump service and shall be complete with internal thermal overload protection, crankcase heater and suction line accumulator.

2.02 CONTROLS:

A. Units shall have factory wired controls including all components necessary for standard sequences of heating and cooling. Provide heat/cool thermostat with automatic changeover and humidistat in accordance with Controls Specification.

B. Units shall be provided with hot gas reheat humidity control with multi-stage capability. Hot gas reheat shall be capable of producing “neutral” air (75° F) at “No Load” conditions (Unoccupied) without the need for supplemental electrical reheat.

PART THREE – EXECUTION:

3.01 INSTALLATION:

A. Mount unit with clearances as recommended by the manufacturer. Coordinate wall openings with General Contractor as applicable.

END OF SECTION 15732

SECTION 15745 – WATER SOURCE HEAT PUMPS HORIZONTAL/VERTICAL

PART ONE – GENERAL:

1.01 Units shall be provided factory complete with compressor, fan, refrigerant piping, filter and factory installed controls. Units shall be UL listed, A.R.I. approved and meet all applicable requirements of ASHRAE 90.1.

1.02 Basis of design for Heat pump units shall be as manufactured by Trane model GEHV and DXHF as scheduled on plans. Equal products by Climate Master will be considered pending a full submittal is provided to the engineer by the manufacturer a minimum of **10 days prior to bid**. If prior approval submittal package is not received in the allotted timeframe, Climate Master will be removed as an approved equal by addendum. Any changes electrically, or otherwise as a result of the contractor providing alternate approved equipment is the responsibility of the mechanical contractor.

PART TWO – PRODUCTS:

2.01 Cabinet for horizontal/vertical concealed units shall be constructed of zinc coated, heavy gauge, galvanized steel and shall consist of a framework of rigid steel structural sections, exterior hanger brackets and panels lined with acoustic type fibrous glass, secured and coated to prevent detachment and erosion of fibers. Removable panels shall allow access to service and replace blower, motor, motor compressor, coil and controls.

2.02 Units shall include all refrigeration components including high efficiency rotary or scroll compressor, reversing valve, air refrigerant heat exchanger leak tested to 450 psig, thermostatic expansion device and water refrigerant heat exchanger suitable for 650 psig water circuit design pressure. Compressors shall be located out of air stream. All electrical components not an integral part of the hermetic circuit shall be installed so that they can be adjusted or replaced through service access panels from a single side of the machine. This panel must also provide access to the condensate drain for inspection and cleaning. Water, condensate, power and control connections shall be made on the same side adjacent to the access panel. Sound attenuation shall be applied as a standard design feature. This attenuation package shall include, vibration isolation to the compressor and water-to-refrigerant coil, unit base stiffeners, insulated metal compressor enclosure, and a second stage of vibration isolation to the compressor and water-to-refrigerant base pan. Refrigerant shall be R-410A.

2.03 Units shall be provided with a basic control package which, at a minimum shall contain a low and high pressure switch along with a compressor lockout relay for control assistance. High voltage connections shall be made at the equipment's contactor. Each device shall be factory mounted, wired and tested in the equipment. Controls package shall be compatible with the specified DDC building energy management system (EMS). Freeze control and high refrigerant pressure safety cutouts are to be furnished which must be manually reset either by turning off, then back on at the thermostat or by interrupting power to the air conditioner. Compressor control logic shall provide anti-short cycle relays, random start relays and electronic sensor drain pan switch overflow protection. All controls except thermostats are to be factory installed and wired within the air conditioner cabinet. There phase units shall have phase loss/brownout protection.

2.04 The fan shall be a forward-curved style wheel constructed of corrosion resistant galvanized metal. The fan shall be in the draw-through position. Removal of the motor and fan wheel shall be accomplished with a factory provided orifice ring that attaches the wheel and motor to the fan housing in a single assembly eliminating the need to access the set screw on the backside of the fan hub. The fan motor shall be an ECM programmable type motor pre-programmed in the factory for four selections of constant airflow consisting of 110%, 100%, 90% and 80% of the scheduled airflow. The motor shall have permanently sealed bearings and protected by an internal thermal overload. The motor shall be connected with a quick disconnect plug.

2.05 In addition to the standard warranty, the Contractor shall provide the Owner with a five (5) year warranty certificate which includes labor and material for repair or replacement of any portion of the refrigeration circuit consisting of the motor compressor assembly, air coil, water coil, expansion device, reversing valve exclusive of solenoid coil and inter-connecting tubing which is found to be defective in material or workmanship.

PART THREE – EXECUTION:

3.01 HEAT PUMP UNIT:

A. Support indoor unit on 2 ½" x 2 ½" x ¼" angle iron with four (4) spring type vibration isolators.
B. Provide four (4) 16 gauge galvanized steel straps of sufficient size to secure unit to angle supports.

C. Install indoor unit with manufacturer's required minimum clearances to all service panels.

3.02 INDOOR UNIT AUXILIARY DRAIN PAN:

A. Provide an auxiliary drain pan of 16 gauge galvanized steel a minimum 2" deep with all welded seams. Pan shall extend a minimum of 3" beyond unit casing on all sides. Provide a float switch in pan to de-energize unit if pan fills with condensate.

3.03 CONDENSATE PIPING:

A. Condensate piping shall be type "L" hard copper full size of indoor unit connection a minimum of 1" with P-trap and cleanout tee with plug at trap. Route condensate drain as indicated.

3.04 INSULATION:

A. Insulation shall be provided on condensate piping. Insulation shall be ¾" thick "Rubatex" or "Armaflex." Seal all joints with adhesive. Insulation shall not be cut lengthwise to install.

B. All piping shall be hung with clevis type hangers complete with insulation saddles. Pipe hangers shall be as manufactured by Michigan Hanger Co., Grinnell or B-Line. Hangers equal to M-CO #403.

3.05 INSTALLATION:

A. Heat pumps shall be installed in strict accordance with the manufacturer's recommendations.

3.06 FLEXIBLE HOSES:

A. Provide reinforced circulating water connection hoses suitable for 300 psig working pressure. Hoses shall consist of a stainless steel outer braid with an inner core of non toxic synthetic polymer material. Hoses shall be suitable for clear water temperatures from 33 degrees F to 211 degrees F without the use of glycol. Each hose shall be a minimum of 24" long with diameter same as unit connections and threaded swivel connections on each end.

3.07 PIPING SPECIALTIES:

A. Each heat pump shall be provided with ball valves, inlet strainers, motorized control valves (quick open/slow close type, and an automatic flow control valve as manufactured by Hays Fluid control). See the Condenser Water Distribution Systems piping specifications and water source heat pump piping details for the manufacturers and piping arrangements of these specialties.

3.08 FACTORY START-UP:

A. Entire air conditioning system shall be started by a factory trained representative of the manufacturer of the heat pump equipment. Representative shall check all phases of operation including refrigerant charge, controls, operation and make any necessary adjustments to the system. Submit in triplicate a signed report by a factory employee stating system is operating satisfactorily.

END OF SECTION 15745

SECTION 15748 – PACKAGED VENTILATION AIR DEHUMIDIFICATION UNITS

PART ONE – GENERAL:

1.01 Units shall be self contained, split or packaged as indicated, consisting of filters, evaporators, fans and motors, heat exchangers, outside air intake, cooling coil, condensate collector and drain, compressor, condenser fan and motor, total energy wheel, hot gas reheat coil, interconnecting refrigerant piping and factory installed control end devices wired to a terminal strip with no controller and no interface. Units must be capable of providing first source sensible cooling. The units shall be designed in accordance with UL requirements and be A.R.I rated.

1.02 Units shall be ETL/UL listed and meet all applicable requirements of ASHRAE 90.1 – AHRI-920, with respect to performance operating points with no interruption in dew point/reheat delivery. All points in AHRI-920 must be achieved at all times.

1.03 Provide Manufacturer's 5 Year Parts & Labor Warranty for entire unit.

1.04 Units shall be as manufactured by Trane Model KCC or equal by Greenheck-Model RVE as alternate bid. See bid form.

PART TWO – PRODUCTS:

2.01 BASE FRAME:

A. Cabinet Base Rails: Side and end base rails shall include openings for forklift and tie-down access. To protect unit base from fork damage side rails shall include removable heavy gauge fork pockets.

2.02 UNIT CASING:

A. Unit shall be built for outdoor use with cabinet panels constructed of 2" double-wall foamed panel construction throughout the indoor section of unit to provide nonporous, cleanable interior coated galvanized steel surfaces. All interior seams exposed to airflow shall be sealed. Insulation shall be 2" polyisocyanurate foam metal encapsulated with no exposed edges. Initial R value of 6.6 per inch of thickness.

B. Cabinet construction shall provide double wall hinged access doors providing easy access for all parts requiring routine service. Water and Air Tight Hinged Access Doors shall provide access to air filters, heating section, electrical and control cabinet sections, ERV and 100% power exhaust fan section, supply air fan section, evaporator and reheat coil sections. Insulated doors shall be constructed to allow the hinges to be reversed in the field. Hold-open device shall be factory installed on all hinged access doors. Chains shall not be used as hold-open devices. Fans and energy recovery components shall be mounted on slide racks for ease of maintenance.

C. Drain Pan material shall be Type 430 Stainless steel drain and constructed to sloped in two directions to ensure positive drainage with corners exposed to standing water and drain fittings welded liquid tight to prevent leaks. Pan shall have a minimum depth of 2". Base of drain pan shall be insulated with 1" thick foam insulation.

D. Cabinet top cover shall be one-piece construction or where seams exist, it shall be double-hemmed and gasket-sealed.

E. Interior Corrosion Protection: Interior surfaces shall be a stainless steel. Cabinet shall include interior liner constructed of 304 stainless steel seams. All unit coils shall be coated-see coating requirements below in specification.

F. Exterior Corrosion Protection: Exterior cabinet panels shall be a base coat of G-90 galvanized steel with exterior surfaces cleaned, phosphatized and finished with a weather-resistant baked enamel finish. Unit's surface shall be in compliance with ASTM B45 salt spray testing at a minimum of 672-hour duration.

2.03 HEAT EXCHANGER – ENERGY RECOVERY SECTIONS

A. The rotor media shall be made of aluminum, formed into a honeycomb structure to prevent corrosion, minimize pressure loss, avoid plugging, and to maintain wheel performance through the expected life of the unit. Paper, Plastic, Mylar, Air-Exchange wheels, or fibrous media are not acceptable. The rotor media must be coated to resist corrosion. All surfaces must be coated with a non-migrating desiccant layer to ensure that adequate latent capacity is provided. The desiccant coating must be firmly bonded to the aluminum surface and will not be dislodged when challenged with high velocity air up to 5000 feet per minute. Products that lose desiccant when served with high velocity air are not acceptable. The cassette must be a slide out design for serviceability. The media shall be cleanable with low temperature steam, hot water or light detergent without degrading the latent recovery.

B. Sensible and latent recovery efficiencies must be clearly documented through a testing program conducted in accordance with ASHRAE Standard 84 and AHRI 1060. The testing must have been conducted by a qualified independent organization. The performance test reports must be provided for engineering review as part of the submittals for this project. The rotor design shall ensure laminar airflow to minimize parasitic pressure loss and to optimize the operating efficiency of the system fans. The pressure loss across the media shall be no greater than the scheduled pressure loss values.

C. The rotor media shall be permanent, with an anticipated life of 20 years. It must be tested in accordance with ASTM Standard E-84 and provide smoke and flame spread ratings of less than 25 and 50 as required by NFPA 90A and UL 1995. A copy of the ASTM E-84 test report confirming the method of test and results shall be provided with the submittal. Heat recovery wheels

incorporating “throw-away” media and tested to UL900 for Class 2 filters are not acceptable.

D. The rotor shall be supplied with perimeter brush seals and face contact seals to minimize air leakage and wheel bypass. The rotor media shall be supported by a structural aluminum hub and aluminum reinforcing spoke system. The rotor bearings must be greaseable and provide L10 life in excess of 20 years.

E. The cassette framework shall be made of galvanized steel to prevent corrosion. The rotor must be driven by long-life polyurethane/polyester composite link belt system. The rotor/cassette shall be designed so that belt can be removed or serviced without the removal of the bearing. A 3 phase A/C gear motor shall be utilized to accommodate variable speed applications.

2.04 FAN SECTIONS:

A. The supply and exhaust fans shall be centrifugal plenum type heavy duty Class I or II with non-overloading backward inclined or airfoil wheels, AMCA certified. Supply and Exhaust Fans shall be high efficiency backward curved impeller. Fan wheel shall be statically and dynamically balanced. Provide shafts constructed of solid hot rolled steel, ground and polished, with key-way, and protectively coated with lubricating oil. Bearings shall be heavy duty grease lubricated self-aligning ball or roller pillow block type.

B. Supply and Exhaust Fans shall be provided with factory mounted and wired variable frequency drives and Supply and Exhaust Fans shall be provided with integral Piezometer Flow Rings for Air Flow Measurement.

C. Condenser fans shall be direct drive with premium efficiency motors, statically and dynamically balanced, draw through in the vertical discharge position. Shall be direct drive vertical discharge design with low-noise corrosion resistant glass reinforced polypropylene props, powder coated wire discharge guards and electro-plated motor mounting brackets. Provide condenser fans with integral, factory mounted variable frequency drives (VFDs) for modulating head pressure control.

2.05 MOTORS & DRIVES:

A. Fan, motor and belt drive shall all be mounted on a spring isolated chassis (minimum isolation efficiency 90-95%). Belt drives shall have a minimum service factor of 1.5. Motor electrical connections are to be factory pre-wired to the unit control panel.

2.06 DAMPERS:

A. General: All dampers shall be of low leakage type with blade edge and side seals. Dampers shall be constructed of galvanized steel (14-gauge frames/16-gauge blades) with self-lubricating porous bronze bearings.

B. Outside & Exhaust Air Shut-Off Dampers: Parallel blade dampers with electric modulating operators shall be provided to prevent infiltration of unconditioned air into the building when unit is not in operation.

C. Recirculation Air Damper: Parallel blade damper with electric two (2) position actuator shall be provided to allow for space dehumidification when in the unoccupied mode without the introduction of outside air.

2.07 EVAPORATOR, CONDENSER, HGRH COILS:

A. Cooling/dehumidification coils, Condenser coils, Hot gas reheat coils shall be constructed with copper tubes mechanically bonded to configured aluminum plate fins with performance certified by A.R.I. standards. Coils shall be factory leak tested in accordance ANSI/ASHRAE 15-1992 at a minimum pressure of 500 PSIG.

B. Evaporator coil shall include six rows of cooling interlaced for superior sensible and latent cooling with a maximum of 12 FPI for ease of cleaning.

C. The condenser coil shall have a fin designed for ease of cleaning.

D. Reheat coil shall be fully integrated into the supply airstream and be capable of delivering design supply air temperature. To prevent re-hydration of condensate from evaporator coil, the evaporator coil face and the hot gas reheat coil face shall be separated by a minimum of six inches.

E. Coil Coating for condenser, evaporator, Hot Gas Reheat Coils: All coils shall have a factory applied flexible epoxy polymer e-coat uniformly applied to all coil surface areas with no material bridging between fins. The coating process will ensure complete coil and coil casing encapsulation and a uniform dry film thickness of 1.2 mills on all surface areas including fin edges and meet 5b rating cross hatched adhesion per ASTM B3359- 93. Corrosion durability will be confirmed through testing with no less than 6,000 hours salt spray resistance per ASTM B117-90 using scribed aluminum test school coupons. Field coatings and spray coatings are not acceptable.

2.08 FILTERS:

A. The supply and exhaust air filters shall be 2” deep MERV 8 pleated cartridge type as standard, provided an average efficiency of 25-30% by ASHRAE Standard 52-76 test method. In addition, provide 4” deep MERV 13 pleated filters. Filters shall be Farr or equal. Face velocity through the filters shall not exceed 500 FPM at the unit’s rated nominal capacity.

2.09 HEATING:

A. Modulating Indirect Gas Fired Heating System: Completely assembled and factory installed heating system shall be located in the primary heating position located downstream of the indoor fan assembly and be integral to

unit and approved for use downstream from refrigerant cooling coils in units mounted outdoors. Threaded gas connection shall terminate at manual shut-off valve. Provide capability for sidewall or thru-base gas piping.

B. Heaters shall include high turn-down burners firing into individual stainless-steel tubular heat exchangers. Heat exchangers shall be constructed of type 439 stainless steel and be a high efficiency dimpled tubular design capable of draining internal condensate. Units with multiple heaters shall include one fully modulating high turndown heater with additional on-off heater sections. Total heater turndown shall be of 20:1.
C. Heater outdoor air inlet shall be hooded and include internal baffle system to prevent rain blow thru. To prevent recirculation of flue gas and to prevent flue gas condensate from draining onto and obstructing the heater air inlet the inlet shall be hooded and shall be located a minimum of 11” beneath the flue outlet. Inlet hood shall include bird screen.
D. Heater flue outlet(s) shall include hooded outlet with wire cloth all constructed of Type 430 stainless steel. Hooded outlet shall be sealed to prevent flue gas recirculation.
E. Gas Burner Safety Controls: Provide safety controls for the proving of combustion air prior to ignition, continuous air proving monitoring following ignition and continuous electronic flame supervision.
F. Unit controls shall monitor heat output and shall discontinue all heating attempts and or unit operation in the event the heating section fails to ignite or fails to maintain programmed supply air temperature/time.
G. Inducer fan shall be direct drive high pressure centrifugal type with two speeds and shall include built- in thermal overload protection.
H. Limit controls: High temperature automatic reset limits shall be located on blower wall and in indoor fan chamber to shut off gas flow in the event of excessive temperatures resulting from restricted indoor airflow, or loss of indoor airflow.
I. Flame roll-out safeties shall provide continuous monitoring of proper burner operation.

2.10 ELECTRICAL:

A. Control panel(s) shall be provided with hinged access doors and an approved locking device in a NEMA 3R enclosure. All high voltage power components such as fuses, switches and contactors shall include a service personnel protection barrier or shall be a listed as touch-safe design. Field wiring access to be provided thru unit base into isolated enclosure with removable cover.

1. Power wiring to be single point connection.

2. Wiring internal to the unit shall be colored and numbered for identification.

3. Unit shall be factory wired to field wiring terminal block mounted in isolated enclosure.

4. Factory wired main non-fused power disconnect and overcurrent device shall be rated for total unit connected power

5. SCCR rating shall be a minimum of 65kA

6. Factory wired Voltage/Phase monitor shall be included as standard. In the event of any of the following, the units will be shut down and a fault code will be stored in the monitor for the most recent 25 faults. Upon correction of the fault condition the unit will reset and restart automatically.

a. Phase Unbalance Protection: Factory set 2%
b. Over/Under/Brown Out Voltage Protection: +/-10% of nameplate voltage
c. Phase Loss/Reversal
d. Single Phase Protection

A. Factory to mount and wire 120-volt convenience outlet. Field wiring of convenience outlet not acceptable.

B. All low voltage field wiring connections shall be made at factory installed low voltage terminal strip.

2.11 COMPRESSORS AND AIR-COOLED CONDENSING UNIT:

A. Unit shall be provided complete with an air-cooled condensing unit of the size and capacity as indicated on the equipment schedule. Provide each unit with two hermetically sealed independent refrigerant circuits factory-supplied completely piped with liquid line filter-drier, liquid line charging port, suction and liquid line pressure ports, sight glass, and thermal expansion valve, suction line accumulator, and charge compensator

B. ACCU shall have a minimum of two (2) independent refrigerant circuits, a minimum of 2 modulating digital scroll compressors-one for each circuit- to provide infinite modulating capacity between 5% and 100% of capacity for each circuit. Hot gas bypass is not permitted.

C. Condensing Unit/Compressors must be able to provide mechanical cooling down to 55 F ambient while maintaining DX Cooling Coil Leaving Air Dew Point at a constant 48 F, and, be able to provide 20-degree temp rise with full hot gas reheat capacity.

D. Each compressor shall have a crankcase heater to minimize the amount of liquid refrigerant present in the oil sump during off cycles. Each compressor shall be mounted on rubber vibration isolators, to reduce the transmission of noise.

E. Unit shall be capable of providing design supply air conditions (leaving air - dry bulb and wet bulb) during part load operation. Part Load Design point shall be demonstrated at engineer’s request; 68F db / 64.3F wb ambient conditions, unit shall deliver supply air design conditions (leaving air - dry bulb and wet bulb), while maintaining 70 reheat.

F. Provide each circuit with automatic reset high and low pressure and high temperature switches for safety control.

G. Condenser coil hail guards shall be factory installed.

2.12 UNIT CONTROLS:

A. Main Unit Controller (MCM) shall be provided by CMI. (There shall be no control interface devices, no integration, no BacNet, and no controllers provided by the VAU manufacturer.) VAU manufacturer shall provide and factory install the following control end devices and wire all to a terminal strip, with no controller and no interface:

1) Outdoor Air Temperature Sensor
2) Outdoor Air Humidity Sensor
3) Outdoor Air Flow Measuring Station
4) Outdoor Air Modulating Damper and Actuator
5) Outdoor Air Total Energy Wheel Modulating Bypass Damper and Actuator
6) Exhaust Air Total Energy Wheel Modulating Bypass Damper and Actuator
7) Total Energy Wheel Rotation Sensor
8) Total Energy Wheel Enable
9) Return Air/Mixed Air Modulating Damper and Actuator
10) Return Air Temperature Sensor
11) Return Air Humidity Sensor
12) Return Air Duct Pressure Sensor
13) Filter Differential Pressure Switch – Status
14) Exhaust Fan Piezometer Air Flow Station
15) Exhaust Fan ECM Variable Speed Fan Control
16) Exhaust Damper and Actuator
17) Exhaust Damper End Switch
18) Exhaust Air Temperature Sensor
19) 0-10 vDc Input for Single/Dual Digital Compressor Capacity Modulation
20) Evaporator Leaving Air Temperature Sensor
21) 0-10 vDc Input for Hot Gas Reheat Modulation
22) Supply Fan Status
23) Supply Fan Piezometer Air Flow Measuring Station
24) Supply Fan ECM Variable Speed Fan Control
25) Modulating Gas Heat
26) Unit Leaving Air Temperature Sensor for Discharge Air Temperature.

PART THREE – EXECUTION:

3.01 Unit shall be provided with factory start-up and check-out by manufacturer's personnel, no exceptions. Provide written report by manufacturer documenting start-up to Engineer for approval. Inspections and 5-year parts and labor warranty work shall be performed by manufacturer's personnel, no exceptions. Manufacturer shall employ a minimum of 10 certified technicians, within 25 miles of job site, qualified to work on equipment.

3.02 Mount unit on structural aluminum or hot dipped galvanized seismic roof curb per Section 15890 with flashing assembly that complies with the National Roofing Contractors Association requirements. The roof curb on the top elevation must be true and level. Contractor shall provide supplemental steel to attach curb to structure as recommended by Curb Manufacturer. See Specification Section 15890 for product and design criteria.

3.03 Provide type “L” hard copper P-trap assembly at each condensate drain connection with threaded cleanout plug full size of unit connection a 1” minimum. Depth of trap shall be sufficient for drainage with static pressure of unit.

3.04 Insulation shall be provided on refrigerant section and condensate piping. Insulation shall be ¾” thick “Rubatex” or “Armaflex.” Seal all joints with adhesive. Insulation shall not be cut lengthwise to install. All exterior refrigerant piping shall be covered with 22-gauge aluminum or 24-gauge stainless steel jackets. Provide 1” thick “Rubatex” or “Armaflex” on refrigerant suction piping 1 ½” O.D. and larger.

3.05 All piping shall be hung with clevis type hangers complete with insulation saddles. Route liquid line above suction and tie wrap 4’ o.c. with 3/8” wide nylon straps without compressing insulation. Pipe hangers shall be as manufactured by Michigan Hanger Co., Grinnell or B-Line. Hangers equal to M-CO #403.

END OF SECTION 15748

SECTION 15808 – DUCTWORK

PART ONE – GENERAL:

1.01 Ductwork, including exhaust, shall conform to all applicable requirements of the latest issue of NFPA Pamphlet No. 90A. All ductwork, elbows, take-offs, transitions and etc. shall conform to the recommendations of SMACNA duct construction standards as a minimum requirement, unless otherwise indicated by the contract documents.

1.02 Ductwork shall be installed to operate without noise or vibration and shall be air tight. The Contractor shall be responsible for measuring at the building all conditions, space available, piping, light fixtures, ceiling heights, etc. that affect ductwork installation prior to fabrication. Ductwork shall be constructed as job progresses, not in advance.

PART TWO – PRODUCTS:

2.01 LOW PRESSURE DUCTWORK:

A. Low pressure and exhaust ductwork shall be galvanized sheet steel constructed to the requirement of SMACNA Table 1-5 for 2" W.G. static pressure, unless otherwise noted. Duct and fitting sealing requirements shall be in accordance with SMACNA Table 1-2, Seal Class "A". Duct tape is not allowed. Seismic restraints shall be provided for all ducts with a cross sectional area of six (6) square feet and larger in accordance with the International Building Code, International Mechanical Code and SMACNA Seismic Restraint Manual, Latest Edition. Gauges and reinforcing shall be as follows:

MAXIMUM SIDE INCHES	STEEL U.S. STANDARD GAUGE*	TYPE OF TRANSVERSE JOINT CONNECTIONS	BRACING
Up to 24	24	S, Drive, Pocket or Bar Slips, 7'-10" o.c.	None
25 to 30	24	S, Drive, Pocket or 1" Bar Slips, 7' – 10" o.c.	1" x 1" x 1/8" Angles 4' o.c.
31 to 40	22	Drive, 1" Pocket or 1" Bar Slips on Centers	1" x 1" x 1/8" Angles 4' o.c.
41 to 60	22	1 ½" Angle Connections, 1 ½" Pocket or 1 ½" Bar Slips with 1 3/8" x 1/8" Bar reinforcing 7' 10 " o.c.	1 ½" x 1 ½" x 1/8" Angles 4' o.c.

61 to 90	20	1 ½" Angle Connections, 1 ½" Pocket or 1 ½" Bar Slips with 1 3/8" x 1/8" Bar reinforcing 7'10" o.c.	1 ½" x 1 ½" x 1/8" Angles 2' o.c.
91 and Up	18	2" Angle Connections, 1 ½" Pocket or 1 ½" Bar Slips with 1 3/8" x 1/8" Bar reinforcing 3'9" o.c.	1 ½" x 1 ½" x 1/8" Angles 2' o.c.

2.02 ROUND INSULATED FLEXIBLE DUCTS & SPIN-IN COLLARS:

A. Insulated flexible ducts shall consist of an inner core of acoustically transparent CPE inner film or perforated corrugated aluminum with sound attenuating features complete with a factory applied exterior jacket of R 4.5 fiberglass insulation and reinforced metalized vapor barrier with 0.05 ASTM E96 permeance rating. Duct shall be UL listed as Class 1 air duct, standard UL 181 with flame spread and smoke developed ratings of 25 and 50 respectively.
Minimum working pressure shall be 4" W.G. positive. Flexible ducts shall be:

(1) Flexmaster 1M – Acoustical Insulated
(2) Clevaflex – Clevaform DB-series-type DBA acoustical duct

B. Spin-in collars shall be constructed of galvanized steel with scoop and damper.

PART THREE – EXECUTION:

3.01 *Gauge Stamps: Turned out and on bottom of ducts.

3.02 All supply and return duct elbows with an inside radius of less than ¾ of duct width shall have single thickness turning vanes. All square elbows shall have double thickness turning vanes.

3.03 All exhaust duct elbows shall have not less than 6" inside radius. All square elbows shall have single thickness turning vanes.

3.04 Splitter dampers and branch take-off extractors shall be installed where indicated and shall be adjustable and shall have locking quadrants.

3.05 All branch take-offs shall be 45-degree entry type per SMACNA Fig. 2-6. No straight tap or butt fittings allowed.

3.06 Flexible duct connections shall be provided where ductwork connects to equipment and shall be Ventglas 30 oz. woven glass fabric double coated with neoprene, fire retardant, waterproof, air tight and UL listed.

3.07 Duct sizes indicated on plans are interior dimensions. Increase metal duct sizes as required for acoustical or interior insulation.

3.08 All ductwork shall be supported by 1" x 1/8" galvanized iron straps with a maximum spacing of 8'. Straps shall be bolted or clamped to the structure and be turned and fastened to bottom of the duct so that duct weight is not on the fastening screws.

3.09 Provide 1" diameter test slots with cover for insertion of thermostat or test instruments at all locations required to perform operations under paragraph "Balancing."

3.10 Provide duct access doors to afford easy access to entering air side of items requiring maintenance or inspection (such as thermostats, fire damper, etc.). Doors shall be of ample size for service required (18" x 12" minimum) and provided with frame, brass hinges, handle, clamping device and gasket for air tight joint.

3.11 Round flexible ducts shall be installed in extended condition free of sags and kinks using only the minimum length required to make the connection. Abrupt bends and turns that crimp the duct and restrict the air flow will not be permitted. Horizontal supports shall be ¾" wide 22-gauge flat galvanized steel sheet banding material. Flexible ducts shall be supported on 36" centers. Maximum allowable length of a flexible duct shall be 8'. If extended run-out is indicated, round galvanized steel shall be used for run-out length in excess of 8'.

3.12 The entire duct system shall be free from rattles. If rattles exist after ductwork has been installed, the labor and materials necessary to eliminate rattles shall be done at the expense of this Contractor.

3.13 All return duct connections to air devices shall be rectangular unless otherwise indicated on plans. Use of flexible duct is prohibited on any return or exhaust ductwork.

3.14 Where ceiling plenum returns are used, the return duct shall be fitted with a bell-mouth entry covered with 1" x 1" galvanized hardware cloth.

3.15 Kitchen hood exhaust ductwork systems shall be constructed to the requirements of NFPA 96. Ductwork shall be a minimum of 18-gauge 316 stainless steel with all seams and joints sealed liquid tight with a continuous external weld. Dishwasher hood exhaust shall be 16-gauge stainless steel.

3.16 Prior to substantial completion, Contractor shall retain an independent licensed and professional testing agency that specializes in indoor air quality that will test for excessive dust and/or debris that may be present in the duct system. If it is determined that cleaning of duct is necessary, the Contractor shall employ a qualified duct cleaning agency to perform the work at no additional cost to the Owner.

END OF SECTION 15808

SECTION 15820 – DAMPERS

PART ONE – GENERAL:

1.01 Mechanical Contractor shall furnish and install all dampers as indicated on drawings or called for under Specifications.

1.02 Dampers shall be as manufactured by Air Balance, Inc., Phillips-Aire, Ruskin Manufacturing Co. or Louvers and Dampers, Inc.

PART TWO – PRODUCTS:

2.01 MANUAL & AUTOMATIC DAMPERS:

A. Manual and automatic dampers shall be of the multi-louver opposed blade type equipped with an external operating shaft. Locking device shall be provided for manual dampers.

2.02 FIRE DAMPERS:

A. Fire dampers for low pressure and exhaust ductwork shall be parallel blade positive closure mounted in a galvanized steel channel frame. Dampers shall be curtain type meeting all UL 555 and NFPA requirements. Dampers shall be high free area style with blade package mounted out of air stream. Dampers in stainless steel ductwork shall be constructed of type 304 stainless steel. Fuse line shall be 160 degrees. Fire dampers shall have a UL label with a 1 ½ hour rating for use in partitions with ratings of up to two (2) hours. Fire dampers shall have a UL label with a three (3) hour rating for use in partitions with ratings of up to four (4) hours.

B. Fire dampers shall be provided as follows:

1. In all duct passages through fire rated assemblies.

2. In all duct passages through floor.

3. In fire rated openings used for return air passages.

4. See Architectural floor plans for locations and ratings of all fire rated assemblies.

C. Ceiling radiation dampers shall be installed at air device penetrations of a fire rated ceiling. Dampers shall be UL listed with 165 degrees F. fusible link. Phillips-Aire Series 8 (rectangular) or 9 (round) dampers or approved equal.

2.03 SMOKE DAMPERS:

A. Smoke dampers shall be classified by Underwriters Laboratories as Leakage Rated Dampers for Use in Smoke Control Systems under the latest version of UL Standard 555S and shall bear a UL label. Smoke dampers and their

operators shall be qualified under UL 555S to a minimum elevated temperature of 250 degrees F. Dampers shall be qualified at UL 555S Leakage Class II. Combination dampers shall comply with both UL 555 and UL 555S.

B. Electric operators shall be installed by the damper manufacturer at time of damper fabrication. Installation of damper with operator and smoke detectors shall be coordinated with Controls Contractor to provide a complete and operational smoke damper in accordance with NFPA 90A.

C. Provide smoke dampers and smoke detectors at each duct penetration of a smoke wall. Refer to Architectural plan for locations of all smoke walls. Refer to control sections of Specifications for smoke detector hardware requirements. Detectors shall meet requirements of NFPA 72.

PART THREE – EXECUTION:

3.01 Fire and smoke dampers shall be provided with access doors to operate and reset. Provide identification markers with lettering a minimum of ½" high on each access door stating "fire damper" or "smoke damper" as applicable per requirements of I.B.C. 715.4 and I.M.C. 607.4. Areas around dampers shall be fire stopped with fire resistant materials consistent with UL tested assembly requirements.

3.02 Where fire and smoke dampers are located above a hard or security ceiling, Contractor shall provide access doors in ceiling to reach dampers. Coordinate door and frame style with Architectural Finish Schedule. Submit to Architect for approval.

END OF SECTION 15820

SECTION 15833 – SERIES FAN POWERED VAV BOXES WITH ELECTRIC HEAT

PART ONE – GENERAL:

1.01 SYSTEM DESCRIPTION:

A. Ceiling mounted series fan powered variable air volume control box for installation in a ceiling that permits access to the unit. Manufacturer shall supply unit(s) of the design, number, size and performance as shown on the equipment drawings and in schedules. Units are for use in conjunction with air distribution manifolds, ceiling mounted diffusers and electric controls.

1.02 QUALITY ASSURANCE:

A. Insulation and adhesive shall meet NFPA 90A requirements for flame spread and smoke generation and UL 181 requirements for anti-erosion properties.

B. Units shall be tested and certified in accordance with A.R.I. Standard 880.

1.03 DELIVERY, STORAGE & HANDLING:

A. Units shall be stored, handled, and installed per manufacturer's recommendations.

1.04 MANUFACTURER:

A. Units shall be manufactured by Trane or prior approved substitute.

PART TWO – PRODUCTS:

2.01 EQUIPMENT:

A. General: Factory assembled pressure independent system and externally powered variable air volume control box. Unit shall be complete with an inflatable bellows, damper, air flow indicator and stops for minimum and maximum airflow settings, removable access panel, collars for duct connections and all required special features. Control box shall be clearly marked with an identification label that lists such information as unit nominal cfm, maximum and minimum factory set airflow and coil type when applicable. Series fan shall be capable of CFM at scheduled ESP. See VAV box schedule.

B. Unit Cabinet:

1. Constructed of galvanized steel with inlet and outlet collars for duct connections.

2. Insulated with 1” thick, 1 ½ lb/cu. ft density glass fiber insulation with double wall construction. Insulation shall be completely encapsulated with 26-gauge galvanized steel.

3. Removable panel shall provide access to internal components.

C. Damper Assembly:

1. Factory calibrated, consisting of a swing damper controlled by an internally mounted system powered inflatable bellows and an externally mounted electric actuator.

2. Bellows shall be capable of withstanding up to 10” w.g. internal pressure.

3. Equipped with manually field adjustable stops to set minimum and maximum damper opening limits.

D. Controls:

1. Controls for VAV boxes will be direct digital per Controls Specifications.

2. VAV box ddc controller, electric damper actuator and velocity pressure sensor will be provided by the Control Contractor to the VAV box. Manufacturer for factory installation wiring and setup. VAV box manufacturer will provide a control transformer (coordinate with Controls Contractor) and terminal strip for field power and control wiring (coordinate with Controls Manufacturer).

E. Operating Characteristics:

1. Unit operation shall be pressure independent throughout the entire operating range. Cfm limiters that provide pressure independence only at maximum airflow are not acceptable.

2. Minimum and maximum airflow rates shall be maintained throughout the operating static pressure range of the unit.

F. Electric Heating Coil: Coil shall be mounted in a galvanized steel casing and factory installed on the base units as shown on the equipment drawings. Heaters shall have:

1. UL listing

2. Airflow switch and automatic thermal primary safety device

3. Manual reset thermal secondary safety device

4. Control panel with integral contactors

5. Power disconnect and fuses

G. Reconnect to existing medium and low pressure ductwork as indicated on plans.

H. Contractor shall coordinate electrical requirements of fan powered VAV boxes with electrical contractor. FPVAV boxes require neutral wire for fan power. Electrical contractor shall provide 480V, 3 phase, 5 wire including ground for all replacement FPVAV boxes. See plans.

END OF SECTION 15833

SECTION 15846 – CONDENSER WATER DISTRIBUTION SYSTEMS

PART ONE - GENERAL:

PIPING INSTALLATION:

A. Piping shall be installed to provide adequate clearances between piping, adjacent surfaces and other systems to provide normal inspection, testing or servicing of piping and equipment and shall not interfere with normal designed use of the buildings or components. Piping shall be accurately cut and worked into place without forcing or springing. Low points shall be provided with drain valves and high points shall have manual air vents. Condensate drain lines from the air handling units shall be provided with traps and pitched in the direction of flow with a maximum pitch as space will allow. All vertical pipes shall be plumb and all changes in pipe sizes shall be made with reducing fittings. Provide all items, balancing cocks, try-cocks gauge connections etc. as required by the balance and test section.

EQUIPMENT INSTALLATION:

A. Equipment installation shall be strictly in accordance with these specifications, and the installation instructions of the manufacturers. Equipment mounted on concrete foundations shall be grouted before piping is installed. All piping shall be installed in such a manner as not to place a strain on any of the equipment. Flanged joints shall not be bolted tight unless they match adequately.

PIPE AND FITTINGS:

A. CONDENSER WATER PIPING (**NEW ZONE PIPING INSIDE BUILDING ONLY**) See Plans and Steel piping specifications for all new piping in Mechanical rooms M100, A216 and Tower yard M101.

SUMMARY

This Section includes pipe and fitting materials, joining methods and specialty items for the following:

Condenser water piping (Interior piping)

RELATED SECTIONS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections apply to work of this section.

REFERENCE DOCUMENTS

A. ASTM F 2389-07 - Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems- no European equivalent

B. CSA B137.11 - Polypropylene (PP-R) Pipe and Fittings for Pressure Applications

C. NSF/ANSI 14 – Plastic Piping System Components and Related Materials

DEFINITIONS

A. Definitions shall be in accordance with local mechanical codes and ASTM F 2389.

SUBMITTALS

A. Material list naming each product to be used identified by manufacturer and product number, in accordance with the specifications.

QUALITY ASSURANCE

A. Material shall be certified by NSF International as complying with NSF 14, and ASTM F 2389 or CSA B137.11.

B. Material shall comply with manufacturers specifications.

C. Manufacture of PP-R pipe must also manufacture same PP-R resin.

D. Special Engineered products shall be certified by NSF International as complying with NSF 14.

E. Provider of material shall have an Aquatherm certified master trainer on staff and have at least 8 years of experience in the US with this

F. Supplier of material shall have at least 8 years of experience in the US with job names and reference of same ages or greater.

PART 2 – PRODUCTS

PIPE AND PIPING PRODUCTS

A. Pipe shall be manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389 or CSA B137.11. The supplier of the pipe MUST also be the manufacture of the PP-R resin. The pipe shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All pipe shall be made in an extrusion process. All piping shall contain a fiber layer (faser) to restrict thermal expansion. All pipe shall comply with the rated pressure requirements of ASTM F 2389 or CSA B137.11. All pipe shall be certified by NSF International as complying with NSF 14, and ASTM F 2389 or CSA B137.11.

B. Pipe shall be Aquatherm® Mulit-Layer Faser Composite-PPR reinforced piping suitable for condenser water service, available from Aquatherm 7.4, NA or Niron Clima PP-RCT-SDR7.3 Series. Piping specifications and ordering information are available at www.aquatherm.com.

FITTINGS

A. Fittings shall be manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389. The fittings shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All fittings

shall be certified by NSF International as complying with NSF 14, and ASTM F 2389 or CSA B137.11.

B. Fittings shall be Aquatherm® Green Pipe® available from Aquatherm, NA. Fittings specifications and ordering information are available at www.aquatherm.com.

WARRANTY

A. Manufacturer shall warrant pipe and fittings for 10 years to be free of defects in materials or manufacturing.

B. Warranty shall cover labor and material costs of repairing and/or replacing defective materials and repairing any incidental damage caused by failure of the piping system due to defects in materials or manufacturing.

C. Warranty shall be in effect only upon submission by the contractor to the manufacturer valid pressure/leak test documentation indicating that the system was tested and passed the manufacturer's pressure/leak test.

SMOKE AND FIRE RATINGS

A. Where indicated on the drawings that a Plenum-rated Piping System is needed, then the pipe shall be wrapped and/or insulated with standard pipe insulation, field installed. The pipe wrap or insulation shall meet the requirements of CAN/ULC-S102.2-03 or ASTM E84. The system shall have a Flame Spread Classification of less than 25 and Smoke Development rating of less than 50.

UV PROTECTION

A. Where indicated on the drawings that the pipe will be exposed to direct UV light for more than 30 days, it shall be provided with a Factory applied, UV-resistant coating or alternative UV protection.

THERMAL AND VAPOR BARRIER

A. Where standard pipe insulation is indicated on the drawings or in these specifications, the contractor shall provide a thermal (radiant, conductive, and convective) and vapor barrier insulation. The insulation products shall be provided with thickness or as indicated on the drawings or elsewhere in these specifications. The standard pipe insulation shall be UV resistant, CFC-free, non-porous, non-fibrous, and resist mold growth.

PART 3 - EXECUTION

PIPING APPLICATIONS

A. Install listed pipe materials and joining methods below in the following applications:

1. Aboveground: Polypropylene (PP-R) piping in SDR 7.3. All hot and chilled water piping shall rated for a minimum hydrostatic pressure of 150 PSI at 180 degrees F.

FUSION WELDING OF JOINTS

A. Install fittings and joints using socket-fusion, elecrofusion, or butt-fusion as applicable for the fitting or joint type. All fusion-weld joints shall be made in accordance with the pipe and fitting manufacturer's specifications and product standards.
B. Fusion-weld tooling, welding machines, and electrofusion devices shall be as specified by the pipe and fittings manufacturer.
C. Prior to joining, the pipe and fittings shall be prepared in accordance with ASTM F 2389 and the manufacturer's specifications.
D. Joint preparation, setting and alignment, fusion process, cooling times and working pressure shall be in accordance with the pipe and fitting manufacturer's specifications

PIPING INSTALLATIONS

A. Install hangers and supports at intervals specified in the applicable Plumbing or Mechanical Code and/or as recommended by pipe manufacturer.
1.
B. Support vertical piping at each floor and as specified in the applicable Plumbing or Mechanical Code. Piping 2" (63mm) or smaller shall be installed with mid-story guides.
2.
C. Fire stopping shall be provided to both be compatible with the Aquatherm Piping and meet the requirements of ASTM E 814 or ULC S115 , "Fire Tests of Through-Penetration Firestops". Pipe insulations or fire resistive coating shall be removed where the pipe passes through a fire stop and, if required by the firestop manufacturer, for 3 inches beyond the firestop outside of the fire barrier.
3.
D. When installed in systems with pumps in excess of 7.5 HP, piping shall be protected from excessive heat generated by operating the pump at shut-off conditions. Where the possibility exists that the pump will operate with no flow, the protection method shall be a temperature relief valve or comparable level of protection, set to a maximum temperature of 185°F.

E. If heat tracing or freeze protection is specified for the piping, it should be installed on the pipe interior or exterior. It must be suitable for use with plastic piping and be self-regulating to ensure that the surface temperature of the pipe and fittings will not exceed 70°C (158°F).

F. While still accessible all piping shall be pressure/leak tested to the manufacturer's standards. Tests shall be carried out using water, compressed air or a mixture of the two. The test pressure shall be 1.5 times the operating pressure or 150 psi, whichever is greater. Any leaks detected shall be repaired at the contractor's expense by removing the leaking part and replacing with new parts welded per the pipe manufacturer's guidelines. See www.aquatherm.com for additional details and forms.

G. The pipes should be flushed with cold water after finishing the installation. Inspect and test piping systems following procedures of authorities having jurisdiction and as specified by the piping system manufacturer

STEEL PIPE AND FITTINGS:

NEW PIPING WITHIN MECHANICAL ROOMS M100, A216 AND TOWER YARD M101 (SEE PLANS):.

A. **Condenser water piping within Mechanical rooms M100, 216 and Tower yard M101**): 1 ½ inches in diameter and larger shall be black steel, plain and beveled, seamless Schedule 40 conforming to ASTM A53, Grade B, Type S, or ASTM A106, Grade B. Fittings shall be standard weight steel, weld type. Pipe 1 ¼ inches in diameter and smaller shall be type "K" hard copper conforming to ASTM B88 with wrought copper fittings. Joints in copper pipe shall be silver brazed. All pipe and fittings shall be manufactured by Wheatland Tube or Allied Tube with steel weld bend fittings. Copper pipe shall be as manufactured by Cerro Tube or Mueller with Nibco or Mueller fittings. Horizontal piping shall be reduced in size by eccentric reducers with flat side up. Vertical piping shall be reduced in size by concentric reducers. All steel pipe and fittings shall be made in the USA.

B. Drip pan drain lines shall be Type "L" hard copper. Drain lines shall be provided with "P" traps.

VALVES:

A. **All valves installed within the condenser water system shall be metallic**. Gate valves 2 inches and smaller, bronze body, 125 pound class, solid wedge, Nibco Fig. T or S111; 2 1/2 inches and larger, iron body, bronze trimmed, solid wedge, non-rising stem, 250 pound class for steam, 125 pound class for water, Nibco Fig. F-669 for steam and Fig. F-619 for water.

B. Globe valves 2 inches and smaller, bronze body, renewable disc, 200 pound class for steam, 125 pound class, for water, Nibco Fig. T or S211 for water and Fig. T-256-AP for steam; 2 1/2 inches and larger, iron body, bronze trim, 125 pound class for water, 250 pound class for steam, bolted bonnet, renewable seat and disc, Nibco Fig. F718-B for water and Fig. F768-B for steam.

C. Check valves 2 inches and smaller, bronze body, horizontal swing, regrinding type, "Y" pattern, renewable disc, 125 pound class for water, 200 pound class for steam, Nibco Fig. T-413-B for water and Fig. T-453-B for steam; 2 1/2 inches and larger, iron body, bronze trim, bolted bonnet, horizontal swing, renewable seat and disc, Nibco Fig. F-918-B.

D. Strainers 2 inches and smaller, bronze body, 0.333" monel mesh screen, standard 125 pound class, Sarco Type BT; 2 1/2 inches and larger, semi-steel body, 1/16" perforations for 2 1/2" to 3" inclusive and 1/8" perforations for 4" and above brass screen, standard 125 pound class, Sarco Type AF-125.

E. Ball valves shall be provided for all water source heat pump hose kit. Isolation valve 2” and smaller. 2 1/2” and larger isolation valves shall be gate valves as specified. Ball valves shall be Nibco S-FP-600A.

F. All valves shall be as hereinbefore specified or equal to figure numbers by Hammond,

Nibco, Crane, or Milwaukee. All valves furnished shall be of the same manufacturer.

PIPING APPURTENANCES:

A. Pipe Sleeves: Pipe sleeves shall be provided where pipes and tubing pass through masonry or concrete walls, floors, roofs, and partitions. Sleeves in outside walls below and above grade, in floor, or in roof slabs, shall be steel pipe. Sleeves in partitions shall be 24 gauge zinc-coated sheet steel. Space between pipe, tubing, or insulation and the sleeve shall be not less than 1/4 inch. Sleeves shall be held securely in proper position and location before and during construction. All sleeves shall be of sufficient length to pass through entire thickness of walls, partitions, or slabs. Sleeves in floor slabs shall extend 2 inches above the finished floor. Space between the pipe or tubing and the sleeve shall be firmly packed with 1 1/2 PCF fiberglass and caulked tight.

B. Floor, Wall and Ceiling Plates: Plates on exposed pipes shall be chromium-plated steel or nickel-plated cast iron; all other plates shall be painted cast iron, malleable iron, or steel.

C. Flashing for Buildings: Where pipes pass through building roofs and outside walls, proper flashing shall be provided and shall be made tight and waterproof.

D. Unions and flanges: Unions or flanges shall be placed where necessary to permit easy disconnection of piping and apparatus, and as indicated. Each connection having a screwed-end valve shall have a union. Unions shall be used on piping under 2 inches in diameter, and flanges shall be used on piping 2 1/2 inches and over in diameter. Dielectric unions or flanges shall be installed between ferrous and non-ferrous piping, equipment, and fittings; except that bronze valves and fittings may be used without dielectric couplings for ferrous-to ferrous or non-ferrous to non-ferrous connections. Dielectric fittings shall utilize a non-metallic filler which will prevent current flow from exceeding 1 percent of the short circuit current. The spacer shall be suitable for the pressure and temperature of the service.

E. Expansion Tank: Expansion tank shall be welded steel designed for not less than 125 psig working pressure and shall be constructed and tested in accordance with Section VIII of the ASME Boiler Pressure Vessel Code. Tank shall be zinc coated (galvanized) inside and out after fabrication. Tank shall include a properly sized Airtrol tank fitting, Drain-O-Tank fitting gauge glass, pressure reducing valve, ASME relief valve and air gap between relief outlet and drain. The design working pressure of the tank shall be either the head imposed on it by the system or 150 psig, whichever is greater. Install tanks on angle iron cradles suspended from the ceiling structure with rods attached. Expansion tanks shall be manufactured by Bell & Gossett, John Wood Co., or Wessels Co.

F. Thermometers: Shall be 9" scale, corrosion resistant baked enamel finished aluminum case mercury-in-glass red reading type, industrial series fitted with bulb chamber and separable socket with extension neck to suit insulation thickness. Thermometers shall be adjust angle type and shall be as manufactured by H.O. Trerice, Marshalltown, Marsh Instrument Co., or prior approved equal.

Scales:

0 - 100	Degrees F.	Condenser Water

G. Pressure Gauges: Shall be stainless steel or cast aluminum case with 4 1/2" dial and 1/4" bottom connection. Gauges for water service shall have brass needle valves and brass snubber. Gauges for steam service shall have brass needle valve, brass snubber and steel syphon. Pressure gauges shall be as manufactured by H.O. Trerice Co., Marshalltown, Marsh Instrument Co., or prior approved equal.

Scale	
0 - 100	PSI

H. Flow Meters: Shall be provided where indicated and shall be installed as per manufacturer's instruction. The meter shall be direct reading in gallons per minute and shall be rated for 240 degrees F. maximum temperature, 150 PSI operating pressure and 225 PSI test pressure. Flow meters shall be manufactured by Presso, Flow Design, Metraflex or prior approved equal.

I. Flow Stations: Shall be provided as indicated. Stations shall be Presso "Bin", or prior approved equal. Provide one differential pressure meter set to Owner at completion of project.

J. Flexible Connectors: Shall be provided where indicated and on all piping passing through the building expansion joint line. Flexible connectors shall be constructed of an annular inner corrugated stainless steel close pitched hose and protected by stainless steel overbraid. Braided stainless steel hoses must be suitable for temperatures up to 850 degrees F. The rated working pressure of the braided metal hose must have a minimum 4:1 safety factor. Flexible connectors shall be manufactured by Flex-Hose Co., Metraflex, Mason Industries, VMC, or prior approved equal.

K. Expansion loops shall be provided with dimensions as indicated on drawings. Four moment/alignment guides shall be provided for each loop. The first guide shall be four pipe diameters from the base of the loop, and the second guild shall be 14 pipe diameters from the first guide. Provide supplemental steel as required to attach to structure. Guides shall be Grinnell Fig. 256 or equal by Michigan or B-Line.

L. Circuit setters shall be provided as indicated, for water source ventilation air units. Setters shall be Bell & Gossett, Hays Fluid Control, or prior approved equal.

M. Auto flow valves shall be provided for all water source heat pumps. Auto flow valves shall be matched to unit being served and shall automatically limit flow to 10% of specified value, over a 40 to 1 differential pressure of 2 to 80 PSID. Valve body shall be rated for 400 PSI working pressure, valve shall be as manufactured by Hays Fluid control

PIPE HANGERS:

A. Provide all rods, clamps, inserts, etc. as required to properly support all pipe.

B. Pipe hangers shall be Michigan Figure Numbers as follows or equal by PHD. Provide additional pipe saddles 16 gauge galvanized rolled steel x 24" long at each hanger as detailed.

C. Insulated condenser water piping - Figure No. 403.

PIPE SIZE	MAXIMUM SPAN - FEET	MINIMUM ROD SIZE - DIAMETER
1"	8 FEET	3/8
1 1/2"	8 FEET	3/8
2"	8 FEET	3/8
3"	8 FEET	1/2
4"	8 FEET	5/8
5"	8 FEET	5/8
6"	8 FEET	3/4
8”	8 FEET	3/4
10”	8 FEET	1”
12”	8 FEET	1”

Note: Above pipe hanger spacing is for piping installed in locations other than existing condenser water piping. Contractor shall reuse existing pipe hanger rods at existing locations where available. This contractor is responsible for additional hangers in locations where existing hanger rods exceed the manufacturer’s maximum recommended hanger spacing for listed pipe sizes.

CONDENSER WATER PUMPS:

A. Pumps shall be end suction base mounted flexible coupled centrifugal pumps constructed of cast iron housing and bronze impeller with internally flushed mechanical seals. Pump seals shall be suitable for ethylene glycol. Bearings shall be ball type and shall be efficiently sealed and isolated to prevent loss of oil or entrance or dirt or water. Pump and motor shall be mounted on a common fully open groutable base and shall be complete with ANSI and OSHA rated coupling guard with viewing window. Pump volute shall have integrally cast pedestal volute support. (Over hung pump volutes will not be accepted.) Volute shall include gauge ports at nozzles and vent and drain ports. A center drop out spacer coupling shall be furnished to facilitate and access the pumps working components without disturbing motor or piping and for ease of maintenance. Pump shall be a true back pull out design. Pumps for variable speed applications shall be furnished with an inverter duty motor and an EDPM coupling sleeve. Motors shall be scheduled horsepower, speed, voltage and enclosure design and meet NEMA specifications and Epact 92 Energy Efficient Standards. Motors shall be non-overloading at any point on the pump curve and shall be selected so that the operating point on the selected impeller curve will lie at or to the left (shut-off side) of, and not more than five percent below the maximum efficiency for the impeller. Motors shall be premium efficiency.

B. Pumps shall be installed on foundations as indicated, properly leveled, grouted and realigned by the Installing Contractor per the manufacturer’s installation manual. Each pump shall be factory aligned, checked, and started by the manufacturer’s qualified representative. A start-up report shall be submitted to the Engineer.

C. All pipe connections to the pumps shall have not less than five pipe diameters of straight pipe before any fittings. For all pump suction connections, provide a suction diffuser as manufactured by Bell & Gossett Co., or prior approved equal.

D. Pumps shall be Model 1510, (In-line, or Horizontal Split Case as noted on pumps

schedule) as manufactured by Bell & Gossett, Peerless, Crane, or Taco.

E. All condenser water pumps scheduled for variable frequency operation shall be provided with inverter duty motors. Pump motors shall be as manufactured by Siemens, Baldor, or US motor. **WEG motors are not acceptable**. VFD's shall be provided by Controls Contractor. See control specification.

AIR SEPARATORS:

A. Shall be designed with tangential openings (straight through connections will not be accepted), ASME designed to create a low velocity vortex where air is separated and removed from the circulating water. Air separator shall be designed and constructed per ASME Section VIII, Division I. Construction shall be of cast iron for 2 1/2" and smaller and steel construction for 3" and larger. Air separator shall include a galvanized steel strainer and stainless steel collector tube. Maximum working pressure shall be 125 psig minimum and maximum operating temperature of 350 degrees F. Air separators shall be Bell & Gossett "Rolairtrol" or prior approved equal.

CLEANING SYSTEM:

A. Water piping system shall be cleaned out using a hot (200degrees F) solution of trisodium phosphate mixed one pound to fifty gallons of water or per chemical manufacturer's recommendations. Remove or valve off any item subject to damage. If required by manufacture's specification and or written instructions, control valves shall be removed and spacers provided. Condenser water pumps shall circulate the solution for 12 hours after which the system shall be drained down and completely flushed not less than 3 times. While cleaning system strainers each time. At no time during cleaning or flushing shall water flow through water source heat pumps or ventilation air units. Fill shall be done with clean water initially treated with corrosion inhibitors per manufacturers recommendations. Water treatment shall include (12) month madatory testing and treatment to coincide with warranty period.

TESTS:

PIPING SYSTEMS:

A. All piping systems shall be tested after the lines have been cleaned and before any insulation covering has been applied. Piping systems shall be tested at a pressure of 1 1/2 times the design working pressure and in no case less than 150 psig. All piping shall be hydrostatically tested using water not exceeding 100 degree F. In the tests, gages, traps, and other apparatus which may be damaged by the test shall be removed or valved off from the system before the tests are made. A calibrated test pressure gauge shall be installed in the system to observe any loss in pressure. The required test pressure shall be maintained for a sufficient length of time to enable an inspection to be made of all joints and connections. All defects which develop during testing shall be rectified, and the piping systems shall be retested until they show no defect of weakness and are tight.

IDENTIFICATION TAGS AND COLOR CODES:

3.01 PIPE MARKING:

A. After all piping has been painted with the proper color code; all piping shall be coded and marked with PERMA-CODE pipe markers as manufactured by W. H. Brady Company or an approved pipe marker company. Markers shall be applied to properly label piping as follows:

1.) 2 1/4" width markers on all pipes 3" diameter and larger, 1 1/2 width markers on all pipe smaller than 3" in diameter.

2.) An arrow marker with each pipe content marker. The arrow always pointing away from the pipe marker and in the direction of flow. In flow is possible in both directions use a double-headed arrow marker.

3.) Apply pipe content marker and arrow marker as follows:

a. At each valve to show proper identification of contents and direction of flow.
b. At every point of pipe entry or exit where a pipe goes through a wall.
c. On each riser and "T" joint.
d. Every 50 feet on long continuous lines. (Alternate method: Identify long continuous lines at every bay or aisle.)

B. Markers shall be applied where there are not obstructions, and shall be secured by spiral wrapping with banding tape, color matching service, at each end of the marker.

C. Identification of piping: All steel piping, bare and insulated, shall be given two (2) coats of finished paint. (One [1] coat primer / one [1] coat finish paint). Painting of pipe shall occur after Engineer's inspection of chilled and hot water piping and pressure testing and prior to insulation. All insulated pipe shall also be painted on the exterior surface of the insulation with paint as recommended by manufacturer. Paint shall be Glidden Industrial Enamel (with colors indicated below) or Sherwin-Williams, Devoe Paints or other approved paint manufacturers. Samples of colors or and paint shall be submitted for approval before application. Paint shall comply with low VOC LEED requirements.

CODING	**GLIDDEN**
Condenser Water Supply & Return	Green
Hot Water Supply & Return (Boiler supply/return)	Orange

D. Drains and Vents: Same color as system served.

E. Tanks: Will be painted the same color as the most significant dangerous liquid or gas (For example: Tank, Steam and Hot water - Safety Orange) flowing to, through and from the tank.

F. Identification tags and plates: All equipment, gauges, thermometers, valves, and controllers shall be provided with tags numbered and stamped for their use. Plates and tags shall be of brass or suitable nonferrous material and shall be securely mounted or attached. All circuit setters shall be tagged with final balanced GPM at project completion.

G. Location chart: Provide a framed location chart and diagram showing numbers and

location of every valve and shut-off cock. Attach chart in location as directed.

END OF SECTION 15846

SECTION 15866 - INSULATION (DUCTWORK AND CONDENSER WATER PIPING)

PART ONE - GENERAL:

1.01 All insulation shall have a composite fire and smoke hazard rating which shall include insulation, jacket, facing, and adhesive. Flame spread rate shall not exceed 25 with smoke development not in excess of 50. Accessories (adhesives, mastics, cements, tapes) shall be rated as specified for insulation. Samples of all types of insulation shall be submitted for approval. Piping and duct work shall be tested, thoroughly cleaned and approved before insulation is applied.

PART TWO - PRODUCTS:

2.01 Duct insulation shall be as manufactured by Manville, Certain-Teed, Owens-Corning, Knauf, or approved substitute.

2.02 Pipe insulation shall be Armaflex or Rubatex.

PART THREE - EXECUTION:

3.01 SUPPLY, RETURN AND OUTSIDE AIR DUCTWORK:

A. All concealed ductwork, including flexible duct connections, diffuser boots, and backs, VAV box heater/ manifold sections, etc. shall be insulated with 2" thick, 1 PCF density, flexible insulation with factory applied vapor barrier consisting of Foil-Scrim-Kraft. Insulation shall be secured to ductwork with Benjamin Foster 85-20 adhesive. All joints shall be stapled and finished with a 3" wide strip of glass fabric and mastic.

B. All transfer air ducts shall be insulated internally with ¾” Armaflex S.A. as detailed for return air sound trap on plans. Insulation shall be secured with weld pins.

C. All ductwork serving ventilation air vents shall be insulated as described above for supply and return ductwork.

3.03 PIPING (NON-FERRUS PPE PLASTIC CONDENSER WATER PIPING):

A. All PPE Aquatherm or Niron piping installed within the building ceiling plenum areas shall be insulated with Certain-Teed 500 degree Spap-on ASJ/SSL pipe insulation. Fiberglass shall not be used for exterior condenser water piping. Exterior condenser water and all condensate piping shall be insulated and heat traced with closed-cell, flexible elastomeric molded pipe insulation. All joints shall be sealed using Armstrong 520 adhesive. All seams, longitudinal and butt joints, shall be covered with Armaflex insulation tape, 2" wide. Butt joints shall be wrapped first with the longitudinal seam tape butted to the wrap. Where multiple layers are required, all seams shall be staggered, and insulation tape shall be applied to outermost seams only. Insulation thicknesses shall be as follows:

Service	Pipe Size	Insulation Thickness
Condensate	All	¾”
Condenser Water (Interior)	All	½”

Condenser Water (Exterior)	All	2”

B. Fittings shall be insulated in strict accordance with manufacturer's recommendations using materials as specified in Paragraph 3.04 A. Mitered and radius covers shall be prefabricated as shown in manufacturer's literature. All seams in fitting covers shall be sealed with adhesive and covered with insulation tape as described above.

C. All materials and methods described above shall be in strict accordance with manufacturer's recommendations unless specifically otherwise indicated.

D. Interior chilled water piping as labeled above refers to all chilled water piping located within a conditioned space.

3.05 APPURTENANCES:

A. Provide not less than 16 gauge galvanized steel shields, 24" long, 180 degree bend, inserted between the hanger and insulation for chilled water piping insulation. Provide integral pipe supports sealed in the insulation as recommended by manufacturer.

3.06 OUTDOOR PIPING:

A. In Addition to insulation requirements, all outdoor condenser water piping shall be covered with 26 gauge stainless steel jacket banded 4” O.C. with stainless steel bands of same gauge.

END OF SECTION 15866

SECTION 15870 – FOUNDATIONS AND SUPPORTS

PART ONE – GENERAL:

1.01 Provide all necessary foundations, supports, pads, bases, and piers required for all air conditioning equipment and for all other equipment furnished under this contract.

PART TWO – PRODUCTS & EXECUTION:

2.01 For rotating machinery, and for all equipment where foundations are indicated, furnish and install concrete pads as shown. All pads shall be extended 6" beyond machine base in all directions with top edge chamfered and be 6" thick, unless otherwise noted. New housekeeping pads are required in second floor mechanical pump room (Room 216). Existing housekeeping pads for boilers in Main Mechanical Room M100 shall be reused. See details and seismic specifications for seismic inertia base requirements.

END OF SECTION 15870

SECTION 15890 - VIBRATION AND SEISMIC CONTROL

PART ONE - GENERAL:

1.01 All vibration isolation and seismic control materials specified herein shall be provided by a single manufacturer to assure single responsibility for their proper performance. Installation of all vibration and seismic control materials specified herein shall be accomplished following the manufacturer's written instructions.

1.02 The Contractor shall furnish a complete set of shop drawings and other necessary information, of all mechanical equipment to receive vibration isolation and seismic devices, to the vibration isolation and seismic control materials manufacturer. The information to be furnished shall include operating weight of the equipment to be isolated, distribution of weight to support points and dynamic characteristics along with any internal isolation systems to be analyzed. The Contractor shall also furnish a complete layout of piping and ductwork to be isolated, including vertical risers, showing size or weight and support points of the piping and ductwork system, to the vibration isolation and seismic control materials manufacturer, for selection and layout of mountings.

1.03 The vibration and seismic control materials manufacturer shall use the above listed information to design a complete system of vibration and seismic mounts in accordance with the contract documents along with the International Building Code with date as indicated on the code analysis section of the contract documents, SMACNA “Seismic Restraint Manual” latest edition, and ASHRAE HVAC Applications handbook, Sound and Vibration Control section, latest edition. The vibration and seismic control materials Contractor shall analyze all “multiple degrees of freedom” systems and provide properly designed isolation systems avoiding all resonance frequencies. To accomplish this, the vibration and seismic control materials supplier shall employ an Engineer registered in the State of South Carolina to design all isolation and restraint systems and prepare a complete set of calculations and shop drawing submittals with his professional Engineer’s seal certifying that the design meets all requirements of these contract documents. A seismic design “errors and omissions” insurance certificate must accompany submittals from the vibration and seismic Engineer. Manufacturer’s product liability insurance certificates are not acceptable.

1.04 The vibration and seismic control Engineer or his designated representative shall inspect the project upon completion of the applicable work and provide written certification that the installation is in compliance with the approved shop drawing submittals. This certification shall also bear the professional Engineer’s seal and shall become part of the contract closeout documents. All seals shall be signed and dated appropriately.

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

PART TWO - PRODUCTS AND EXECUTION:

2.01 VIBRATION ISOLATION:

A. All mechanical equipment shall receive external vibration isolation. Internal component isolation of equipment shall not be considered equivalent but shall be considered when analyzing systems with multiple degrees of freedom.

B. Vibration isolators shall be selected based upon known operating weight distributions and dynamic characteristics of the isolated equipment, with the quantity and location as required by the component drawing. Isolator type shall be tabulated for each isolated piece of equipment. Complete calculations of vibration analysis shall be included with submittals, including but not limited to fundamental and harmonic frequencies.

C. Isolators shall have either known non-deflected heights of spring element or calibration markings so that, after adjustment, when carrying their load, the deflection under load can be verified to determine if the load is within the proper range of the isolator and if the correct degree of vibration isolation is being provided.

D. Isolators shall function in the linear portion of the load versus deflection curve. Theoretical vertical natural frequency shall not differ from the design objectives by more than + 10%.

E. Spring mounts shall have seismic housings as required by Paragraph 2.02.

F. Isolation of equipment shall be as follows:

1. Suspended equipment shall be isolated form the building structure by means of noise and vibration isolators. Units shall be supported with spring and neoprene type isolators, springs to be as described above. Isolators shall be VMC Series RSH.

2. Roof mounted equipment shall be isolated from the building structure by means of a structural aluminum or hot dipped galvanized structural steel isolation curb. The structural spring isolation curbs shall bear directly on the roof support structure and be flashed and waterproofed into the roof's membrane waterproofing system. Roof curbs shall be installed to accommodate the pitch of roof. Contractor shall provide and install all supplemental steel required for seismic attachment of curb to structure as designed by manufacturer. Field fabricated curbs shall not be used. Curb shall come factory assembled. No bolt together corners will be allowed. The curb shall consist of a rigid lower section containing properly spaced pockets with fully adjustable spring isolators. All springs shall be color coded for proper identification and spring pocket shall allow for easy removal or replacement of any spring without disturbance of the supported equipment. Pockets shall have removable waterproof covers to allow for spring adjustment. Spring pockets shall contain combination vertical and horizontal restraint in conjunction with a 1/4-inch-thick neoprene rubber bushing which will resist wind and seismic forces. All springs shall be installed in series

with a 1/4-inch-thick neoprene acoustical cup or pad. Curbs supplied shall be factory acoustically lined with 1 inch 3 PCF duct liner. An air tight neoprene seal shall be incorporated into the curb design to prevent air leakage or infiltration. Air seal must not be exposed so that it could be damaged or that in the event of the air seal failure, water could leak into the curb's interior. Wood nailer and flashing shall be provided and curbs shall be manufactured to NRCA standards. Curbs shall include a means of incorporating a sound barrier package, consisting of two layers of waterproof gypsum board furnished and installed by the Mechanical Contractor. Provide 6", R-19 sound attenuating batt insulation equal to Certa Sound as manufactured by Certainteed, batt insulation shall fill all voids within the curb between the roof deck and the unit above. Additionally, the mechanical contractor shall provide ½" treated plywood around the entire perimeter of the curb over the rigid insulation supplied by the roofer to allow for roofer to properly flash curb. Individual pier supported curbs are not acceptable. Roof equipment supports to be VMC type P or R.

3. Mechanical equipment as noted shall be mounted on a rigid structural steel base. The equipment including the base shall be mounted on or suspended from vibration isolators as applicable. Base shall be VMC Type WFB.

4. Floor mounted equipment as noted shall be provided with a noise and vibration isolated structural steel concrete slab inertia base mounted on isolators. Spring mounts shall be recessed at corners. Inertia base shall be VMC Type MPF or WPF as applicable.

2.02 SEISMIC CONTROL:

A. All mechanical equipment, piping, ductwork, etc. shall be provided with seismic restraints in accordance with the International Building Code, International Mechanical Code, and SMACNA Seismic Restraint Manual, Latest Edition requirements, as a minimum.

1. All equipment isolated or not, shall be bolted to the structure to allow for seismic acceleration with no failure or displacement. All connections shall be positive bolted type; no friction clamps of any kind are allowed.

2. Provide cable and connection sets for suspended equipment at each of four corners secured to the building structure.

3. Provide seismic roof curb systems fastened to roof structure for roof top equipment.

4. Floor mounted equipment shall be provided with seismically housed springs or springs with seismic snubbers as determined by the equipment to be isolated.

END OF SECTION 15890

SECTION 15900 - CONTROLS

PART ONE - GENERAL:

1.01 The control equipment shall be the standard product of a single, reputable control manufacturer and shall be installed by trained mechanics regularly employed by the control manufacturer. The system shall be the electric type. A typewritten control sequence shall be framed and displayed where directed.

1.02 All items of equipment, materials, and labor necessary and/or incidental to the hereinafter specified sequence of operation shall be provided with the control system. Items such as auxiliary controls, interlocks, relays or other sequencing devices shall be fully coordinated with the heating and cooling equipment approved for the installation.

1.03 All control wiring required for this installation is included in this contract and shall be color coded. All control wiring shall be in conduit. Conduit, wiring sizes, and type of insulation shall be in accordance with DIVISION 16E - ELECTRICAL, and shall conform to the latest issue of the National Electrical Code. All electrical equipment shall bear UL labels. Each control circuit shall be protected by a circuit breaker of the proper size.

PART TWO - PRODUCTS AND EXECUTION:

2.01 SMOKE WALLS:

A. Contractor shall provide circuits, conduit, wire, detectors, and listed operator/smoke damper at each duct penetration of a smoke wall in accordance with NFPA 72 and 90A.

2.02 THERMOSTATS/HUMIDISTATS:

A. Thermostats shall be mounted 48" above finished floors, unless otherwise noted. Provide heavy-duty key lock steel guards by "AA" Industries, Model T18L secured to wall with lead anchors and #10 screws or equal by Shaw-Perkins.

2.03 CONTROLLERS:

A. All controllers shall be labeled with engraved bakeolite plastic plates indicating control function and correct set point. Label shall clearly relate to controller by functional name as indicated on control wiring diagram.

2.04 FIRE PROTECTION:

A. All air handling units 2000 CFM and above shall be provided with smoke detectors in the return air ducts and smoke dampers in accordance with the International Mechanical Code. Air handling units that are a part of a smoke control system shall have smoke detectors and smoke dampers regardless of capacity.

B. The smoke detectors shall be designed to detect combustion gases, fire and smoke in the supply and return air streams of the air handling units as indicated. The smoke detectors shall consist of sampling tubes which extend into the return and supply air section and, while the fan is operating, shall continuously sample air. The smoke detector shall be of the ionization type. Materials and equipment shall be the standard catalogued products of concerns regularly engaged in the manufacture of the products and shall be the latest standard design that conforms to the specification requirements and bear the UL label and Factory Mutual Laboratories label. The smoke detection system shall be interlocked with the smoke dampers and air handling unit fan motor and shall, when energized, close the smoke dampers and shut down the fan motor. Smoke dampers shall be wide open before air handling unit fan motor begins operating. Smoke detectors shall have reset switch and red alarm light. Provide extra contacts for tie-in with building fire alarm system. If no fire alarm system is provided under Division 16, this Contractor shall provide an alarm panel with visual and audible signals for each detector with a location map. Graphic annunciator panel shall be located at a constantly attended location per I.M.C. Section 6.06.4.1. Coordinate location with Owner and Architect. Installation shall meet requirements of NFPA 72.

C. Smoke Dampers: Dampers shall meet the requirements of NFPA 72, 90A, UL 555 and 555S. All damper frames shall be constructed of No. 13 gauge galvanized sheet metal and shall have hat-shaped end channels for duct mounting. Damper blades shall not exceed 6" in width. All blades are to be corrugated type construction, fabricated from two sheets of No. 22 gauge galvanized sheet-metal spot welded together. All damper blade bearings are to be made of oil impregnated sintered bronze and will turn freely in the frame. Replaceable synthetic elastomer seals shall be provided. The dampers shall be provided with seals installed along the top, bottom and sides of the frame and along the upper edge of each blade edge. Seals shall provide a tight-closing, low-leakage damper. Leakage and flow characteristics charts shall be submitted prior to installation of dampers.

D. Furnish shop dampers to ductwork contractor for installation. Control contractor shall supervise damper installation.

E. For air handling units 2000 CFM and under capacity but serving an area used for egress, provide smoke detectors in accordance with International Mechanical Code requirements.

F. Provide necessary control devices and wiring to shut off kitchen make-up air units upon activation of the kitchen hood fire extinguishing system. Provide controls to shut off hood exhaust fans when exhaust air temperature reaches 350 degrees F. Interlock with building fire alarm system.

G. Provide ionization type smoke detector in the inlet of each exhaust fan of 15,000 CFM or more. Sampling tubes shall detect combustion gases and/or smoke and stop the fan when detector is activated. Detector unit shall be equipped with reset switch and red alarm light. Provide extra contacts for tie-in with building fire alarm system.

E. Provide Carbon Monoxide sensors in supply ducts of all units (new and existing)

equipped with gas fired heat. Upon sensing of products of combustion, CO sensor shall shut down associated unit and send a “Trouble” signal to the building Fire Alarm Panel. CO and Smoke detectors shall not activate the building fire alarm system and shall initiate local shutdown of unit. Smoke and CO sensors shall not perform a “global” shutdown of the HVAC system.

2.05 ENERGY MANAGEMENT SYSTEM (EMS) - (SEE EMS SPEC. SECTION):

A. Provide control center located as indicated on the HVAC drawings, per Section 15904 of the specifications. The control center shall contain numbered terminals of sufficient quantity to permit the required connections. Provide two 120v power supplies and a water pipe ground wire inside control center.

B. Provide conduit and install Belden #9967 2-conductor shield cable from panel to main distribution switchboard. Provide current transformers on main bus bars for demand limiting function.

2.06 CERTIFICATION:

A. Furnish to the Architect/Engineer two copies of certification signed by authorized representative of the control company that:

(1) Control system has been checked-out and operates according to drawings and specifications.

(2) All controls are guaranteed unconditionally for one year from date of acceptance and will be serviced for this period free of charge.

(3) Photostatic copies of as-built wiring diagram and control zones have been framed under glass and posted on job.

(4) Maintenance personnel or responsible party has been instructed as to the operation of control system. Keys for guards and control centers have been turned over to Owner.

B. The control and energy management systems shall be as manufactured by Siemens.

END OF SECTION 15900

SECTION 15904 – DDC CONTROLS – WATER SOURCE HEAT PUMP

PART ONE - GENERAL:

1.01 The control equipment shall be by Seimens. The system shall be the direct digital type. A typewritten control sequence shall be framed and displayed where directed. As built control drawings to be framed and wall hung as directed. The control contractor shall submit pricing for this project to the general contractor and will contract though the general contractor. The control contractor shall not be a sub-contractor to the mechanical contractor.

1.02 All items of equipment, materials, and labor necessary and/or incidental to the hereinafter specified sequence of operation shall be provided with the control system. Items such as auxiliary controls, interlocks, relays, or other sequencing devices shall be fully coordinated with the heating and cooling equipment approved for the installation.

1.03 All control wiring required for this installation is included in this contract and shall be color coded. All control wiring shall be in conduit. Conduit, wiring sizes, and type of insulation shall be in accordance with DIVISION 16E - ELECTRICAL, and shall conform to the latest issue of the National Electrical Code. All electrical equipment shall bear UL labels. Each control circuit shall be protected by a circuit breaker of the proper size.

A. All wiring shall be in conduit. Minimum conduit size shall be 3/4". Minimum wire size shall be 16 gauge. Conduit shall be sized in accordance to "NEC" requirements and shall be provided with extra pull wire. No analog cable or binary wire shall be grouped in the same conduit. All analog cable shall be shielded cable, minimum size 22 gauge.

B. Provide conduit and install two (2)-conductor shielded cable from EMS panel to main electrical panel. Provide CT equipment in main electrical panel for demand limiting function. Coordinate space requirement with Electrical Contractor.

1.04 Complete submittal data, including equipment specifications, piping and wiring diagrams and sequences of operation shall be furnished for approval before installation is begun. Upon job completion four (4) sets of as-built control drawings shall be furnished the Owner.

1.05 The Control Contractor shall furnish and install all equipment, accessories, wiring and instrument piping required for a complete and functioning system.

A. The building control system shall possess a fully modular architecture, permitting expansion through the addition of more stand-alone control units, sensors, actuators, operator terminals, and/or a general purpose CPU.

B. Supervision and checkout of the system shall be by local branch engineers and technicians directly employed by the Control Contractor.

1.06 This specification defines the minimum equipment and performance requirements for a direct digital control building control system.

A. Acceptable manufacturer: Siemens

PART TWO - PRODUCTS AND EXECUTION:

2.01 SMOKE WALLS:

A. Contractor shall provide circuits, conduit, wire, detectors, and listed operator/smoke damper at each duct penetration of a smoke wall in accordance with NFPA 90A.

2.02 LABELING:

A. Controllers shall be labeled with engraved bakeolite plastic plates indicating control function and correct set point. Label shall clearly relate to controller by functional name as indicated on control wiring diagram and shall be mechanically fastened, no adhesive back tags accepted.

2.03 FIRE PROTECTION:

A. All air handling units over 2000 CFM shall be provided with smoke detectors and smoke dampers, as required, in accordance with the Standard Mechanical Code.

B. The smoke detectors shall be designed to detect combustion gases, fire and smoke in the return air stream of the air handling units as indicated. The smoke detectors shall consist of sampling tubes which extend into the return air section, and while the fan is operating, shall continuously sample air. The smoke detector shall be of the ionization type. Materials and equipment shall be the standard cataloged products of concerns regularly engaged in the manufacture of the products and shall be the latest standard design that conforms to the specification requirements and bear the UL label and Factory Mutual Laboratories. The smoke detection systems shall be interlocked with the smoke dampers and air handling unit fan motor and shall, when energized, close the smoke dampers and shut down the fan motor. Smoke dampers shall be wide open before air handling unit fan motor begins operating.

C. Smoke Dampers: Dampers shall meet the requirements of NFPA 90A. All damper frames shall be construction of No. 13 gauge galvanized sheet metal and shall have hat-shaped end channels for duct mounting. Damper blades shall not exceed 6" in width. All blades are to be corrugated type construction, fabricated from two sheets of No. 22 gauge galvanized sheet metal spot welded together. All damper blade bearings are to be made of oil impregnated sintered bronze and will turn freely in the frame. Replaceable synthetic elastomer seals shall be provided. The dampers shall be provided with seals installed along the top, bottom, and sides of the frame and along the upper edge of each blade edge. Seals shall provide a tight-closing, low-leakage damper. Leakage and flow characteristics charts shall be submitted prior to installation of dampers.

D. Furnish dampers to ductwork contractor for installation. Control Contractor shall

supervise damper installation.

E. Kitchen Hood: Interlock make-up air fans with fire extinguishing system in hood to shut fans down upon activation. Hood exhaust fans shall have an adjustable high limit shutdown switch set initially at 350 degrees F.

2.04 BUILDING CONTROL SYSTEM:

A. The building control system specified herein shall be a direct digital control system which can, without additional equipment, perform all of the automatic temperature control and energy management functions as required in this specification. Direct Digital Control shall be defined as a control technique through which the process variable is continuously monitored by a digital computer which accomplishes loop control by calculating a control solution for output to a control device.

The system, as specified, shall independently control the building's HVAC equipment to maintain a comfortable environment in an energy efficient manner. The building operator shall communicate with the system and control the sequence of operation within the building.

B. SYSTEM ARCHITECTURE:

1. The building control system shall consist of a network of independent, stand-alone control units. Each stand-alone control unit shall be capable of performing all specified control functions in a completely independent manner. Additionally, control units shall be capable of being networked for single point programming and for the sharing of point information and control instructions between panels. All operator communication with the system shall be via operator terminals provided as required. It shall be possible for each control unit to have a dedicated local display or for a collection of control units to share a single operator terminal.

C. SYSTEM COMPATIBILITY:

1. Control Contractor shall verify that water source heat pump electronic control boards such as Trane, McQuay Mark IV and electronic equipment control units such as the SCU's and TCU's are completely compatible and will function properly.

D. STAND-ALONE CONTROL UNIT (SCU):

Each control unit shall be capable of full operation either as a completely independent unit or as a part of the building-wide control system. All units shall contain the necessary equipment for direct interface to the sensors and actuators connected to it.

Control strategies shall be Owner definable at each control unit, and for all control units in the system from any one operator terminal. Each control unit shall provide the ability to support its own operator terminal if so desired.

1. Each stand-alone control unit shall include its own microcomputer controller, power supply, input-output modules, termination modules, and battery. The battery shall

be self-charging and be capable of supporting all memory within the control unit if the commercial power to the unit is interrupted or lost for a minimum of one hundred (100) hours.

The stand-alone control unit shall be listed by Underwriters Laboratories (UL) against fire and shock hazard as a signal system appliance unit. The unit shall also be listed by U.L. Canada (ULC) and Canadian Standards Association (CSA).

The SCU (field panel) shall be furnished with a use programmable language and internal memory of at least 128K RAM for local storage of extended trend date. Field panels with less than 128K may be used only if the total number of terminal control units assigned to that SCU (field panel) is limited to 20.

The SCU (field panel) shall have built-in diagnostics to display at the operator terminal the amount of available RAM in each SCU (field panel) on the network.

The network shall be able to detect changes in any SCU's (field panel's) and terminal control unit's point status and report this change to all terminals accessing the network.

The operator shall have the capability to override the operation of any SCU (field panel) or terminal control unit by command at a terminal connected to any SCU (field panel) on the network. The SCU (field panel) shall accept and execute operator commands to override all terminal control unit functions including set points from the SCU (field panel) operator terminal. No additional hardware or software changes shall be required at the terminal control unit to execute SCU (field panel) overrides.

2. Sensor/Input Signals:

   Each stand-alone control unit shall be capable of direct interface to a variety of industry standard sensors and input devices.

   It shall be possible for each stand-alone control unit to monitor the following types of inputs:

   *analog inputs
   - 4-20 mA
   - 0-10 vDC
   - thermistors
   - 3-15 psi
   *digital inputs
   - dry contact closure
   - pulse accumulator

3. Actuators/Output Signals:

   The stand-alone control unit shall directly control pneumatic and electronic actuators and control devices. Each control unit shall be capable of providing the

following control outputs:

*digital outputs (contact closure)
- motor starters, sizes 1 to 4
*analog outputs
- 3-15 PSI
- 4-20 mA
- 0-16 vDC

*pulsed outputs (contact closures)
- motor starters, sizes 1 to 4

4. Building Control Functions:

Each Stand-alone Control Unit within the Building Control System shall perform both temperature control functions and energy management routines as defined by the operator.

All temperature control functions shall be executed within the stand-alone control unit. Loop control shall be executed via direct digital control algorithms. The user shall be able to customize control strategies and sequences of control, and shall be able to define appropriate control loop algorithms and choose the optimum loop parameters for loop control. Control loops shall support any of the following control modes.

*Two-position (on-off, slow-fast, etc.)
*Proportional (P)
*Proportional plus integral (PI)
*Proportional, integral, plus derivative (PID)

It shall be possible to fully create, modify or remove control algorithms within a specific stand-alone control unit while it is operating and performing other control functions. Input for these changes may be made directly into the stand-alone control unit or via the network from any other control unit. Each control loop shall be fully user definable in terms of:

*sensors/actuators that are part of the control strategy
*control mode
*gains
*control action
*sampling time

In order to minimize wiring and sensor costs, provide stand-alone control units that are able to share point information such that control sequences or control loops executed at one control unit may receive input signals from sensors connected to other stand-alone control units within the network. If the network communication link fails or the other stand-alone control unit malfunctions, the control loop shall continue to function using the last value received from the stand-alone control units.

Each stand-alone control unit shall be capable of performing the following energy management routines as a minimum:

*time of day scheduling
*start/stop time optimization
*peak demand limiting (temperature compensated)
*duty cycling (temperature compensated)
*outdoor air reset
*event initiated programs

In addition, the Owner shall be able to create customized control strategies based upon arithmetic, Boolean or time delay logic. The arithmetic functions shall permit simple relationship between variable (i.e. +, -, x) as well as more complex relationships (i.e. square root, exponential).

The system shall permit the generation of job-specific control strategies that can be activated in any of the following ways:

*continuously
*at a particular time-of-day
*on a pre-defined date
*when a specific measured or controlled variable reads a selected value or state
*when a piece of equipment has run for a certain period of time.

Upon a loss of commercial power to any stand-alone control unit, the other units within the network shall not be affected, and the loss of operation of that unit shall be reported at the designated operator's terminal. All control strategies and energy management routines defined for the stand-alone control unit shall be retained during a power failure via the battery with the unit for a minimum of eight (8) hours. Upon resumption of commercial power, the control unit shall resume full operation without operator intervention. The unit shall also automatically reset its clock such that proper operation of timed sequences is possible without the need for manual reset of the clock.

E. OPERATOR INTERFACE:

The building control system shall permit full operator communication including: obtaining information about the performance of his system; allowing the operator to change the system operation; the diagnosing system malfunctions. Operator communication shall be through the use of any one of the following operator terminals:

*portable hand-held operator's terminal
*printer
*central operator's terminal

It shall be possible to have one operator's terminal at each stand-alone control unit, or

to have a single operator's device which can be connected to any panel in the network. The building control system shall permit complete operation of any stand-alone control unit within the network, from any operator terminal within the system. It shall also be possible to send operator messages between different terminals, and acknowledge alarms at any terminal.

The network shall be addressable as a whole and shall not require referencing a particular control unit for the commanding or monitoring of points on the network.

F. PORTABLE OPERATOR'S TERMINAL:

1. A portable full function Operator's Terminal shall be provided for operator readout of system variables, override control, servicing, troubleshooting and adjustment of control parameters. The terminal must be fully equipped to interface with the field panel and terminal control unit. The terminal must contain as a minimum, a 56 character ASCI II keyboard set and have a minimum display of five lines by 40 characters. The portable operator's terminal shall be available from at least one other manufacturer as a standard product usable without modification.

2. The terminal must communicate in full English language with accompanying English or SI (International System of Units) Engineering Units for inquiry, reporting, and programming purposes.

3. When used remotely or locally the functionality shall include:

   (a) Indicate system status (heating, cooling, out of control range).

   (b) Display space temperature.

   (c) Display, set, and manually override space temperature set point and dead-band.

   (d) Set and change heating/cooling dead-band.

   (e) Select application mode.

   (f) Assign terminal control unit address.

   (g) Display and manually override stages (on/off)

   (h) Set and change control loop gains.

   (i) Change unoccupied/occupied mode.

   (j) Change length of time for occupied override mode.

   (k) Ability to send and receive messages.

4. Changes made during the setup or normal operation to the terminal control unit by

the portable operator's terminal or central terminal shall not be affected by loss of communication on the communication bus or by a power outage.

5. It shall not be necessary to disconnect the communication bus for communication between the portable operator's terminal and the terminal control unit.

G. USE PROGRAMMABILITY:

All temperature control strategies and energy management routines shall be definable by the operator through an operator's terminal. It shall be possible for the operator to modify system functions independently after receiving the training from the Control Contractor as previously specified. The system shall be provided complete with all equipment and documentation necessary to allow a trained operator to independently perform the functions listed below:

*read the value of a measured variable (i.e. temperature)
*start or stop equipment
*monitor the status of equipment being controlled
*read the set point of a control loop
*determine the control strategies that have been defined for a specific piece of equipment
*generate displays of control strategies
*add/delete control loops to the system
*create, modify or delete control strategies
*assign sensors and/or actuators to a control strategy
*tune control loops through the adjustment of control loop parameters
*enable or disable control strategies
*generate hardcopy records of control strategies on a printer
*select points to be alarmable and define the alarm state(s).

H. SELF DIAGNOSTICS AND ALARM REPORTING:

Each stand-alone control unit shall contain self diagnostics that continuously monitor the proper operation of the unit. A malfunction of the unit will be reported, and will inform the operator of the nature of the malfunction, and the control unit affected. It shall be possible to annunciate malfunctions as well as other control unit alarms at a selected central operator's terminal.

I. TERMINAL CONTROL UNIT COMPONENTS (TCU):

1. The terminal control unit must be listed by Underwriters Laboratory under the following categories UL 916 PAZX and UL 864 UDTZ. (CSA Certification is required.)

2. Control of terminal units (heat pumps) shall be accomplished by a microprocessor based stand-alone controller utilized Direct Digit Control. The control algorithms shall be proportional and integral (and derivative). The Terminal Control Unit shall interface to the building control system in a multi-drop communications network

originating at the control system field panel. An individual controller shall be provided for each terminal unit.

Each terminal control unit shall contain resident programs which are field selectable for a specific application. All resident programs shall be contained in non-volatile memory using EEPROM, EPROM, and PROM. Systems that employ volatile (RAM) memory shall provide 72 hours battery back-up for each terminal control unit.

3. Each terminal control unit shall be accessible for purposes of control and monitoring from central or remote operator's terminals as specified herein.

4. The terminal control unit shall continue its primary control function independent of other network communication. Revision to a failed (normally open or normally closed contact position) mode on separation from the communication bus is not desirable.

5. An operator's terminal connected to any field panel on the network directly or via modem, will have access to all terminal control units. Under no circumstances will it be necessary to identify the specific bus, field panel, or terminal control unit prior to obtaining values or status for any point in the building system.

6. From a terminal connected to any field panel it shall be possible to issue global commands to the terminal control units. Global commanding of all terminal control units shall include but not be limited to:

   (a) Initializing stop and start of terminal unit fans.

   (b) Occupied and unoccupied heating set point change.

   (c) Occupied and unoccupied cooling set point change.

J. ROOM SENSOR:

1. Each room temperature sensor shall come complete with a terminal jack and override switch integral to the sensor assembly. The terminal jack shall be used to connect the portable operator's terminal to control and monitor all hardware and software points associated with the terminal unit. A terminal jack may be alternatively located on a stainless steel wall plate mounted adjacent to the sensor.

   An override switch will initiate override of the night setback or unoccupied mode to normal (day) operation when activated by the occupant. The switch function may be locked out, canceled, or limited as to time or temperature in software by an authorized operator at a central or remote operator's terminal. The override switch may be alternatively located on a stainless steel place adjacent to the sensor.

2. Space temperature sensors may be:

   (a) Thermistor; or

(b) 4-20 mA output RTD.

3. The room sensor shall be firmly attached to the wall with screws inside a recessed box with blank cover plate.

4. The operator shall be able to assign temperature ranges for the room set point for heating and cooling and night set back for the heating and cooling mode independent of each other.

5. The room sensor shall be accurate to within +.5 degrees F (+.3 degrees C) and have a minimum set point adjustment range of 55 degrees to 85 degrees F 13 degrees to 30 degrees C).

2.05 SEQUENCE OF OPERATION:

A. WATER LOOP CONTROL PANEL:

The cooling tower, tower pumps, primary pumps, secondary pumps, boiler pump, and three (3) way heating valve shall be controlled through a stand-alone control unit incorporating direct digital control as follows.

Three (3) way heating valve shall be modulated to maintain a minimum 65 degree supply water temperature. The boiler shall be maintained at 80 degree boiler temperature during heating season.

As the loop temperature rises to 80 degrees F, the positive closure damper on cooling tower (CT-1) shall open. On a rise in supply water temperature to 85 degrees cooling tower pump(s) shall start. On a further rise in temperature the cooling tower fan shall start. On a temperature drop, each stage shall be de-energized in the reverse order. Cooling tower spray pumps and tower fan VFD's shall be modulated to match building load.

Primary loop pump (if primary/secondary system is used) (PWP-1) shall start ten minutes before earliest heat pump. If water flow is not established through a differential pressure switch, pump 1 shall be de-energized and primary loop pump 2 (PWP-2) shall be started. If flow is not established by pump 2 differential pressure switch, no heat pump shall be permitted to operate.

Primary loop pumps 1 and 2 shall be automatically alternated as lead and lag pump based on run time.

Secondary pump (SWP) shall be started ten minutes before the earliest heat pump in its zone is activated. If flow is not established by differential flow switch or if zone return water temperature is out of manufacturer's recommended limits as sensed by temperature sensor in zone return water, no heat pump in that zone shall be allowed to operate.

Provide electronic sensors and differential pressure switches on each secondary zone water return pipe. Mount sensors to sense actual zone return water before it is mixed back to primary header.

Provide electronic sensors in each zone supply water to shut down that particular zone of heat pumps if loop water is out of temperature range. Report this on alarm printer at remote location.

B. WATER LOOP STATUS PANEL:

On a drop in building supply water temperature below 60 degrees or a rise in temperature above 95 degrees stand-alone controller shall illuminate a LOW TEMP or HIGH TEMP light on status panel and initiate an alarm report on Owner's central alarm printer.

If the lead primary loop pump fails to establish flow, stand-alone controller shall illuminate a PUMP FAIL light on status panel and initiate an alarm report on Owner's central alarm printer.

There shall also be lights for:

1. Cooling tower pump
2. Cooling tower fan
3. Boiler pump
4. Each secondary zone pump
5. Primary loop pumps 1 and 2.

The face of the status panel shall also include:

1. Push-to-Test button for lights
2. Temperature indicator for supply water.
3. Pump-fail reset, normally open contact, button to reset pump-fail light.

C. Heat Pumps:

1.) A Terminal Equipment Controller (TEC) shall be provided for each heat pump. The TEC shall enable the heat pump for operation according to its individual occupied/unoccupied schedule. The TEC shall control the heat pump stages of heating and cooling to maintain the space temperature setpoints.

2.) The motorized outside air damper shall remain closed during all unoccupied times. The motorized outside air damper shall remain closed upon the initial start up of the heat pump. After the room has reached its warm-up or cool-down temperature,

the outside air damper shall open. For packaged heat pumps with energy recovery ventilators, ventilators shall operate only during occupied hours.

3.) When commanded to change over to the Unoccupied Mode, the terminal equipment controller shall raise the cooling set point and lower the heating setpoint to an operator determined value.

4.) During the Unoccupied Mode, the terminal equipment controller may be reset to the Occupied Mode for an operator determined time period. This reset shall be activated by a signal from a local override switch on the room temperature sensor or by command from the operator's terminal. At the end of the operator determined time period, the terminal equipment controller shall return to the Unoccupied Mode.

5.) For packaged heat pumps with hot gas reheat, a separate humidistat shall be provided to control humidity to a predetermined level.

D. Ventilation Air Units:

1.) A Terminal Equipment Controller (TEC) shall be provided for each unit. The TEC shall enable the unit for operation according to its individual occupied/unoccupied schedule. The TEC shall control the stages of cooling to maintain the space temperature and humidity setpoints.

2.) Controls Contractor shall provide space humidity transducers as required.

3.) During Occupied Mode the ventilation air units shall provide dehumidified air to each classroom as scheduled on the plans. The bypass damper shall be modulated based on maintained 1000ppm at the most demanding CO2 sensor in the zone served.

4.) During the Unoccupied Mode, the terminal equipment controller may be reset to the Occupied Mode for an operator determined time period. This reset shall be activated by a signal from a local override switch on the room temperature sensor or by command from the operator’s terminal. At the end of the operator determined time period, the terminal equipment controller shall return to the Unoccupied Mode.

5.) Programming of unit shall be as recommended by manufacturer.

E. VAV Air Handling Units:

1.) Each air handling unit shall be optimally started and stopped by the control system according to its occupied and unoccupied schedule. The AHU smoke dampers shall open, and then the supply fan shall ramp up to its cooling airflow (CFM). The suppy air temperature and static pressure shall reset based on outside air temp and air valve position respectively.

2.) For units utilizing outside air for ventilations, during unoccupied hours and morning

start up operation, the motorized outside air damper shall remain closed. When in occupied operation, the outside air damper shall modulate to maintain its minimum required outside airflow (CFM) as measured by a duct airflow station. For units connected to ventilation air units, the motorized isolation damper shall be closed whenever the unit is stopped.

3.) At duct static pressure transmitter shall be located at two-thirds the distance down the longest duct run, and shall allow the controls to operate the supply fan inlet vanes in order to maintain the duct static pressure setpoint. A duct static pressure high limit switch shall shut down the air handling unit and alarm the control system if its set point is exceeded.

4.) The air handling unit supply air temperature shall be controlled to maintain its setpoint.

5.) AHU duct smoke detectors shall be provided and installed under this section of the Specifications. Wiring the AHU duct smoke detectors to the fire alarm system shall be accomplished by Division 16. Interlock wiring for shutdown of the air handling units for the AHU duct smoke detectors shall be accomplished under this section of the Specifications. The AHU duct smoke detectors will alarm the system in the event that products of the combustion are detected.

6.) The AHU will be provided with a filter status airflow switch across the AHU filter bank which will alarm the system when the airflow pressure drop exceeds its setpoint.

F. VAV Boxes with Electric Heat:

1.) During the occupied mode, the Terminal Equipment Controller (TEC) modulates the primary supply air damper within user defined separate heating and cooling maximum and minimum air volume settings by sensing the inlet air velocity (CFM).

2.) On a rise in temperature above the room cooling setpoint, the Terminal Equipment Controller (TEC) shall modulate open the duct supply air damper to maintain room temperature.

3.) Similarly, on a fall in temperature below he room heating setpoint, the Terminal Equipment Controller (TEC) shall modulate the supply duct damper to its minimum position of 50% of rated air flow, and then the electric heating coil shall be modulated to maintain the room temperature.

4.) When commanded to change over the Unoccupied Mode, the Terminal Controller shall raise cooling setpoint and decrease the heating setpoint (as appropriate) to operator-determined values.

5.) During the Unoccupied Mode, the Terminal Controller shall be reset to the Occupied Mode for an operator determined time period. This reset shall be activated by a signal from a local override switch on the room temperature sensor. At the end of the operator determined time period, the Terminal Controller shall return to the Unoccupied Mode.

6.) The Controls Contractor shall be responsible for providing power wiring to all VAV box controls as required for proper operation.

G. Exhaust Fans:

1.) Exhaust fans shall be controlled by either the building energy management system, local thermostat, or wall switch as indicated on the contract drawings and equipment schedule.

H. Unit Heaters and Water Heaters:

1.) Unit heaters and water heaters shall be controlled by the building energy management system or local thermostat as indicated on contract drawings.

I. Lighting Control:

1.) Lighting shall be controlled by the building EMS per ASHRAE 90.1. Refer to electrical plans and details for locations of lighting contactor panels.

2.06 CERTIFICATION:

Upon the system completion and before final inspection of the system the control manufacturer shall thoroughly check all aspects of the control system and operation. He shall submit two copies of written certification to the Engineer and Owner of the following:

1. All sensors, thermostats, controls have been checked, calibrated and are working properly.

2. Sequence of operation is working as specified.

3. All relays, controllers, starters, terminal control units, transformers, terminal blocks have been labeled with a mechanically fastened bakelite tag with lettering engraved to represent actual points in reference to as-built control drawings.

4. As-built drawing and framed drawing prepared and submitted to Owner and posted as specified.

5. Owner's representatives have been consulted for approval of system operation.

6. Safety devices have been tested and certified for proper operation.

7. Keys, etc. for control centers have been turned over to Owner.

8. Training/Owner's Instruction: The Control System Contractor shall provide two copies of an operator's manual describing all operating and routine maintenance service procedures to be used with the system. The Control Contractor shall instruct the Owner's designated representatives in these procedures during the start-up and test period. The duration of the instruction period shall be no less than

24 hours. These instructions are to be conducted during normal working hours. The instructions shall consist of both hands-on and classroom training at the job site.

9. Warranty: The building control system, including all hardware and software components, shall be unconditionally warranted for a period of one year following the date of final acceptance. Any defects arising during this period shall be corrected without cost to the Owner.

END OF SECTION 15904

SECTION 15995 – TESTING AND BALANCING OF AIR AND WATER SYSTEMS

PART ONE - GENERAL:

1.01 SCOPE:

A. The owner shall employ an independent testing and balancing firm specializing in total system testing and balancing. The balancing firm shall be a member of the Associated Air Balance Council (AABC) or certified by the National Environmental Balancing Bureau (NEBB). The balancing firm shall provide all labor, equipment, engineering and test equipment required to test, adjust, and balance all heating, ventilating, air-conditioning, and exhaust systems as hereinafter specified.

B. Testing and balancing shall be provided under the commissioning contract, approved firms are as follows:

1. TAB Services, Inc. – Atlanta, GA
2. Carolina Air and Water Balancing – Columbia, SC
3. Hilton Services – White Rock, SC
4. Phoenix Agency, Inc. - Winston-Salem, NC
5. Palmetto Air and Water Balance – Greenville, SC

PART TWO - PRODUCTS AND EXECUTION:

2.01 The balancing contract shall incorporate the following:

A. Adjust and balance the complete mechanical system.

B. Upon completion of the air handling systems, the Contractor shall have the balancing firm perform the following tests and compile the following information of each item of equipment and submit four bound copies of this information to the Architect for approval.

2.02 All medium pressure ducts shall be duct air leak tested with less than 5% leakage prior to insulation.

2.03 All test equipment will be furnished by the Balancing Contractor and will remain his property. All instruments will have been calibrated within the last month.

2.04 The Balancing Firm will warrant solely that the system will be set to within 10% of the values as established by the plans and specifications and also adjust to minimize drafts in all areas.

2.05 Any changes that are required for the final balancing results as determined by the Balancing Contractor will be provided by the respective Contractors who are to supply and install such equipment under their contractual obligations. Such changes may encompass, but not necessarily restricted to, the changing of pulleys, belts, dampers, or adding dampers or access panels.

2.06 BALANCING PROCEDURE (AIR):

A. Before starting air balance, check the following items:

1. Check air filters to be sure they are clean and in position.
2. Check for proper belt tension and alignment.
3. Check fan and motor lubrication.
4. Check motor overload protectors or heaters for proper size.

5. Check for proper rotation.

B. Measure supply air volumes by means of the duct traverse method, taking a minimum of sixteen (16) readings. Seal duct access holes with metal snap-in-plugs. The use of duct tape to seal access holes will not be permitted.

C. Adjust balancing dampers for required branch duct air quantities. Dampers shall be permanently marked after air balance is complete.

D. Adjust grilles and diffusers to within 10% of individual requirements specified, and also adjust so as to minimize drafts in all areas.

E. The total air delivery in any particular fan system shall be obtained by adjustment of the particular fan speed.

F. The drive motor of each fan shall not be loaded over the corrected full load amperage rating of the motor involved.

G. All duct systems are to be balanced for lowest static pressure and lowest fan speed possible to deliver required air quantity.

H. Unless otherwise noted, adjust quantity of return air from space to pass 90% of air supplied to space.

I. Where splitter and volume dampers have been provided for balancing of air in ducts, balancing shall be done with register and diffuser volume dampers as fully open as possible.

J. Do not operate fans during times when construction process or cleaning would allow dirt or rubbish to accumulate in the system.

2.07 BALANCING PROCEDURE (WATER):

A. Flow stations are provided where indicated on the drawings.

B. Open all shut-off and balancing valves.

C. Balance secondary system to design flow in each circuit using balancing valve in the return lines at systems water circulating pumps.

D. The Contractor shall balance the primary water system by adjusting the balancing valves to achieve the specified GPM flow through the system.

E. The Contractor shall include in this contract the trimming of all pump impellers on project as required by ASHRAE 90.1, or as deemed necessary by Engineer/Owner.

2.08 CERTIFICATION:

Furnish to the Architect/Engineer two copies of the following data, signed by an authorized representative of the balancing firm who is a Registered Professional Engineer:

A. Air System Data:

1. Room

2. Supply or Return Size

3. Design CFM

4. Measured CFM

5. Percent of Design CFM

6. Equipment: (Air handling units and exhaust fans)

   a.) Installation Data:

   1 - Manufacturer and model
   2 - Size
   3 - Arrangement, discharge, and class
   4 - Motor HP, voltage, phase, cycle, and full load amps
   5 - Location and local identification data

7. Design Data: (Data listed in schedules on drawings and specifications)

   a.) Recorded (test) Data:

   1 - CFM
   2 - Static pressure
   3 - RPM
   4 - Motor operating amps
   5 - Motor operating B.H.P.

B. Water System Data:

1. Pumps:

   a.) Installation Data:

   1 - Manufacturer and model
   2 - Size
   3 - Type drive
   4 - Motor, HP, voltage, phase, and full load amps

   b.) Design Data:

   1 - GPM
   2 - Head
   3 - RPM
   4 - BHP and amps

   c.) Recorded Data:

   1 - Discharge pressures
   2 - Suction pressures
   3 - Operating head
   4 - Operating GPM
   5 - No-load amps
   6 - Full flow amps
   7 - No-flow amps

2. Air Heating and Cooling Equipment:

a.) Design Data:

1 - Load in BTUH or MBh
2 - CFM
3 - Entering and leaving water temperatures
4 - Entering and leaving air conditions (D.B. and W.B.)
5 - GPM
6 - Water pressure drop

b.) Recorded Data:

1 - Load in BTUH or MBh
2 - CFM
3 - Entering and leaving water temperatures
4 - Entering and leaving air conditions (D.B. and W.B.)
5 - GPM
6 - Water pressure drop

2.09 FINAL AIR BALANCE:

A. Perform final air balance after building is occupied. On final air balance adjust air quantities as required to maintain space temperatures in building at design conditions plus or minus 2 degrees F. Submit data sheets on recorded temperatures. Indicate time of day and outdoor temperature on data sheets.

B. A preliminary Test and Balance Report shall be issued to the Mechanical Contractor and Engineer prior to the issuance of the final Testing and Balancing Report outlining all deficiencies in the installed system. These listed deficiencies shall be corrected and/or resolved prior to finalizing the Test and Balance Report.

END OF SECTION 15995

DIVISION NO. 16 – ELECTRICAL

SECTION 16010 - GENERAL REQUIREMENTS

PART ONE - GENERAL:

1.01 SCOPE:

A. The General and Special Conditions are a part of this Section of the Specifications.

B. Provide all labor, equipment, material, and operations required for complete, safe, and quietly operating electrical systems in accordance with Specifications and Drawings and subject to terms and conditions of the contract.

C. Drawings and Specifications are complementary and what is called for by either shall be as binding as if called for by both.

D. Examine other Drawings and Specifications and bring to the attention of Architect prior to bid time any omissions or discrepancies in this DIVISION.

1.02 CODES, RULES, PERMITS, FEES, AND APPLICABLE PROVISIONS:

A. Comply with the 2005 edition of the National Electrical Code, 2006 International Building Code, 2003 Life Safety Code, and Municipal Code requirements. In case of conflict, Municipal Code shall govern.

B. The Contractor shall give all requested notices, obtain necessary permits, and pay all required fees.

C. Deliver to Architect permits and certificates.

1.03 DRAWINGS:

A. Project Drawings: The Drawings accompanying this Specification are generally diagrammatic and do not show all details of bolts, nuts, connections, and the like required for the complete system, and do not indicate the exact location of conduit, fixtures, equipment, etc., unless definitely dimensioned or noted. While these Drawings shall be followed as closely as possible, all dimensions shall be checked at the building and any necessary changes shall be made to accord with structural and architectural conditions, equipment to be installed or with the work of the different trades, without additional cost to the Owner, and as directed by the Architect. Any component item which is necessary for the proper operation of any system under this contract shall be furnished and installed by the Contractor without extra charge.

1.04 EXAMINATION OF CONDITIONS:

A. It is understood and agreed that the Contractor has, by careful examination, satisfied himself as to the nature and location of the work, the conformation of the ground, the character, quality, and

quantity of the materials to be encountered, the general and local conditions, and to all other matters which can affect the work under this contract.

1.05 COORDINATION:

A. Coordinate work with other trades to avoid interferences and establish necessary space requirements and tie-ins for each trade.

B. Prior to starting installation, furnish to the General Contractor and all Sub-Contractors concerned, copies of approved shop drawings showing location of equipment, piping, and etc.

C. Schedule periodic meetings with other trades before and during installation to avoid conflicts and assure that conduits and equipment are installed in the best manner, taking into consideration head-room, maintenance, appearance, and replacement.

END OF SECTION 16010

SECTION 16040 - GENERAL COMPLETION, ELECTRICAL

PART ONE - GENERAL:

1.01 GENERAL REQUIREMENTS FOR INSTALLATION:

A. Piping, fixtures, equipment, etc., shall be located to avoid interference with structural and architectural conditions, or with the work of different trades. Provide off-sets where necessary to avoid footings, piers, columns, beams, windows, other piping, mechanical systems, and other systems, etc., specifically inform the General Contractor as to the correct size and location of all chases, openings, supports, sleeves, etc., required for the system. Furnish and install sleeves, inserts, bolts, etc., and arrange for the cutting of walls, floors, roofs, etc., and the proper closing of all openings. Cutting of construction, where unavoidable, must be done by the General Contractor, but shall be paid for by the electrical contractor. No part of the building may be broken out, cut, burned, or permanently removed without the approval of the Architect.

PART TWO - PRODUCTS:

2.01 WORKMANSHIP AND MATERIALS:

A. Workmanship shall be of the best quality and none but competent mechanics skilled in their trades shall be employed. The Contractor shall furnish the services of an experienced superintendent, who will be constantly in charge of the erection of the work, until completed and accepted.

B. Unless otherwise hereinafter specified, all materials and equipment shall be new, of best grade, and as listed in printed catalogs of the manufacturer. Each article of its kind shall be the standard product of a single manufacturer.

C. The Architect shall have the right to accept or reject material, equipment and/or workmanship, and determine when the Contractor has complied with the requirements herein specified. Where departures from indicated arrangements are required, written approval for such changes shall be obtained from Architect's representative.

D. All manufactured materials shall be delivered and stored in their original containers. Equipment shall be clearly marked or stamped with the manufacturer's name and rating.

E. All material and equipment used on this project shall be stored in a weatherproof, bonded warehouse. Contractor shall submit insurance certificate to the Architect prior to storing any materials or equipment. No equipment or materials used on this project shall be stored outside exposed to the weather. Before final payment can be made, a notarized statement with the material invoiced to the Owner must be furnished to the Architect.

2.02 DIVISION OF WORK:

A. Coordinate all opening locations with General Contractor, see paragraph 2.03.

B. The electrical contractor shall provide concrete foundations, curbs and pads for electrical

equipment and fixtures. Unless otherwise noted, set all floor and/or ground mounted equipment on 6" high concrete pads reinforced with 6 x 6 10/10 mesh. Pads shall be approximately 6" larger than equipment base and have 1" x 1" chamfer on all edges. Pads to have carborundum brick rubbed finish. Surface finish shall be uniformly smooth.

C. General Contractor will provide flashing of conduits into roofing. The electrical contractor shall provide counterflashing.

D. Provide complete power wiring and connections for mechanical systems specified under the mechanical specifications. This work includes all raceways, conductors, outlets, and pull boxes, line voltage, on-off switches where indicated and disconnecting means as indicated and required by applicable codes. Where magnetic motor starters (controllers) are furnished by others, install and wire complete; where controllers are provided already mounted on equipment, wire complete. In all cases, provide power wiring to controller and load controlled. Wire sizes between controllers and loads shall be the same as feeder size to controller, do not reduce. Make all connections and color code per this DIVISION. Safety switch enclosures shall be NEMA Type 3R outdoors and wet locations; NEMA Type 1 elsewhere. Not included in this DIVISION are temperature control wiring, equipment control wiring and interlock wiring required to operate the mechanical system. Refer to the mechanical specifications for a summary list of types of equipment provided under that DIVISION. The electrical contractor shall provide outlet box for thermostat with 3/4" conduit to corresponding mechanical unit. The electrical contractor shall provide a 3/4" empty conduit between indoor air handling unit and exterior heat pump on split system units; this conduit is in addition to thermostat conduit noted above.

2.03 OPENINGS - CUTTING, REPAIRING:

A. The electrical contractor shall cooperate with the work to be done under other Sections in providing information as to openings required in walls, slabs, and footings for all conduits and equipment, including sleeves, where required.

B. All drilling, cutting, and patching required for the performance of work under this Section shall be performed by the General Contractor and the cost thereof shall be borne by the electrical contractor.

C. Holes in Concrete: Sleeves shall be furnished, accurately located and installed in form before pouring of concrete. The electrical contractor shall pay all additional costs for cutting of holes as the result of the incorrect location of sleeves. All holes through existing concrete shall be either core drilled or saw cut. All holes required shall have the approval of the Structural Engineer prior to cutting or drilling.

2.04 EXCAVATION AND BACKFILL:

A. General: The Contractor shall do all excavating and backfilling necessary to receive the work shown on the drawings.

Excavations shall be made to the proper depth, and the trenches shall be graded uniformly to provide solid bearing along the entire length of the conduit. All trenches shall be excavated so that conduits will have at least (6) inches clearance on each side. Conduits in fill or loose sand shall have trench bottom tamped to 95% maximum density compaction prior to laying conduits.

B. Backfilling: Do not fill any trenches until all conduits have been inspected. After the work is installed, tested, inspected, and approved, the trenches shall be refilled in six-inch layers with clean, damp earth, with each layer thoroughly tamped before proceeding with additional layers. Remove from site all excess earth, rock and other debris resulting from excavation and backfill work.

2.05 NAMEPLATES:

A. On all panelboards, disconnect switches, transformers, and enclosures provide engraved phenolic plastic nameplates. Unless otherwise noted, nameplates to be 1/16" thick plastic with 1/4" high white letters on black background. Hand lettering, typing under tape, embossed letters on plastic, etc., will not be acceptable

B. Attach nameplates with two rivets.

2.06 CLEANING EQUIPMENT AND MATERIALS:

A. Provide for the safety and good condition of all materials and equipment until final acceptance by the Owner. Protect all materials and equipment from damage. Provide adequate and proper storage facilities during the progress of the work.

B. All fixtures, conduits, finished surfaces, and equipment shall have all grease, adhesive labels, and foreign materials removed.

2.07 CLEANING UP:

A. Remove from the premises all unused material and debris resulting from the performance of work under this Section.

2.08 DAMAGES:

A. Cost of repairing damage to building, building contents, and site during construction and guarantee period resulting from this work is a part of this contract.

2.09 TEST PERFORMANCE:

A. Upon completion of the work, the system shall be free of faults, including short circuits, grounds, and open circuits, and loads balanced across phases to obtain minimum neutral current in all feeders and branch circuits. All communications systems shall operate at a standard representative of the best state of the art for the particular system involved. All life safety systems shall be demonstrated and certified as to operation in compliance with the codes and the intent of these Specifications. Test system in the presence of the Engineer or his representative, and operate to comply with the true intent of Plans and Specifications. Defray cost of all adjustments required to correct deficiencies; replace defective material and equipment, do not repair.

2.10 FINISHED PLANS:

A. As-built Drawings: Upon completion of the work, the Contractor shall furnish and deliver to the Owner two (2) sets of as-built drawings to correspond in size to the tracings, showing among other things, layouts of utility systems and functional systems (such as public address, fire alarm and telephone). All pertinent dimensions and elevations of buried work shall be given.

2.11 INSTRUCTIONS:

A. Provide a hard back, three-ring file folder containing all warranties, catalog data and the manufacturer's recommendations and the frequency with which each is to be done. Each sheet shall be initialed by the manufacturer's agent as being correct. Provide columns on each sheet so that they may be dated by maintenance personnel when each individual function is performed. Contractor shall furnish a typed maintenance manual in a hard back, three-ring binder explaining all maintenance functions. The Contractor shall instruct and demonstrate each maintenance function to the Owner's Representative. The Owner's Representative shall in turn sign the maintenance sheets indicating his under-standing of the instructions. Coordinate all equipment start-ups with the Owner, so that they may be present.

B. The Contractor shall instruct the Owner's Representative in complete detail as to the proper operation of the overall systems. Advise the Owner as to where to order common replacement items. Deliver to the Owner the manufacturers' agent's name, address, and the telephone number of each piece of equipment.

2.12 GUARANTEE:

The Contractor agrees:

A. To correct defects in workmanship, materials, controls, equipment, and operation of the system for a period of one (1) year from the date of acceptance.

B. To remove any item not specified or given written approval and replace it with the specified item.

C. That the systems installed will safely, quietly, and efficiently perform their respective functions in accordance with the design.

END OF SECTION 16040

SECTION 16050 - BASIC MATERIALS AND METHODS

PART ONE - GENERAL:

1.01 APPROVALS AND SUBSTITUTIONS:

A. All requests for substitutions shall be submitted so as to be received by the Engineer at least ten (10) calendar days before bid date. Approved material will be listed in addendum form.

B. Contract prices shall be based on material and equipment as specified, unless written approval is obtained for any deviations. Requests for substitutions before bid date may be submitted by Contractors or by Equipment Manufacturer's Representatives.

C. Requests for approvals should be submitted in the form of a letter (with one copy minimum) on a letterhead of submitting firm, along with a self-addressed, stamped, return envelope. Letter shall be addressed to the Engineer and referenced to this project.

D. If there are no deviations between the items submitted and the plans and specifications, then the submittal letter should contain the statement, "Items are in accordance with plans and specifications with no deviations". An item with deviations from the plans and specifications may be submitted for approval consideration. Letter should then state, "Item submitted is in accordance with plans and specifications, except for the following deviations." Deviations should then be listed in itemized form.

E. Items approved shall not be construed as authorizing deviations from the plans and specifications. Contractor shall be responsible for verifying all dimensions with available space conditions with provisions for proper access, maintenance, and part replacement, and for coordination with other trades - mechanical, plumbing, structural, etc., for proper services and construction requirements.

F. Where such approved deviations require a different quantity and arrangement of wiring, conduit and equipment from that specified or indicated on the drawings, the Sub-Contractor shall furnish and install any such structural supports, controllers, starters, electrical wiring and conduit, and any other additional equipment required by the system, at no additional cost to the Owner.

PART TWO - PRODUCTS AND EXECUTION:

2.01 MANUFACTURER'S INSTRUCTIONS:

A. Prior to purchasing equipment, procure product manufacturer's application, installation, and operating instructions for use in conjunction with the system design drawings and specifications during construction. If there exists any conflict between the manufacturer's publications and the design drawings and specifications, immediately notify the Engineer, in writing. Upon notification by the Engineer, proceed in accordance with his instructions.

2.02 Operations and Maintenance Manuals:

A. Prior to project closeout, the Sub-Contractor shall submit for approval, a completed operations and maintenance manual to the engineer for review. The operations and maintenance manual shall contain at least the following items. Exclusion of items is permissible only when the scope of electrical work outlined in these contract documents does not include an item listed below:

1. Electrical Contractor's warrantee / guarantee showing dates of acceptance and duration.
2. Product data sheets, diagrams, performance curves, and charts published by the manufacturer. Complete electrical characteristics and manufacturer's part numbers shall be provided for all equipment.
3. Charts which explain the conduit color coding scheme used for conduit and wire throughout the facility.
4. Insulation resistance test results for all feeders.
5. Operating & users instruction manual(s) for Lighting control systems
6. Final circuit breaker trip and time delay settings
7. Chart listing fuse ampacity, type and manufacturer's part number installed in each disconnect.
8. Operating & users instruction manual(s) for any generators, transfer switches, or lighting inverters.
9. Copy of the UL "Master Label" for any lighting protection system required elsewhere in the contract documents.
10. Operating & users instruction manual(s) for the fire alarm system.
11. As built shop drawings and plans for the fire alarm system indicating device locations and all calculations.
12. Digital media with as built fire alarm system program and all required programming password & user names.
13. Copy of the fire alarm system paperwork required by the NFPA to be completed by the fire alarm system installer.
14. Operating & users instruction manual(s) for the security, telephone, public address, or sound augmentation and reinforcement systems.
15. A copy of the seismic submittal for electrical installation signed and sealed by the seismic engineer.

2.03 SHOP DRAWINGS:

A. The Sub-Contractor shall submit for approval detailed shop drawings of all equipment and all material required to complete the project, and no material or equipment may be delivered to the job site or installed until the Sub-Contractor has in his possession the approved shop drawings for the particular material or equipment. The shop drawings shall be complete as described herein. The Sub-Contractor shall furnish the number of copies required by the General and Special Conditions of the contract, but in no case less than six (6) copies.

B. Prior to delivery of any material to the job site, and sufficiently in advance of requirements to allow Architect ample time for checking, submit for approval detailed, dimensioned drawings or cuts, showing construction, size, arrangement, operating clearances, performance characteristics and capacity. Each item of equipment proposed shall be a standard catalog product of an established manufacturer and of equal quality, finish, and durability to that specified.

C. Samples, drawings, specifications, and/or catalogs submitted for approval shall be properly labeled indicating specific service for which material or equipment is to be used, section and article number of specifications governing, Contractor's name, and name of project.

D. Catalogs, pamphlets, or other documents submitted to describe items on which approval is being

requested, shall be specific and identification in catalog, pamphlet, etc., of item submitted shall be clearly made in ink. Data of a general nature will not be accepted.

E. Approval by the Architect and/or Engineer of shop drawings for any material, apparatus, devices, and layouts shall not relieve the electrical contractor from the responsibility of furnishing same of proper dimension, size, quantity, quality, and all performance characteristics to efficiently perform the requirements, and intent of the contract documents. In addition, approval shall not relieve the electrical contractor from responsibility for errors of any sort on the shop drawings. If the shop drawings deviate from the contract documents, the electrical contractor shall advise the Architect and/or Engineer of the deviations, in writing, accompanying the shop drawings, including the reasons for deviations.

F. Failure of the Sub-Contractor to submit shop drawings in ample time for checking shall not entitle him to an extension on contract time, and no claim for extension by reason of such default will be allowed.

G. The table on the following pages shall be included in the front of the shop drawing submittal. Sections of the specifications that are included in the specifications manual for this project shall require a submittal for each item listed. Incomplete or partial submittals shall be rejected.

Spec Section	#	Item Description
Site Lighting	1	Landscape lighting fixtures
	2	Lamps
	3	Type FSIFP outlet boxes
General Completion	1	Insurance Certificate indicating that stored materials are held in a bonded warehouse
	2	Superintendent's name, job trailer phone and fax numbers
	3	Name Plates type and attachment method
Conduit	1	Conduit , Cables, Tubing
	2	Supports
	3	Fittings and connectors
	4	Expansion joints
	5	Ground Bushings
	6	Tracing tape
	7	Sealants
	8	Fire Wall Penetrations (Provide U.L. Listing Number)
Busways	1	Busway
Under floor Ducts	1	Duct system sharing joiners, spaces, covers, supports, seats, etc.
Surface Metal Raceway	1	Surface raceway system - include all components
Wires and Cables	1	Wire – minimum size, manufacturer, insulation type
	2	Connectors and lugs
Outlets, Switches & Boxes	1	Outlet boxes
	2	Floor Boxes
Wall Switches	1	Switches (Also indicate color, load type, terminal type, and rating)
	2	Plates
Receptacles	1	Receptacles
	2	Plates
Lighting Control Relay System	1	Relay cabinet and relay modules
	2	Override switches
	3	Cables
	4	Photocells
Dimming System	1	Dimmer panel and dimmer modules
	2	Control consoles
Lighting Control Sensors	1	Sensors

Spec Section	#	Item Description
	2	Power Packs
Motor Starter	1	Motor starters
Motor Control Center	1	
		Documentation showing installers experience with submitted system
	2	Motor control center with all components and appurtenances.
Panel boards	1	
		Panel boards (also indicate short circuit current rating and withstand rating)
Fuses	1	
		Fuses
	2	Fuse Cabinet
Main Switchboard	1	Main Switchboard (also indicate short circuit current rating and withstand rating)
Motor & Circuit Disconnects	1	Disconnect Switches
Dry Type Transformers	1	Dry type transformers
Pad Mounted xformers	1	Pad mounted transformer
Generator Set	1	Generator
	2	Transfer Switch
	3	Vibration Isolation
	4	Mounting / pad dimensions
	5	Cooling system
	6	Exhaust system
	7	Control system
	8	Engine heater
	9	Battery and charger
	#	Main line circuit breaker
External TVSS / SPD	1	Surge Protective Devices
Underground Electrical Work	1	Ground rods
Service and Metering	1	Meter sockets
	2	CT cabinets
Grounding	1	Grounding devices and fitting
	2	Ground rods
Lighting Fixtures	1	Light Fixtures
	2	Lighting Control Systems
	3	Arc Keeper Devices
	4	Generator Transfer / Switch bypass devices (GTD)
	5	Occupancy Sensors

Spec Section	#	Item Description
	6	Lighting Inverter Systems
Exterior Sports Lighting Poles	1	Data and calculation showing that submitted pole complies with contract documents
	2	Data and calculation showing that submitted foundation complies with contract documents
	3	Poles
	4	Foundations
	5	Lighting protection system
Emergency Lighting System	1	Inverter units
	2	Battery charger
	3	Batteries
	4	Cabinets
Fire Alarm System	1	Fire Alarm System Control Panel
	2	Power Supply / Batteries
	3	Smoke Detectors / Heat Detectors
	4	Addressable modules
	5	Cables and Wiring
	6	Manual Pull Stations
	7	Notification Devices
	8	Documentation that certifies that the installer has been factory trained on the submitted system.
Security System	1	Control panel
	2	Control key pads
	3	Enclosure
	4	Magnetic door contacts
	5	Motion detector
	6	Sounder
Office phone Sys.	1	Telephone system control cabinet
	2	Hand/desk sets
	3	Wire and cables
Integrated Telecomm / Telemedia Systems	1	Integrated telephone, public address and telemedia control system
	2	Outline drawing of system control cabinet
	3	FCC registration number with signal equivalent
	4	Wiring diagrams showing typical connector

Spec Section	#	Item Description
	5	Certification of completion and installation and service training from system manufacturer
Classroom Intercom, Master-clock & Program System	1	Console
	2	AM-FM tuner, cassette player
	3	AM-FM antenna
	4	Administrate telephone
	5	Staff telephone
	6	Room call-in switch
	7	Digital master clock
	8	Speakers/ back boxes
	9	Exterior speakers
	10	Cable
Public Address System Replacement	1	Equipment cabinet
	2	Control panel
	3	AM-FM tuner, cassette player
	4	Power amplifier
	5	Selection panels
	6	Master clock and program distribution system
	7	Room call-in switch
	8	Speakers/ back boxes
	9	Exterior speakers
	10	Cable
Public Address Communication Sys (w/phones)	1	FCC registration number of the submitted system
	2	Data sheets for all equipment being provided
	3	Internal control cabinet drawings showing internal block diagram connections
	4	Wiring diagrams showing typical field wiring connections
	5	Documentation that installer maintains service and parts for submitted system
Sound Augmentation Systems	1	Microphones, receptacles, extension cables and stands
	2	Mixer/ pre-amp
	3	Amplifiers
	4	Cables
	5	Equipment housing

Spec Section	#	Item Description
	6	CD player
	7	Monitor headphone
	8	Equalizer
	9	Crossover network
	10	High frequency horns and drivers
	11	Low frequency loudspeaker and enclosure
Sound Reinforcement System	1	Microphones, receptacles, extension cables and stands
	2	Mixer/ pre-amp
	3	Equalizer
	4	Crossover network
	5	Amplifier
	6	speakers
	7	Equipment housing
	8	Cable
Athletic Field Sound Augmentation System	1	Microphones
	2	Amplifiers / mixers
	3	Speakers & mounting brackets
	4	Equipment housing
	5	Cd players/mixers/compressors/power conditioners
	6	Cables / wall plates
Coaches' Communication Sys	1	Master station
	2	Headset 1 belt system
	3	Head coach switch module
	4	Extension cables
Television Distribution System	1	Block diagram of system showing catalog numbers of amplifiers, splitter, taps and cables
	2	Head end amplifiers
	3	Noise filters
	4	Pre-amplifiers, re-amplification and pads
	5	Coaxial cable
Media Management Center and Video Distribution	1	Internal control cabinet block diagram
	2	Wiring diagrams showing typical field wiring connections
	3	FCC registration number
	4	Data sheets for all equipment being provided
	5	Cable

Spec Section	#	Item Description
Telecom Infrastructure	1	Cable trays and supports
	2	Fire wall penetrations
	3	Grounding equipment
	4	Hand Hole Boxes and Covers
	5	Cables
	6	Communication outlets
	7	Grounding equipment
Vibration & Seismic Control	1	Complete set of calcs and shop drawings with PE seal certifying that the design meets seismic req.
	2	Seismic design errors and omissions insurance certificate.

END OF SECTION **16050**

SECTION 16111 - CONDUIT

PART ONE - GENERAL:

1.01 Minimum size conduit shall be ½". Other sizes shall be as indicated on the Plans, or required by the National Electrical Code for number and size of conductors installed. All conduit joints shall be cut square, threaded, reamed smooth and drawn tight. Bends or offsets shall be made with standard conduit ells, field bends made with an approved bender or hickey, or hub-type conduit fittings. Number of bends per run shall conform to National Electrical Code limitations. All wiring, regardless of voltage, shall be in conduit.

PART TWO - PRODUCTS:

2.01 RIGID METAL CONDUIT (OR IMC):

A. Shall be used for:

1. Service.

2. Exposed branch circuits where subject to damage.

3. Branch circuits underground where outside of building line if not installed under 3" of concrete.

2.02 RIGID NONMETALIC CONDUIT (RNC):

A. Shall be used for:

1. Branch and feeder circuits underslab where inside of the building line (ground floor only).

2. Branch circuits underground where outside of the building line and below at least 3" of concrete or within duct banks

B. Shall be schedule 40 PVC.

2.03 PVC COATED RIGID GALVANIZED METAL CONDUIT

A. Shall be used for:

1. Corrosive exterior environments around cooling towers.

2.04 ELECTRICAL METALLIC TUBING (EMT):

A. Shall be used for:

1. All areas not listed in paragraphs 2.01, 2.02 and 2.03.

PART THREE - EXECUTION:

3.01 RACEWAYS:

A. Horizontal and vertical conduit runs may be supported by one hole malleable straps, clamp-backs or other approved devices with suitable bolts, expansion shields, or beam clamps for mounting to building structure or special brackets. Adjustable hangers may be used to suspend large conduits when separately located. If adjustable trapeze hangers are used to support groups of parallel conduits, U-bolt or similar type clamps shall be used at the end of a conduit run and at each elbow. J-bolts or approved clamps shall be installed on each third intermediate trapeze hanger to fasten each conduit. Hangers shall be painted with two coats of oil paint. Where excessive corrosive conditions are encountered, hanger assemblies shall be protected, after fabrication, by sheradizing or galvanizing, special paint, or other suitable preservative methods. The use of perforated iron straps, wire, etc., for supporting conduits will not be permitted. The required strength of the supporting equipment and the size and type of anchors shall be based on the combined weight of conduit, hanger, and cable.

B. Conduit installed in exterior wall shall be routed in stud or block cavity not in air spaces between block and brick.

C. Where any run of rigid conduit may change to a run of EMT, or vice-versa, such a change shall be made in a junction or outlet box, as elsewhere required, with each conduit terminating separately therein.

D. Conduit shall be continuous from outlet to outlet and from outlets to cabinets, pull boxes or junction boxes, and shall be secured to all boxes with locknuts and bushings in such a manner that each system shall be electrically continuous throughout. Conduit ends shall be capped to prevent entrance of foreign materials during construction.

E. Conduit terminals at cabinets and boxes shall be rigidly secured with locknuts and bushings as required by the National Electrical Code and other electrical codes. All conduit bushings shall be of the insulating type with two locknuts.

F. All conduit shall be installed complete before conductors are pulled in. All conduit shall be cleaned and free of foreign matter inside before any conductors are pulled in. A run of conduit which has become clogged shall be entirely freed, or shall be replaced.

G. A pullwire shall be left in each run of empty conduit. Pullwire shall be 16 gauge galvanized steel.

H. Run all conduit at right angles to or parallel to walls of building.

I. Use short pieces, approximately two feet, of flexible metal conduit to connect motors and other devices subject to motion and vibration.

J. Support conduit and secure to forms when cast in concrete so that conduit will not be displaced during pouring of concrete. Stuff boxes and cork fittings to prevent entrance of contaminants during concrete pouring and at other times during construction prior to completion of conduit installation.

K. Use expansion fittings with copper bonding jumpers to assure ground continuity across expansion joints in walls, floors, and ceilings. Use double locknuts and bushings on panel feeders at panel enclosures.

L. Install grounding bushing on all conduit entering or leaving main switchboard. Connect each bushing to switchboard ground bus with a separate #4 bare copper conductor, lugged to bus.

M. Any EMT connectors must be all steel compression type with insulated throat. EMT couplings shall be all steel compression type. No cast fittings of any type will be accepted.

N. Color coding shall be provided every 8'-0" on conduit or factory colored conduits shall be used and shall be as follows:

1. 480 volt, single and three phase - Orange

2. 208 volt, single and three phase - Green

3. 120 volt - Yellow

4. Fire alarm system - Red

5. Motor and other control systems - Blue

6. Telephone and communications - White

7. Security - Brown.

O. All firewall penetrations shall be properly fireproofed with U.L. listed system that conforms to the wall or floor type, wall or floor fire rating, and to the size and number of conduits penetrating the wall or floor.

P. Conduit shall not be routed within 1.5” of the underside of a corrugated metal roof deck and shall not be fastened to or supported from the underside of a corrugated metal roof deck.

Q. Underground conduits outside of the building line shall be installed as follows:

1. Conduits shall be a minimum of 30" below grade.

2. Rigid non-metallic conduit shall have an electronically detectable tracing tape installed above them.

3. Rigid non-metallic conduit bends shall be pre-manufactured “factory” bends or field made bends using “hot box” style conduit benders.

4. Rigid non-metallic conduit shall be installed below a minimum of 3" of concrete

5. Rigid non-metallic conduit joints shall be made per the manufacturer's instructions including use of primer prior to application of glue.

R. Underground conduits inside of the building line shall be installed as follows:

1. Conduits shall be run under vapor barrier and shall be routed or shall be installed deep enough to prevent penetration of building footers or other structural supports.

2. Conduit shall have rigid steel 90's installed where penetrating slab. Rigid steel 90's shall have two coats of asphaltum and all wrench marks and etc., shall be touched-up after conduit has been assembled.

3. Rigid non-metallic conduit joints shall be made per the manufacturer's instructions including use of primer prior to application of glue.

S. Conduits shall not be installed within the concrete slabs of intermediate floor levels.

T. Conduits which are subjected to large temperature differences or those which enter the building from the exterior shall be sealed. The sealing method shall be equal to poly water FST. Conduits to be sealed include:

1. Those which enter the building from the exterior.

2. Those which enter coolers or freezers.

3. Those which pass through unconditioned portion of the building.

4. Those which supply rooftop equipment.

U. Conduits shall not be installed above or on top of a roof without expressed permission of the engineer. Conduits serving rooftop equipment shall be routed within the building and penetrate the roof plane vertically at the equipment being supplied.

V. Conduits installed in masonry construction shall be routed vertically in block cavities. They shall not be routed horizontally for more than 24" within block wall where such installation requires excessive cutting or notching of each block.

W. Where surface mounted conduits are permitted, they shall be painted to match the adjacent wall surfaces.

X. Bridging between steel joist framing shall not be used to support conduits.

Y. Parallel sets of conductors routed below grade shall be installed in duct banks.

1. Duct bank shall be encased in concrete with at least three inches of concrete at the top and bottom and two inches on each side. A horizontal and vertical separation between the ducts of 3 inches shall be maintained by installing thermoplastic high impact spacers at 4 foot intervals. Spacers shall be equal to Carlon #SPxW30-2.

2. Stagger the joints of the conduits by rows and layers so as to provide a duct line having the maximum strength.

3. During construction, protect partially completed duct lines from the entrance of debris such as mud, sand and dirt by means of suitable conduit plugs.

4. As each section of a duct line is completed, draw a testing mandrel not less than 12 inches long with a diameter 1/4 inch less than the size of the conduit through each conduit, after which draw a brush having the diameter of the conduit, and having still bristles through until the conduit is clear of all particles of earth, sand, and/or gravel; then immediately install conduit plugs.

5. Conduits shall be sized as indicated on project drawings. Provide steel reinforcing in concrete duct bank as indicated on drawings. Separate conduit as indicated.

6.) Install the top of the concrete envelope not less than 30 inches below grade or as indicated on project Drawings.

Z. Concrete used to cover below grade conduits shall be 3000 psi concrete with 1 inch maximum aggregate

END OF SECTION 16111

SECTION 16120 - WIRES AND CABLES

PART ONE - GENERAL:

1.01 CONDUCTORS:

A. Provide soft-drawn copper conductors in raceways as shown on Drawings. Conductors shall conform to the latest NEC requirements and meet ASTM specifications, with 75/90 degree C, Type THWN/THHN insulation.

B. All wire and cable shall be new, with size, grade of insulation, voltage and manufacturer's name permanently imprinted on outer covering at regular intervals, and delivered to the job site in complete coils and reels. All wires sized #10 and smaller shall be solid, and sizes #8 and larger shall be stranded.

1.02 COLOR CODING:

A. Wire and cable shall have colored insulation in sizes #10 and smaller; and in sizes #8 and larger shall be color coded on the job using Scotch color tape, E-Z code, Brady, or equal wire markers. Color coding shall be as follows:

240 DELTA/120 or 208 WYE/120 VOLT SYSTEM	480 WYE/277 VOLT SYSTEM
Phase A - Black	Phase A - Brown
Phase B - Red	Phase B - Orange
Phase C - Blue	Phase C - Yellow
Neutral - White	Neutral - Gray
Grounding - Green	

*Provide permanent identification of color coding in each branch circuit panelboard as per NEC.

PART TWO - PRODUCTS:

2.01 CONDUCTORS:

A. Wire and cable shall be as manufactured by Colonial Wire & Cable, Essex, Southwire Co., General Cable, Rome Cable, or approved equal.

2.02 CONNECTORS:

A. Connectors, lugs, and terminals, shall be as manufactured by 3M Company, Ideal, Anderson, Thomas & Betts, OZ Electrical Mfg. Co., or approved equal.

PART THREE - EXECUTION:

3.01 CONDUCTORS:

A. Minimum wire size for all branch circuits shall be #12 except where indicated otherwise. If the distance from the panelboards to the first outlet exceeds 50 ft., the minimum size conductor for this run shall be #10. If the distance from the panelboards to the first outlet exceeds 100 ft., the minimum size conductor for this run shall be #8. If in special cases this distance must be exceeded, larger conductors of sizes noted on the plans shall be installed.

B. Do not pull conductors before completion of masonry, concrete, and other trades which generate dust and debris.

C. Wire and cables shall be suitably protected from weather during storage and handling and shall be in good condition when installed.

3.02 TERMINATIONS:

A. Conductors #8 and larger shall be connected to equipment by means of pressure type mechanical lugs. Where multiple conductors are connected to the same terminal, each conductor shall be provided with an individual lug.

B. Solderless connectors of the proper type shall be used for all wiring connections. Where compression type connectors are noted on the plans and in the specifications, they shall be installed with approved hydraulic tools to assure a permanent, mechanically secure, high-conductivity joint. Where soldered joints are specified, the cable joint shall be mechanically strong before soldering. Solder shall be carefully applied without use of acid. Soldered connection shall be wrapped with rubber and friction or insulating plastic tape in a manner approved for circuit voltage.

3.03 TAPS AND SPLICES:

A. All cable taps, and splices shall be made secure with solderless pressure type connectors, unless otherwise specified. Where compression type connectors are noted on the plans and in the specifications, they shall be installed with approved hydraulic tools to assure a permanent, mechanically secure, high-conductivity joint. Where soldered joints are specified, the cable joint shall be mechanically strong before soldering. Solder shall be carefully applied without use of acid. Soldered connection shall be wrapped with rubber and friction or insulating plastic tape in a manner approved for circuit voltage.

B. All high-voltage conductor and cable splices, connections, and terminations shall be made with termination or splicing kits containing the necessary connectors and insulating materials for the specific cable size and type involved.

C. Where conductors are to be connected to metallic surfaces, the coated surfaces of the metal shall be polished before installing the connector. Lacquer coating of conduits shall be removed where ground clamps are to be installed.

D. Join conductors with twist on wire connectors sized for the number and gauge of conductors or by

soldering, brazing, or welding. Tape all soldered or brazed connections or cover with approved prefabricated insulating devices to provide insulation resistance at the connection equal to that of the wire. Make splices in boxes or fittings only. Push in type wire connectors shall not be used.

3.04 INSULATION RESISTANCE TESTING

A. All panel board and switchboard feeders shall be tested prior to energizing. 480V feeders shall be tested at 1000 VDC, 208V and 240V feeders shall be tested at 500 VDC.

B. All current carrying and neutral conductors in every set of conductors shall be tested. Each current carrying and neutral conductor shall be tested to ground and to each other.

C. All resistance measurements shall be recorded after 60 seconds and all measurements shall be temperature corrected to 60 degrees F.

D. For each test measurement, the electrical contractor shall record the following information: Project name, date, temperature, humidity, testers name, testing device manufacturer and model number, feeder origin and termination points, test voltage, set number (for parallel feeders), conductor length, conductor size, measurement origin and termination (for example “A phase to ground “or” A phase to B phase”), insulation resistance in meg-ohms per foot at 60 degrees F, and the signature of the tester. A sample form is attached and a spreadsheet which calculates the corrected insulation readings in meg-ohms per foot at 60 degrees F is available from the engineer.

E. All feeder insulation resistance measurements shall be forwarded to the engineer for review prior to energizing of the feeder. Copies shall also be collected into a binder and submitted to the owner as part of the operations and maintenance (O & M) documentation.

F. Cables with an insulation resistance measurement corrected to 60 degrees F, which is less than 2 meg-ohms per foot shall be replaced by the electrical contractor at no additional cost to the owner.

END OF SECTION 16120

MECHANICAL RENOVATIONS TO MYRTLE BEACH HIGH SCHOOL

Project Name			**Tester's Name**		
Test Date			**Tester's Signature**		
Test Voltage (use 1000 volts for 480V, 500 volts for 208 /240V)		Volts DC	**Testing Device (Make & Model)**		
Feeder Origin			**Feeder Destination**		
Feeder Operating Voltage		Volts	**Feeder Length**		Feet
Temperature		Degree F	**Humidity**		% RH

	MEASURED INSULATION READING (in Meg Ohms at ambient temperature)													
Set #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
A TO B														
A TO C														
B TO C														
A TO N														
B TO N														
C TO N														
A TO G														
B TO G														
C TO G														
N TO G														

	CORRECTED INSULATION READING (Meg Ohms/ft at 60 deg F temperature)													
Set #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
A TO B														
A TO C														
B TO C														
A TO N														
B TO N														
C TO N														

MECHANICAL RENOVATIONS TO MYRTLE BEACH HIGH SCHOOL

A TO G														
B TO G														
C TO G														
N TO G														

SECTION 16155 - MOTOR STARTERS

PART ONE - GENERAL:

1.01 Motor control shall be provided for all motors except where such controllers and devices are furnished by the manufacturer as an integral part of the equipment. Each motor shall be provided with thermal overload protection. The overload protection device shall be provided in each phase either integral with the motor or controller, or shall be mounted in a separate enclosure. The protective devices shall be of the manually reset type. Automatic control devices may control the starting and stopping of motors directly, provided the devices used are designed for that purpose and have an adequate horse power rating; otherwise, a magnetic starter shall be used with the automatic-control device actuating the pilot control circuit. Magnetic starters shall be provided with a three position selector switch marked "Hand-Off-Automatic". Connections to the selector switch shall be such that only the normal automatic regulatory control devices will be by-passed when the switch is in the "Hand" position; all safety control devices and motor overload protection devices shall be connected in the selector switch. Provide an "ON" push button in the cover, connected to the "hand" position of the selector switch. Motor controls shall conform to NEMA standards and be UL listed.

PART TWO - PRODUCTS:

2.01 Motor starters shall be manufactured by Allen Bradley, Square D, General Electric Co., Westinghouse, or approved equal.

END OF SECTION 16155

SECTION 16160 - PANELBOARDS

PART ONE - GENERAL:

1.01. Description of Work

A. Where shown on the plans, indicated in the riser diagram, or listed in the panelboard schedule, furnish and install power, distribution, and lighting panels of the size and type indicated.

1.02. Submittal Requirements

A. Where indicated on the plans, manufacture shall furnish a selective coordination report with the product submittal. This report shall include all of the time current curves for all of the overcurrent devices in the indicated system.

1.03. Basis of Design

A. The overcurrent protection system basis of design is GE. Any changes necessary to achieve selective coordination of other approved manufacturer's equipment shall be the sole responsibility of the electrical contractor.

PART TWO - PRODUCTS:

2.01. Manufacturers

A. Panelboards shall be manufactured by General Electric, Square D, Siemens, Cutler Hammer, or prior approved equal.

2.02. Materials and Components

A. Distribution and power panelboards shall be of the dead-front safety type, equipped with thermal-magnetic circuit-breaker branches of sizes and types noted on the Drawings or indicated in the panelboard schedule. Breakers shall provide instantaneous trip on short circuits and time-delay trip on overloads. Main busbars shall be equipped with solderless lugs and all spaces shall be bussed. Panelboard assembly shall be enclosed in a code - gauge steel cabinet with ample wiring gutters on top, sides, and bottom. Cabinet doors shall be equipped with spring latches with locks and shall be keyed alike.

B. Lighting panelboards shall be of the circuit breaker type of sizes listed in the panelboard schedule or noted on the Drawings. The panels shall have mains only with solderless lugs on the main busbars. Branches shall have circuit breakers of the sizes indicated on the panel schedule. Cabinets shall be of the code - gauge steel with ample wiring gutters for all wires and connections. Doors shall be the single type with spring latches with locks and all keyed alike.

C. Unless otherwise indicated on the drawings, all panelboards shall have a fully rated symmetrical short circuit fault current rating of at least 22,000 amperes. Series rated panels are not acceptable.

D. All panelboards shall have bolt on breakers. Plug in breakers are not acceptable.

E. Circuit breakers shall be 20-amp, 1 pole unless indicated otherwise.

F. Panels shall be 17" minimum width.

G. Surface Mounted panels which are noted elsewhere in these contract documents to have TVSS/SPD protection shall have TVSS/SPD units mounted adjacent to the panels. See the details and other specifications for more details.

H. Flush mounted panels which are noted elsewhere in these contract documents to have TVSS/SPD protection shall have integral units with Performance characteristics as close as possible to the external units. Integral TVSS/SPD units shall be furnished by the panelboard manufacturer.

PART THREE - EXECUTION:

3.01. Installation

A. From each flush mounted panelboard, stub a minimum of five one inch empty conduits into area above ceiling.

B. Install in each panelboard a plastic-covered typewritten circuit directory in metal frame. Indicate name, address and service telephone number of installer. Directory shall list the load served and the location of the load for each breaker. Directory shall indicate the final room numbers designated by the owner and not necessary those shown by the architect on the floor plans.

C. All multiwire branch circuits shall have a handle tie supplied by the panel board manufacture installed to simultaneously open all ungrounded conductors. The electrical contractor may substitute multi pole breakers for this purpose at his discretion. All conductors that comprise the multiwire branch circuit shall be bundled and tye-wrapped together at the point where they enter the panel.

D. Electrical contractor shall furnish and install leak protection pans under all non-electrical system piping which passes over electrical panels and pitch pan to drain away from electrical equipment.

E. The electrical contractor shall apply warning label which states “Warning arc flash hazard appropriate PPE required”. The warning label design shall comply with ANSI Z535.4

F. Except where existing panels are being replaced, conductors shall not be spliced within a panel or pass through a panel. Conductors shall be neatly routed within the panel and excess wiring shall be removed.

3.02 NAMEPLATES:

A. On all panelboards, provide engraved phenolic plastic nameplates. Unless otherwise noted, nameplates to be 1/16" thick plastic with 1/4" high white letters on black background. Hand lettering, typing under tape, embossed letters on plastic, etc., will not be acceptable.

B. Attach nameplates with two rivets.

C. Label shall indicate, panel name, suppling panel or transformer, voltage and phasing similar to:

PANEL PA1
120/208 VOLTS / 3 PHASE
SUPPLIED FROM 45 KVA
TRANSFORMER T1

END OF SECTION 16160

SECTION 16161 - FUSES

PART ONE - GENERAL:

1.01 MATERIALS AND COMPONENTS:

A. Fuses shall be listed and meet UL and/or NEMA Standards for Class K5, J, L, and RKI fuses, or as indicated on the drawings.

B. Where fuses are required elsewhere in the specifications or on the drawings for individual motor circuit protection, for motor control centers, and for motor starters, these fuses shall be class K5 fuses unless otherwise indicated. Class K5 fuses shall be dual element cartridge design with high interrupting capacity, current limiting effect, 200,000 ampere RMS symmetrical at rated voltage minimum, and a minimum time delay of ten (10) seconds at five hundred percent (500%) load.

C. Class J and L fuses shall be provided as indicated on the Drawings for protection of non-motor loads.

D. Fuse voltage rating shall be 250 volts for 120/208 volt system and 480 or 600 volts for 277/480 volt system.

1.02 SPARE FUSE CABINET

A. All spare fuses shall be stored in their original cartons in a spare fuse cabinet furnished and installed by the electrical contractor. The cabinet shall be steel, surface mounted, with a hinged door, phenolic “Spare Fuse” label, flush lock, finished with gray baked enamel, and sized as required to house all spare fuses. A directory listing type and location of each fuse shall be mounted on the inside of the door. Spare fuse cabinet shall be similar to BUSSMAN Cat. No. SFC.

B, The spare fuse cabinet shall be wall mounted within sight of the main service panel or switchboard.

PART TWO - PRODUCTS:

2.01 FUSES:

A. Fuses shall be as manufactured by BUSSMAN or GOULD SHAWMUT.

B. Fuses over 600 amps up to 6,000 amps shall be UL Class ‘L’ time-delay fuses equal to BUSSMAN “HI-CAP” KRP-C. The fuses shall hold five hundred percent (500%) of rated current for a minimum of four (4) seconds and clear twenty (20) times rated current in 0.01 seconds or less.

C. Fuses up to 600 amps used for service entrance equipment shall be UL Class RKI dual-element fuses equal to BUSSMAN “LOW-PEAK” LPN-RK for 250 volts or LPS-RK for 600 volts. The fuses shall hold five hundred percent (500%) of rated current for a minimum of ten (10) seconds.

D. Fuses protecting other than service entrance equipment rated over 100 amps up to 600 amps shall be UL Class K5 dual-element fuses equal to BUSSMAN "FUSETRON" FRN-R for 250 volts or FRS-R for 600 volts unless otherwise noted on the Drawings.

E. Fuses 100 amps and under shall be UL Class K5 dual-element fuses equal to BUSSMAN "FUSETRON" FRN-R for 250 volts or FREER for 600 volts unless otherwise noted on the Drawings.

PART THREE - EXECUTION:

3.01 FUSES;

A. The electrical contractor shall furnish and install fuses for all switches, switchboards, distribution panel, or any other electrical equipment furnished under this division of these specifications requiring fuses.

B. The electrical contractor shall furnish one additional set of each type and rating of fuse as spare as well as any required puller or installation devices. These shall be installed in the original boxes in the spare fuse cabinet.

C. The electrical contractor shall provide a chart listing fuse ampacity, type and manufacturer's part number installed in each disconnect. A copy shall of this chart shall be collected into a binder and submitted to the owner as part of the operations and maintenance (O & M) documentation.

END OF SECTION 16161

SECTION 16170 - MOTOR AND CIRCUIT DISCONNECTS

PART ONE - GENERAL:

1.01 Furnish and install heavy-duty disconnect switches at locations shown on Drawings, and in accordance with NEC requirements. Operating mechanisms shall be the quick-make, quick-break type, with arc-suppressing characteristics. Enclosures shall be NEMA Type 1 indoors and NEMA Type 3R in outdoor and wet locations; equipped with cover interlock and provisions for padlocking operating handle in "ON" and "OFF" position.

1.02 Fuses shall be Gould Shawmut or Bussmann. Spare fuse cabinet shall be wall mounted with shelves suitable size to store spare fuses and fuse pullers specified. One additional set of each type/rating of fuse shall be included as spare.

PART TWO - PRODUCTS:

2.01 Safety switches shall be by the same manufacturer as panelboards.

PART THREE – EXECUTION

3.02 NAMEPLATES:

A. On all disconnects, provide engraved phenolic plastic nameplates. Unless otherwise noted, nameplates to be 1/16" thick plastic with 1/4" high white letters on black background. Hand lettering, typing under tape, embossed letters on plastic, etc., will not be acceptable.

B. Attach nameplates with two rivets.

C. Label shall indicate, load served, suppling panel and breaker, voltage and phasing similar to:

AHU #1A
120/208 VOLTS / 3 PHASE
SUPPLIED FROM
PANEL PA1 CIRCUIT 32

END OF SECTION 16170

SECTION 16190 – SUPPORTING DEVICES

PART ONE – GENERAL:

1.01 DESCRIPTION:

A. Support and align all raceways, cable trays, wireways, cabinets, boxes, fixtures, equipment, etc., in an approved manner.

B. Supports shall be in conformance with the requirements of the current building codes and local amendments, or the requirements of this Section, whichever is more stringent.

C. Seismic anchorages, seismic restraints and fixture and equipment supports shall be in accordance with National Uniform Seismic Installation Guidelines (NUSIG).

PART TWO – PRODUCTS:

2.01 MATERIALS, GENERAL:

A. Support raceways on approved types of wall brackets, ceiling trapeze hangers or malleable iron straps. "Perforated plumbers' strap" not permitted as means of support.

1. Acceptable manufacturer's of support brackets and hangers: "Uni-strut," "Kindorf" or "B-line."

2. "Caddy" fasteners are permitted for support of conduit to concealed metal studs and for conduit concealed above suspended acoustical ceilings.

3. All supporting devices located outdoors or in areas subject to moisture shall be hot-dip galvanized or stainless steel.

B. Do not support raceways or equipment from ceiling tie wire or T-bar, piping or ductwork. Support independently.

C. Provide safety wires (a minimum of four [4] 12 gauge hangers) or equivalent chains for each light fixture installed in T-bar or other ceiling suspension systems. Safety wires and chains shall be securely attached to diagonally opposite corners of each fixture and to structure.

D. Surface mounted lighting fixtures supported from T-bar grid shall be attached to the grid with a positive clamp device that completely surrounds the supporting member similar to Caddy "IDS." Provide safety wires as specified in the foregoing.

E. Provide safety wires (a minimum of two [2] 12 gauge hangers) or equivalent aircraft cable for each pendant mounted fixture. Hangers or cable shall be securely attached to fixture, then routed through stem and securely attached to structure.

F. Earthquake Anchorages:

1. Anchor all equipment, raceways, cable trays, etc., to the building structure to resist earthquake forces in accordance with the requirements of the National Uniform Seismic Installation Guidelines for Architects, Engineers, Inspectors and Contractors.

2. Total lateral (earthquake) force shall be not less than 1.00 times the equipment weight acting laterally in any direction through the equipment center of gravity. Provide adequate backing at structural attachment points to accept the forces involved.

3. Provide equipment supported by flexible isolation mounts with earthquake restraining supports positioned as close to equipment as possible without contact in normal operation (earthquake bumpers). The maximum lateral displacement due to the computed earthquake force from above shall not exceed 1.5". Floor mounted equipment weighing less than 2,000 lbs may have one (1) 6 x 6 x 3/8 x 18" steel angle bolted to the floor with four (4) 5/8" diameter bolts placed on four (4) sides of the equipment.

G. Independent support wires above lay in ceilings shall be orange in color.

2.02 HARDWARE, COMPOSITIONS AND FINISHES:

A. In dry indoor areas, all threaded fasteners and associated hardware shall be steel, with a zinc or cadmium plated finish.

B. In general, fasteners in outdoor, damp or corrosive environments shall be of the largest trade size that will fit the item being fastened, shall have the coarsest threads commercially available in that size, and shall be hot-dip galvanized steel. Zinc electroplate will be acceptable only in the smaller sizes where hot-dip galvanized is not commercially available. On metal construction, install with the full length of the threads and the hole wet with cold galvanized touch up compound (Z.R.C. or accepted equal).

C. Where PVC, liquidtight flex or plastic-coated conduit is installed on wood construction in outdoor, damp or corrosive environments, fasteners shall be made of monel or stainless steel alloy suitable for marine environments, such as alloys 430, 446, 18-8, 304, 316 or 347.

2.03 STRUT:

A. U-channel strut for use in heated indoor areas shall be steel. For installations that will be finish painted as part of the project, factory finish of the strut shall be

paintable galvanizing, or phosphatized and primed. For installations that will not be finish painted, the factory finish of the strut shall be galvanized.

B. For outdoor installation of galvanized conduits and boxes, strut shall be steel with hot-dip galvanized finish. All field-cut ends and other breaks in the finish shall be thoroughly treated with cold galvanized touch-up compound (Z.R.C. or accepted equal).

C. U-channel strut for support of PVC or plastic-coated conduits in outdoor, damp or corrosive environments shall be fiberglass, RobRoy "Rob-Glass" or accepted equal, assembled with the manufacturer's standard end sealant and corrosion-protected hardware and accessories.

PART THREE – EXECUTION:

3.01 FASTENING:

A. Secure boxes, wall brackets, cabinets and hangers by means of toggle bolts in hollow masonry; preset inserts or expansion bolts in solid masonry and concrete; machine screws, bolts or welding on metal surfaces; and wood or sheet metal screws in wood construction. Obtain permission from ANC before using any type of powder powered studs.

3.02 FIXTURE SUPPORTS:

A. For other than T-bar ceiling fixtures and for all fixtures weighing more than 56lbs, support luminaries from structural members capable of supporting total weight, under seismic conditions and independently from wiring system. Attach to steel members by approved beam clamps and rods.

3.03 PENDANT FIXTURES:

A. Loop and hook or swivel hanger assemblies for pendent fixtures shall be fitted with a restraining device to hold the stem in the support position during earthquake motions. Pendent-supported fluorescent fixtures shall also be provided with a flexible hanger device at the attachment to the fixture channel to preclude breaking of the support. The motion of swivels or hinged joints shall not cause sharp bends in conductors or damage to insulation.

3.04 ASSEMBLY MOUNTED OUTLET BOX:

A. A supporting assembly that is intended to be mounted on an outlet box shall be designed to accommodate mounting features on 4" boxes, 3" plaster rings and fixture studs.

3.05 WALL-MOUNTED EMERGENCY LIGHT UNIT:

A. Each wall-mounted emergency light unit shall be secured in a manner to hold the unit in place during a seismic disturbance.

3.06 SAFETY WIRES:

A. Attach safety wires to lighting fixtures so that no part of the fixture, in event of ceiling suspension system failure, will drop more than 6" below normal ceiling height. Each end of each wire shall be secured with a minimum of three (3) tight wraps.

3.07 STRUCTURAL ATTACHMENTS:

A. Provide adequate backing at structural attachment points to accept the forces involved.

B. Attachment to plaster or gypsum board not permitted unless specifically approved in writing by ANC on case-by-case basis. Where approved, such attachment shall be by means of molly or toggle bolts.

END OF SECTION 16190

SECTION 16450 - GROUNDING

PART ONE - GENERAL:

1.01 Furnish and install grounding system to comply with NEC and as shown on Drawings.

PART TWO - PRODUCTS:

2.01 Grounding devices and fittings shall be as manufactured by Thomas & Betts, Appleton, OZ Electrical Mfg. Co., or approved equal.

PART THREE - EXECUTION:

3.01 Ground main service by bonding grounding conductor to main cold water pipe, building steel, footing rebar, and at least three 3/4" diameter x 10' long ground rods driven 10' apart outside building in unpaved earth. The rods shall be loop interconnected with each other by a minimum No. 500 MCM AWG bare copper conductor thermal welded, using the proper style mold, to each rod below grade. Electrical Contractor shall provide Engineer with written documentation that service grounding system resistance measures no more than 5 ohms. Measurements shall be made using The Fall of Potential Method. Supplemental grounding electrodes and / or soil supplements shall be installed as necessary to achieve the specified resistance.

3.02 All ground rods and fittings used shall be free from paint, grease, and other poorly conducting material, and contact surfaces shall be cleaned thoroughly to insure good metal-to-metal contact.

3.03 Install bonding jumpers between all panelboards and feeder raceways connected thereto; across pull box and raceway expansion joints and across water meters located within buildings.

3.04 All connections to grounding conductors shall be accessible for inspection and shall be made with solderless connectors brazed or bolted to the equipment or structure to be grounded. Unless otherwise indicated on Drawings, grounding conductors within raceway system shall be installed in exposed rigid steel conduit with both conductor and conduit bonded at each end.

3.05 Provide all motor related equipment, kitchen equipment, transformers and fans with an equipment ground. Equipment grounding conductors shall be sized in accordance with NEC Article 250.

3.06 Do not use flexible metal conduit fittings as a grounding means. Pull a green ground wire in or around each piece of flexible conduit and screw to conduit system with lugs at both ends.

END OF SECTION 16450

SECTION 16890 - VIBRATION AND SEISMIC CONTROL

PART ONE - GENERAL:

1.01 All vibration isolation and seismic control materials specified herein shall be provided by a single manufacturer to assure single responsibility for their proper performance. Installation of all vibration and seismic control materials specified herein shall be accomplished following the manufacturer's written instructions.

1.02 The Contractor shall furnish a complete set of shop drawings and other necessary information, of all electrical equipment to receive vibration isolation and seismic devices, to the vibration isolation and seismic control materials manufacturer. The information to be furnished shall include operating weight of the equipment to be isolated, distribution of weight to support points and dynamic characteristics along with any internal isolation systems to be analyzed. The Contractor shall also furnish a complete layout of raceways to be isolated, including vertical risers, showing size or weight and support points of the system, to the vibration isolation and seismic control materials manufacturer, for selection and layout of mountings.

1.03 The vibration and seismic control materials manufacturer shall use the above listed information to design a complete system of vibration and seismic mounts in accordance with the contract documents along with the International Building Code Section, and SMACNA “Seismic Restraint Manual”. The vibration and seismic control materials Contractor shall analyze all “multiple degree of freedom” systems, and provide properly designed isolation systems avoiding all resonance frequencies. To accomplish this, the vibration and seismic control materials supplier shall employ an Engineer registered in the State of South Carolina to design all isolation and restraint systems and prepare a complete set of calculations and shop drawing submittals with his professional Engineer’s seal certifying that the design meets all requirements of these contract documents. A seismic design “errors and omissions” insurance certificate must accompany submittals from the vibration and seismic Engineer. Manufacturer’s product liability insurance certificates are not acceptable.

1.04 The vibration and seismic control Engineer or his designated representative shall inspect the project upon completion of the applicable work and provide written certification that the installation is in compliance with the approved shop drawing submittals. This certification shall also bear the professional Engineer’s seal and shall become part of the contract closeout documents. All seals shall be signed and dated appropriately.

1.05 Vibration and seismic control systems shall be provided by Vibration Mounting and Controls, Mason Industries, or Consolidated Kinetics.

PART TWO - PRODUCTS AND EXECUTION:

2.01 VIBRATION ISOLATION:

A. Electrical equipment so designated shall receive external vibration isolation. Internal component isolation of equipment shall not be considered equivalent, but shall be considered when analyzing systems with multiple degrees of freedom.

B. Vibration isolators shall be selected based upon known operating weight distributions and dynamic characteristics of the isolated equipment, with the quantity and location as required by the component drawing. Isolator type shall be tabulated for each isolated piece of equipment. Complete calculations of vibration analysis shall be included with submittals, including but not limited to fundamental and harmonic frequencies.

C. Isolators shall have either known non-deflected heights of spring element or calibration markings so that, after adjustment, when carrying their load, the deflection under load can be verified to determine if the load is within the proper range of the isolator and if the correct degree of vibration isolation is being provided.

D. Isolators shall function in the linear portion of the load versus deflection curve. Theoretical vertical natural frequency shall not differ from the design objectives by more than + 10%.

E. Spring mounts shall have seismic housings as required by Paragraph 2.02.

F. Isolation of equipment shall be as follows:

1. Emergency generator as noted shall be mounted on a rigid structural steel base. The equipment including the base shall be mounted on vibration isolators. Base shall be VMC Type WFB.

2.02 SEISMIC CONTROL:

A. All electrical panels, dry type transformers, switch gear, cable trays, and light fixtures shall be provided with seismic restraints in accordance with the International Building Code requirements, as a minimum.

1. All equipment isolated or not, shall be bolted to the structure to allow for seismic acceleration with no failure or displacement. All connections shall be positive bolted type; no friction clamps of any kind are allowed.

2. Provide cable and connection sets for suspended equipment at each of four corners secured to the building structure.

3. Floor mounted equipment shall be provided with seismically housed springs or springs with seismic snubbers as determined by the equipment to be isolated.

END OF SECTION 16890