May 16, 2012

ADDENDA NO. 2

- Revise the Contract Documents in ***INCLUDE*** the following Specification Section 15700 (41pgs).
- The Bid date must be postponed. The new date has not be established.
- Addenda No. 3 will provide new bid date, time and place.

END OF ADDENDA NO. 2

SECTION 15700

HEATING, VENTILATING AND AIR CONDITIONING (HVAC)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

The provisions of the Instructions to Bidders and the Supplementary Instructions (Articles 9 & 10), General Conditions and Supplementary Conditions, Parts I and II of these Specifications shall govern the work under all Divisions or Sections the same as if incorporated therein and are binding on the Contractor and each Subcontractor.

1.02 SCOPE:

A. These specifications together with the accompanying mechanical drawings are intended to provide for the complete installation of a new mechanical system(s) for a portion of the existing facility. The contractor shall use heating, air conditioning and ventilating equipment and materials as specified hereinafter and as indicated and scheduled on the drawings. This contract includes furnishing and installing all equipment, materials, labor and services necessary to provide a complete and operating mechanical system for the building.

B. The Heating and Air Conditioning (H&AC) Contractor shall pay all fees and shall secure all licenses and permits that are required and necessary in order to perform the work set forth in these specifications. He shall comply with the 2009 Editions of the International Building Code, International Mechanical Code, International Plumbing Code, International Energy Code as well as requirements of ADA, EPA, NFPA and all other authorities having jurisdiction over this work.

C. The H&AC Contractor shall do all excavating and backfilling necessary for this work, and he shall promptly remove from the premises weekly all excess earth, debris, and trash for which he is responsible.

D. The General Contractor will do all cutting and patching which is necessary for the installation of the work covered under this contract. The H&AC Contractor shall inform the General Contractor well in advance of the sizes and locations of all chases, openings, lintels, sleeves, etc., required for the installation of the mechanical equipment. Failure to do so will result in the H&AC Contractor bearing the cost of this phase of the work.

E. All work included under this contract shall be performed by skilled and capable workmen under competent supervision, employing the latest and best practices of the various trades involved. All materials and equipment hereinafter specified shall be American made and shall be new and free from flaws and defects of any nature.

F. Refer to the architectural plans and specifications for a complete description of all alternates as they pertain to the mechanical contract.

1.03 DRAWINGS:

A. The mechanical drawings are diagrammatical only and are intended to show the general arrangement of component parts of the H&AC systems. The contractor shall refer to equipment manufacturer's installation instructions for required access and service clearance around equipment. The contractor shall coordinate his work with other trades, and shall furnish and install all fittings, offsets, changes in duct sizes, etc., necessary to avoid interference's with trusses, electrical conduit, framing, etc., without additional cost to the Owner.

B. In case of conflict or doubt as to the drawings or specifications, the contractor shall consult the Architect, calling to his attention all discrepancies, errors or omissions encountered prior to ordering or installing equipment and materials. In no case shall the Contractor proceed in uncertainty.

C. Should any conflict occur between drawings and specifications, the contractor is instructed to estimate for the more expensive equipment or method of doing the work

1.04 BASIS OF DESIGN:

A. The basis of the mechanical design for all equipment is shown on the plans or in the schedules. The dimensional information, electrical characteristics, weight, equipment connections and other pertinent features of this equipment has been coordinated with the architectural, structural, plumbing and electrical disciplines and used by these design professionals as the basis of the design indicated on their respective plans. Any equipment supplier approved to bid this project desiring to provide equipment or products, other than those listed in the schedules or the plans, must provide to all contractors with their price a letter stating how their products differ from the mechanical basis of design as it pertains to dimensions, electrical characteristics, weight, equipment connections and any other pertinent information. Additionally, this letter must be included with the shop drawing submittal for each substituted piece of equipment not scheduled on the plans. Failure to include these letters with the shop drawings for all equipment scheduled will result in the submittals being rejected. By using the price of substitute equipment, the Mechanical Contractor is accepting the responsibility to coordinate any changes with other trades required by his substitution and shall assume any associated cost incurred as a result of substitution. Where conflicts arise during construction as a result of a failure on the Mechanical Contractor's part to coordinate any changes due to equipment substitution and/or to provide for all associated cost incurred, he shall be required to replace the substitute equipment with the equipment scheduled on the mechanical plans at the discretion of the Architect and Engineer.

1.05 APPROVALS:

A. All requests for approval to substitute materials or equipment considered by the Contractor as equal to those specified shall be submitted in writing to the Architect for approval ten (10) calendar days prior to the bid date.

B. See Supplementary Conditions in the Architectural Specifications for complete information concerning substitution of materials and equipment for this project.

C. Within fifteen (15) days after the award of the contract, the H&AC Contractor shall furnish the Architect five (5) sets of complete submittal data (bound and indexed in a 3-

ring binder) on the mechanical equipment and materials that he proposes to use on this project. Each supplier shall provide a name and telephone number of a contact person familiar with the product as a part of the submittal. As a minimum, the following must be submitted and approved before use on this project:

Central Station AHU	Ductwork Materials	Controls Contractor
Variable Air Volume Boxes	Piping Materials	Controls Devices
In-line Pump	Vibration Isolation &	Controls Diagrams
Ventilation Equipment	Seismic Products	T & B Contractor
Air Distribution Devices	Insulation Contractor	T & B Procedure
Louvers and Dampers	Insulation Material	

D. The H&AC Contractor shall be responsible for determining that all products submitted for approval meet given space limitations and maintain all required clearances for proper access and service. Additionally, any changes in electrical requirements must be coordinated with the Electrical Contractor at no added cost to the Owner.

E. Any item of equipment installed on this project that was not specified or approved for substitution, shall be removed and replaced with the item specified, without any cost to the Owner, at the discretion of the Architect.

1.06 "OR EQUAL" CLAUSE:

A. Specific references in the specification to any article, device, product, material, fixture, form or type of construction, etc., by name, make or catalog number, with or without the words "or equal", shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition. The Contractor in such cases may, at his option, use any article, device, product, material, fixture, form or type of construction, which in the judgment of the Architect, expressed in writing, is equal to that named.

B. Written requests for approval to substitute materials or equipment considered by the Contractor as equal to those specified, shall be submitted to the Architect for approval ten (10) days prior to bid opening date. Requests shall list specific model numbers and accessories to be used and shall be accompanied by samples, descriptive literature and engineering information as necessary to fully identify and appraise the product. No increase in contract sum will be considered when requests are not approved. If the Architect finds the item submitted to be equal, he will issue an Addendum making it a part of the Contract documents prior to bidding. After bidding, no further changes will be considered.

C. Do not submit specified products for approval unless requested to do so by the equipment manufacturer.

D. The H&AC Contractor shall be responsible for determining that all products submitted for approval meet given space limitations and maintain all required clearances for proper access and service. Additionally, any changes in electrical requirements must be coordinated with the Electrical Contractor at no added cost to the Owner.

E. Any item of equipment installed on this project which was not specified or approved for substitution, shall be removed and replaced with the item specified, without any cost to the Owner, at the discretion of the Architect.

1.07 DESIGN CONDITIONS:

Heating and air conditioning designs are based on the following conditions:

Winter Season:	20°F. outside. 72°F. inside.
Summer Season:	97°F. dry bulb and 76°F. wet bulb outside. 75°F. dry bulb inside.

PART 2 - PRODUCT

2.01 CENTRAL STATION AIR HANDLER (AHU):

A. Furnish and install where indicated on the plans, a central station air handler of size, type and capacity as scheduled on the drawings. Provide a draw-thru type air handling unit with fan section, coil sections, access sections and filter section as shown on the plans and specified below. The equipment supplier shall clearly state in his bid any exceptions made to the plans and specifications. The Mechanical Contractor is responsible for all expenses that occur due to the noted exceptions.

B. Quality Assurance

1. Air Coils: Certify capacities, pressure drops and selection procedures in accordance with current AHRI Standard 410.

2. Air handling units with fan sections utilizing single fans shall be rated and certified in accordance with AHRI Standard.

3. Certify air handling coils in accordance with AHRI Standard 410. Units shall be provided with certification label affixed to the unit. If air handling coils are not certified in accordance with AHRI Standard 410, contractor shall be responsible for expenses associated with testing of coils after installation to verify performance of coil(s). Any costs incurred to adjust coils to meet scheduled capacities shall be the sole responsibility of the contractor.

C. Warranty

1. AHU manufacturer shall provide, at no additional cost, a standard parts warranty that covers a period of one year from unit start-up or 18 months from shipment, whichever occurs first. This warrants that all products are free from defects in material and workmanship and shall meet the capacities and ratings set forth in the equipment manufacturer's catalog and bulletins.

D. General

1. Manufacturer to provide an integral base frame for either ceiling suspension of units or to support and raise all sections of the unit for proper trapping. Contractor will

be responsible for providing a housekeeping pad when unit base frame is not of sufficient height to properly trap unit. Unit base frames not constructed of galvanized steel shall be chemically cleaned and coated with both a rust-inhibiting primer and finished coat of rust-inhibiting enamel. Unit base height to be included in trap

E. Unit Casing

1. Unit manufacturer shall ship unit in segments as specified by the contractor for ease of installation in tight spaces. The entire air handler shall be constructed of galvanized steel. Casing finished to meet ASTM B117 250-hour salt-spray test. The removal of access panels or access doors shall not affect the structural integrity of the unit. All removable panels shall be gasketed. All doors shall have gasketing around full perimeter to prevent air leakage. Contractor shall be responsible to provide connection flanges and all other framework that is needed to properly support the unit.

2. Casing performance - Casing air leakage shall not exceed leak class 6 (CL = 6) per ASHRAE 111 at specified casing pressure, where maximum casing leakage (cfm/100 ft2 of casing surface area) = CL X P0.65.

3. Air leakage shall be determined at 1.00 times maximum casing static pressure up to 8 inches w.g. Specified air leakage shall be accomplished without the use of caulk. Total estimated air leakage shall be reported for each unit in CFM, as a percentage of supply air, and as an ASHRAE 111 Leakage Class.

4. Under 55F supply air temperature and design conditions on the exterior of the unit of 81F dry bulb and 73F wet bulb, condensation shall not form on the casing exterior. The AHU manufacturer shall provide tested casing thermal performance for the scheduled supply air temperature plotted on a psychrometric chart. The design condition on the exterior of the unit shall also be plotted on the chart. If tested casing thermal data is not available, AHU manufacturer shall provide, in writing to the Engineer and Owner, a guarantee against condensation forming on the unit exterior at the stated design conditions above. The guarantee shall note that the AHU manufacturer will cover all expenses associated with modifying units in the field should external condensate form on them. In lieu of AHU manufacturer providing a written guarantee, the installing contractor must provide additional external insulation on AHU to prevent condensation.

5. Unit casing (wall/floor/roof panels and doors) shall be able to withstand up to 1.5 times design static pressure, or 8-inch w.g., whichever is less, and shall not exceed 0.0042 per inch of panel span (L/240).

6. Unit casing panels shall be 2-inch double-wall construction, with solid galvanized exterior and solid galvanized interior, to facilitate cleaning of unit interior.

7. Unit casing panels (roof, walls, floor) and doors shall be provided with a minimum thermal resistance (R-value) of 13 Hr*Ft2*°F/BTU.

8. Unit casing panels (roof, walls, floor) and external structural frame members shall be completely insulated filling the entire panel cavity in all directions so that no voids

exist. Panel insulation shall comply with NFPA 90A.

9. Casing panel inner liners must not extend to the exterior of the unit or contact the exterior frame. A mid-span, no-through-metal, internal thermal break shall be provided for all unit casing panels.

10. Access panels and/or access doors shall be provided in all sections to allow easy access to drain pan, coil(s), motor, drive components and bearings for cleaning, inspection, and maintenance.

F. Access Doors

1. Access doors shall be 2-inch double-wall construction. Interior and exterior shall be of the same construction as the interior and exterior wall panels.

2. All doors downstream of the cooling coil shall be provided with a thermal break construction of door panel and door frame.

3. Gasketing shall be provided around the full perimeter of the doors to prevent air leakage.

4. Door hardware shall be surface-mounted to prevent through-cabinet penetrations that could likely weaken the casing leakage and thermal performance.

5. Hinges shall be interchangeable with the door handle hardware to allow for alternating door swing in the field to minimize access interference due to unforeseen job site obstructions.

6. All doors shall be a 60-inch high when sufficient unit height is available, or the maximum height allowed by the unit height.

7. Multiple door handles shall be provided for each latching point of the door necessary to maintain the specified air leakage integrity of the unit.

G. Primary Drain Pans

1. All cooling coil sections shall be provided with an insulated, double-wall, galvanized drain pan.

2. The drain pan shall be designed in accordance with ASHRAE 62.1 being of sufficient size to collect all condensation produced from the coil and sloped in two planes, pitched toward drain connections, promoting positive drainage to eliminate stagnant water conditions when unit is installed level and trapped per manufacturer's requirements.

3. The outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition.

4. Drain connections shall be of the same material as the primary drain pan and shall

extend a minimum 2-1/2-inch beyond the base to ensure adequate room for field piping of condensate traps.

5. The installing contractor is responsible to ensure the unit is installed level, trapped in accordance with the manufacturer's requirements, and visually inspected to ensure proper drainage of condensate.

6. Coil support members inside the drain pan shall be of the same material as the drain pan and coil casing.

7. If drain pans are required for heating coils, access sections, or mixing sections they will be indicated in the plans.

H. Fans

1. Fan sections shall have a minimum of one hinged and latched access door located on the drive side of the unit to allow inspection and maintenance of the fan, motor, and drive components.

2. Provide fans of type and class as specified on the schedule. Fan shafts shall be solid steel, coated with a rust-inhibiting coating, and properly designed so that fan shaft does not pass through first critical speed as unit comes up to rated RPM. All fans shall be statically and dynamically tested by the manufacturer for vibration and alignment as an assembly at the operating RPM to meet design specifications. Fans controlled by variable frequency drives shall be statically and dynamically tested for vibration and alignment at speeds between 25% and 100% of design RPM. If fans are not factory-tested for vibration and alignment, the contractor shall be responsible for cost and labor associated with field balancing and certified vibration performance. Fan wheels shall be keyed to fan shafts to prevent slipping.

3. Belt-driven fans shall be provided with grease lubricated, self-aligning, anti-friction bearings selected for L-50 200,000-hour average life per ANSI/AFBMA Standard 9. Lubrication lines for both bearings shall be extended to the drive side of the AHU and rigidly attached to support bracket with zerk fittings. Lubrication lines shall be a clear, high-pressure, polymer to aid in visual inspection. If extended lubrication lines are not provided, manufacturer shall provide permanently lubricated bearing with engineering calculations for proof of bearing life.

4. All fans, including direct drive plenum fans, shall be mounted on isolation bases. Internally-mounted motor shall be on the same isolation base. Fan and motor shall be internally isolated with spring isolators. Unit sizes up to a nominal 4,000 CFM shall have 1-inch spring isolation. Units with nominal CFM's higher than 4,000 shall have 2-inch springs. A flexible connection (e.g. canvas duct) shall be installed between fan and unit casing to ensure complete isolation. Flexible connection shall comply with NFPA 90A and UL 181 requirements. If fans and motors are not internally isolated, then the entire unit shall be externally isolated from the building, including supply and return duct work, piping, and electrical connections. External isolation shall be furnished by the installing contractor in order to avoid transmission of noise and vibration through the ductwork and building structure.

I. Motors and Drives

1. All motors and drives shall be factory-installed and run tested. All motors shall be installed on a slide base to permit adjustment of belt tension. Slide base shall be designed to accept all motor sizes offered by the air-handler manufacturer for that fan size to allow a motor change in the future, should airflow requirements change. Fan sections without factory-installed motors shall have motors field installed by the contractor. The contractor shall be responsible for all costs associated with installation of motor and drive, alignment of sheaves and belts, run testing of the motor, and balancing of the assembly.

2. Motors shall meet or exceed all NEMA Standards Publication MG 1 - 2006 requirements and comply with NEMA Premium efficiency levels when applicable. Motors shall comply with applicable requirements of NEC and shall be UL Listed.

3. Fan Motors shall be heavy duty, open drip-proof operable at 460 volts, 60Hz, 3-phase. If applicable, motor efficiency shall meet or exceed NEMA Premium efficiencies.

4. Belt driven fans shall use 4-pole, 1800 rpm, motors, NEMA B design, with Class B insulation, capable to operate continuously at 104 deg F (40 deg C) without tripping overloads.

5. V-Belt Drive shall be fixed pitch rated at 1.5 times the motor nameplate. Drives 20 hp and larger or any drives on units equipped with VFDs shall be fixed pitch.

6. Manufacturer shall provide for each fan a nameplate with the following information to assist air balance contractor in startup and service personnel in maintenance:

a. Fan and motor sheave part number
b. Fan and motor bushing part number
c. Number of belts and belt part numbers
d. Fan design RPM and motor HP
e. Belt tension and deflection
f. Center distance between shafts

J. Variable Frequency Drive:

1. AHU fan motor shall be operated from a factory mounted, wired and commissioned variable frequency drive model “ACTIVAR” 56 as manufactured by SQUARE “D” or approved equal. The drive shall have the following features as a minimum:

a. Stall prevention to avoid nuisance tripping during a temporary motor overload or overcurrent condition.
b. Speed search which allows the drive to start into a rotating motor.
c. DC injection braking which allows the drive to start into a fan which is reverse wind milling.
d. Power loss ride thru to handle a power outage for up to 2 seconds.

e. Reference loss detection which allows the drive to continue or terminate operation due to an interruption of the reference.
f. Critical frequency rejection which will allow the drive to accelerate or decelerate the motor through a bandwidth where resonant vibration problems of the motor/machine may occur.

2. The variable speed drive shall be configured as follows:

a. NEMA 1 enclosure.
b. Input circuit breaker disconnect.
c. Hand-Off-Auto selector switch with potentiometer.
d. BY-PASS circuit and line contactors.

K. Coils

1. Coils section header end panel shall be removable to allow for removal and replacement of coils without impacting the structural integrity of the unit.

2. Install coils such that headers and return bends are enclosed by unit casing to ensure that if condensate forms on the header or return bends, it is captured by the drain pan under the coil.

3. Coils shall be manufactured with plate fins to minimize water carryover and maximize airside thermal efficiency. Fin tube holes shall have drawn and belled collars to maintain consistent fin spacing to ensure performance and air pressure drop across the coil as scheduled. Tubes shall be mechanically expanded and bonded to fin collars for maximum thermal conductivity. Use of soldering or tinning during the fin-to-tube bonding process is not acceptable due to the inherent thermal stress and possible loss of bonding at that joint.

4. Construct coil casings of galvanized steel. End supports and tube sheets shall have belled tube holes to minimize wear of the tube wall during thermal expansion and contraction of the tube.

5. All coils shall be completely cleaned prior to installation into the air handling unit. Complete fin bundle in direction of airflow shall be degreased and steam cleaned to remove any lubricants used in the manufacturing of the fins, or dirt that may have accumulated, in order to minimize the chance for water carryover.

6. When two or more cooling coils are stacked in the unit, an intermediate drain pan shall be installed between each coil. The intermediate drain pan shall be designed being of sufficient size to collect all condensation produced from the coil and sloped to promote positive drainage to eliminate stagnant water conditions. The intermediate drain pan shall be constructed of the same material as the sections primary drain pan.

7. The intermediate drain pan shall begin at the leading face of the water-producing device and be of sufficient length extending downstream to prevent condensate from passing through the air stream of the lower coil.

8. Intermediate drain pan shall include downspouts to direct condensate to the primary drain pan. The intermediate drain pan outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition.

L. Filters

1. Provide factory-fabricated filter section of the same construction and finish as unit casings. Filter section shall have side access filter guides and access door(s) extending the full height of the casing to facilitate filter removal. Provide fixed filter blockoffs as required to prevent air bypass around filters. Blockoffs shall not need to be removed during filter replacement. Filters to be of size, and quantity needed to maximize filter face area of each particular unit size.

2. Filter type, MERV rating, and arrangement shall be provided as defined in project plans and schedule

3. Manufacturer shall provide one set of startup filters.

M. Dampers

1. All dampers, with the exception of external bypass and multizones (if scheduled), shall be internally mounted. Dampers shall be premium ultra low leak and located as indicated on the schedule and plans. Blade arrangement (parallel or opposed) shall be provided as indicated on the schedule and drawings. Dampers shall be Ruskin CD60 double-skin airfoil design or equivalent for minimal air leakage and pressure drop. Leakage rate shall not exceed 4 CFM/square foot at one inch water gauge complying with ASHRAE 90.1 maximum damper leakage and shall be AMCA licensed for Class 1A. All leakage testing and pressure ratings shall be based on AMCA Standard 500-D. Manufacturer shall submit brand and model of damper(s) being furnished, if not Ruskin CD60.

N. Access Sections

1. Access sections shall be provided where indicated in the schedule and plans to allow additional access for inspection, cleaning, and maintenance of unit components. The unit shall be installed for proper access. Procedure for proper access, inspection and cleaning of the unit shall be provided in the AHU manufacturer's maintenance manual.

O. Central station air handling units shall be TRANE models as scheduled on the plans or equal by CARRIER or JCI.

2.02 FAN POWERED VAV BOX WITH HOT WATER HEATING COIL (VAV):

A. Furnish and install where indicated on the plans, fan powered VAV box(es) of size, type and capacity as scheduled on the drawings. The equipment supplier shall clearly state in his bid any exceptions made to the plans and specifications. The Mechanical Contractor is responsible for all expenses that occur due to the noted exceptions.

B. Manufacturer must participate in the ARI Certification program.

C. Units shall be completely factory assembled, manufactured of corrosion protected welded steel, and fabricated with a minimum of 18-gauge metal on the high pressure (inlet) side of the VAV damper and 22-gauge metal on the low pressure (outlet) side and unit casing. Plenum air filter shall be provided on all Fan Powered units with 3 sets of filters. Provide additional sets as required for limited operation of equipment during construction.

D. Interior surface of unit casing shall be acoustically and thermally lined with a minimum of ½ inch, R-Value 2.1, 1.9 lb/cubic foot density glass fiber with high density facing. Insulation shall be UL listed and meet NFPA-90A and UL 181 requirements.

E. Air volume damper, fans, and controls in single cabinet. Fan powered units shall be provided with removable access panel for servicing interior components.

F. Locate air volume damper assembly inside unit casing. Flow sensor must be provided. Flow sensor must be a ring or cross (bar or single point sensing device is not acceptable) designed for measuring actual CFM. Air volume control damper shall be a factory calibrated assembly consisting of air valve with integral actuator. Electronic DDC actuator shall position damper.

G. DDC Actuator shall be furnished by Controls Contractor and installed by factory.

H. Fan Powered VAV shall contain a hot water coil consisting of copper tubes mechanically expanded into aluminum plate fins, leak tested under water to 300 psig pressure, factory installed.

I. Fan assembly shall consist of a forward curved centrifugal type fan with direct drive permanently lubricated, permanent split capacitor type, thermally protected, three speed motor. Fan motor horsepower shall not exceed the horsepower scheduled for each unit. Fan motors shall be high efficiency such that power requirements shall not exceed those shown in the table below for each motor size.

115 VOLT

FAN HP	AMPS	WATTS
1/15	1.2	115
1/8	2.8	270
1/3	7.5	740
½	8.1	800
3/4	11.5	1140

J. Provide 3 speed fan control switch and disconnect switch, which breaks both legs of power entering the control box.

K. Factory mount transformer for control voltage on fan-powered units. Factory wire fan to terminal strip.

L. Fan powered VAV boxes shall be TRANE models as scheduled on the plans or equal by CARRIER or JCI.

2.03 CENTRIFUGAL IN-LINE WATER PUMPS (CWP):

A. Furnish and install where indicated on the plans, a centrifugal in-line chilled water pump of size, type and capacity as scheduled on the drawings. The equipment supplier shall clearly state in his bid any exceptions made to the plans and specifications. The Mechanical Contractor is responsible for all expenses that occur due to the noted exceptions.

B. Each in-line pump shall be a single-stage centrifugal water pump and shall be furnished complete with cast iron volute, a carbon steel shaft with copper alloy shaft seal, mechanical shaft seal, bronze/brass impeller, ball bearings, back pullout type construction, open drip-proof high efficiency NEMA motor with heavy-duty grease lubricated ball bearings, magnetic starter for pump motor, and other accessories as applicable. Pumps shall be non-overloading throughout their ranges of operation, and shall be designed for continuous service. Pump shall be rated for 175 PSI working pressure. Casing shall have gauge ports at nozzles, and vent and drain ports in casing. Each pump shall be furnished with a metal tag showing the GPM and head capacity of the pump. The liquid cavity shall be sealed off at the motor shaft by an internally flushed mechanical seal with ceramic seal seat and carbon ring, suitable for continuous operation at 225°F. A shaft sleeve shall completely cover the wetted area under the seal.

C. In-line pumps and motor shall have a self-supporting design.

D. In-line chilled water pump shall be TACO model as scheduled on the plans or equal by B&G or PEERLESS.

2.04 VENTILATING EQUIPMENT:

A. Furnish and install ventilating equipment for the building as indicated on the plans, as described below and as scheduled on the drawings. The equipment supplier shall clearly state in his bid any exceptions made to the plans and specifications. The Mechanical Contractor is responsible for all expenses that occur due to the noted exceptions. The General Contractor will provide framed openings in walls and floor as required for the ventilating equipment. All fans shall bear the AMCA Certified Ratings Seal for sound and air performance per AMCA 210.

B. Inline Cabinet Fan (ICF):

1. Furnish and install where indicated on the plans, centrifugal type inline cabinet fan(s) of size and capacity as scheduled on the drawings. Each inline fan shall be furnished complete with a centrifugal type blower, automatic back draft damper, horizontal or vertical discharge outlet as applicable, fan motor with built-in thermal overload protection, time delay wall switch where indicated on the schedule, resilient rubber isolators for blower housing, acoustically insulated housing, and UL label.

2. Inline cabinet fan(s) shall be GREENHECK models as scheduled on the plans or equal by COOK, TWIN CITY FANS, PENN BARRY, BREIDERT, ILG, ACME or CARNES. All suppliers refer to section 1.04 BASIS OF DESIGN for additional bidding instructions.

C. Wall Cap:

1. Install in the exterior wall of the building where indicated on the plans a wall cap of size as noted on the drawings. Each wall cap shall be furnished complete with anodized aluminum construction and backdraft damper.

2. Wall cap shall be GREENHECK model WL or equal by COOK, UNITED ENERTECH, TWIN CITY FANS, PENN BARRY, BREIDERT, ILG, ACME or CARNES.

D. General:

Ductwork, turning vanes, grilles, dampers, and other applicable items that are to be installed in conjunction with the ventilating equipment are specified elsewhere.

2.05 EQUIPMENT SUPPORTS:

A. Air Handler:

1. Air handler(s) with a capacity of 3000 cfm and above shall be installed on a reinforced concrete supporting base furnished by the General Contractor on the equipment room floor slab. Coordinate with the General Contractor to provide a 6 inch pad doweled into the floor slab and extending beyond the unit 6 inches in all directions.

B. Above Ceiling or Ceiling Mounted Equipment:

1. Unless noted otherwise, all fan powered VAV boxes and in-line cabinet fan(s) shall be supported from the members of the floor construction with hanger rods of sizes as recommended by the equipment manufacturers. Hanger rods shall be attached to steel angles or channels of adequate size, which in turn shall be welded or bolted to the members of the floor construction. H&AC Contractor shall furnish and install all supplementary steel, framing members, hanger rods, inserts, etc., as required to properly support all ceiling mounted equipment. Mechanical items of equipment and ductwork shall not be supported from “X” bracing or bridging between joists or trusses.

2.06 VIBRATION ISOLATORS AND SEISMIC RESTRAINTS:

A. All mechanical equipment 3/4 HP and over listed in the Vibration Isolation / Seismic schedule shall be mounted on vibration isolators to prevent the transmission of objectionable vibration and vibration induced sound to the building structure. All isolation materials, flexible connectors and seismic restraints shall be of the same manufacturer.

B. Unless otherwise specified, all mechanical and plumbing equipment, pipe and ductwork shall be restrained to resist seismic forces. Restraint devices shall be designed and selected to meet the seismic requirements as defined in the latest issue of the IBC or local jurisdiction building code.

C. The isolators and seismic restraint systems listed herein are as manufactured by Amber / Booth, Mason Industries, Kinetics, Vibration Eliminator Company or approved equals which meet all the requirements of the specifications, are acceptable. Manufacturer must be a member of the Vibration Isolation and Seismic Control Manufacturers Association (VISCMA).

D. Seismic restraint shall not be required for the following:

1. Hanging, wall mounted and flexibly supported mechanical & plumbing components that weigh 20 pounds (89 N) or less, where I_p = 1.0 and flexible connections are provided between the components and associated ductwork piping.

2. High deformability piping (steel, copper, aluminum with welded, brazed, ground or screwed connections) designated as having an Ip = 1.5 and a nominal pipe size of 1 inch (25 mm) or less where provisions are made to protect the piping from impact or to avoid the impact of larger piping or other mechanical equipment. Note, any combination of piping supported on a trapeze where the total weight exceeds 10 lb/ft. must be braced.

3. High deformability piping (steel, copper, aluminum with welded, brazed, ground or screwed connections) and limited deformability piping (cast iron, FRP, PVC) designated with an Ip = 1.0 and a nominal pipe size of 1 inch and less in the mechanical equipment room or 2" and less outside the mechanical equipment room.

4. PVC or other plastic or fiberglass vent piping.

5. HVAC ducts suspended from hangers that are 12 inches or less in length from the top of the duct to the supporting structure and the hangers are detailed to avoid significant bending of the hangers and their connections. Duct must be positively attached to hanger with minimum #10 screws within 2" from the top of the duct.

6. HVAC duct with an I_p = 1.5 that have a cross-section area less than 4 square feet. HVAC ducts with an I_P = 1.0 that have a cross sectional area of less than 6 square feet.

7. Equipment items installed in-line with the duct system (e.g., fans, heat exchangers and humidifiers) with an operating weight less than 76 pounds. Equipment must be rigidly attached to duct at inlet and outlet.

E. Manufacturer of vibration and seismic control products shall provide piping, ductwork and equipment isolation systems and seismic restraints as scheduled or specified with installation instructions and shop drawings for all materials supplied under this section of the specifications. Seismic restraints shall comply with the SMACNA Seismic Restraint Manual *Guidelines for Mechanical Systems* Second Edition – February, 1998 and Addendum No. 1 September 2000.

F. Submittals shall include calculations to determine restraint loads resulting from seismic forces presented in local building code or IBC, Chapter 16 latest edition. Seismic calculations shall be certified & stamped by an engineer in the employ of the seismic equipment manufacturer with a minimum 5 years experience and licensed in the project's jurisdiction. Provide calculations for all floor or roof mounted equipment and all

suspended or wall mounted equipment 20lbs or greater. Calculations and restraint device submittal drawings shall specify anchor bolt type, embedment, concrete compressive strength, minimum spacing between anchors and minimum distances of anchors from concrete edges. Seismic supplier shall provide shop drawings indicating location of all cable restraints required for pipe and ductwork. Drawings must be stamped by a manufacturer's registered professional engineer.

G. All isolators, bases and seismic restraints exposed to the weather shall utilize cadmium plated, epoxy coat or PVC coated springs and hot dipped galvanized steel components. Nuts, bolts and washers may be zinc-electroplated. Isolators for outdoor mounted equipment shall provide adequate restraint for the greater of either wind loads required by local codes or withstand a minimum of 30 lb./sq.ft. applied to any exposed surface of the equipment.

H. Mechanical and plumbing equipment manufacturers shall provide certification that their equipment is capable of resisting expected seismic loads without failure. Equipment manufacturers shall provide suitable attachment points and/or instructions for attaching seismic restraints.

I. Products:

1. Vibration Isolators:

a. Specification W: a pad type mounting consisting of two layers of ribbed elastomeric pads with a ½" poro-elastic vibration absorptive material bonded between them. Pads shall be Amber / Booth Type NRC.

b. Specification C: a unitized adjustable, stable open spring isolator with a seismic restraint housing which serves as a blocking device during equipment installation. The spring package shall include an elastomeric pad for high frequency absorption at the base of the spring. The springs shall be designed for a minimum kx/ky (horizontal-to-vertical spring rate) of 1.0. Nuts, adjusting bolts and washers shall be zinc-electroplated to prevent corrosion. The spring assembly shall be removable with equipment in place and shall fit within a welded steel enclosure consisting of a top plate and rigid lower housing. Isolated seismic restraint bolts shall connect top plate to lower housing to resist seismic and wind forces in all directions and limit motion to a maximum of 1/4-inch movement before engaging. Surfaces that engage under seismic motion shall be cushioned with a resilient elastomeric pad or grommet to protect equipment. Top plate shall have adequate means for fastening to the equipment and baseplate shall have adequate means for bolting to structure. Entire assembly shall be rated to exceed the applied seismic load. Seismic isolator shall be Amber / Booth type CTER.

c. Specification D: an elastomeric hanger consisting of a rectangular steel box capable of 200% minimum overload without visible deformation, 30-degree rod misalignment and an elastomeric isolation element designed for approximately 1/2" deflection. Hangers shall be Amber / Booth Type BRD.

d. Specification E: a combination spring and elastomeric hanger consisting of a rectangular steel box capable of 200% minimum overload without visible

deformation, 30 degree rod misalignment, coil spring, spring retainers and elastomeric element designed for approximately 1/2" deflection. Spring hangers shall be Amber / Booth Type BSRA.

e. Specification SB: a unitized adjustable open spring isolator and a welded steel housing designed to resist seismic forces in all directions. Restraint surfaces that engage under seismic motion shall be cushioned with a resilient elastomer to protect equipment. Restraints shall allow a maximum of 1/4" movement before engaging and shall allow for the spring to be changed if required. Entire assembly shall be rated to exceed the applied seismic load. Mountings shall be Amber / Booth Type SWSR.

2. Seismic Restraints:

a. Specification SL: a restrain assembly for floor mounted equipment consisting of welded steel interlocking assemblies welded or bolted securely to the equipment or the equipment bases and to the supporting structure. Restraint assembly surfaces which engage under seismic motion shall be lined with a minimum of 1/4-inch thick resilient elastomeric pad to protect equipment. Restraints shall be field adjustable and be positioned for 1/4-inch clearance as required to prevent interference during normal operation. Restraint assembly shall have minimum rating of two times the catalog rating at 1 g. as certified by independent laboratory test. Restraint shall be Amber / Booth type ER.

b. Specification SC: a restraint assembly for suspended equipment, piping or ductwork consisting of high strength galvanized steel aircraft cable. Cable must have Underwriters Laboratories listed certified break strength and shall be color-coded for easy field verification. Secure cable to structure and to braced component through bracket or stake eye specifically designed to exceed cable restraint rated capacity. Break strengths must be per ASTM E-8 procedures. Cables shall be installed to prevent excessive seismic motion and so arranged that they do not engage during normal operation. Restraint shall be type LRC.

J. Installation:

1. Comply with the manufacturer's instructions for the installation and load application of vibration isolation materials and products. Adjust to ensure that units do not exceed rated operating deflections or bottom out under loading and are not short-circuited by other contacts or bearing points. Remove space blocks and similar devices (if any) intended for temporary support during installation or shipping.

2. Locate isolation hangers as near the overhead support structure as possible. Adjust leveling devices as required to distribute loading uniformly on isolators. Shim units as required where leveling devices cannot be used to distribute loading properly. Install isolated inertia base frames and steel bases on isolator units as indicated so that a minimum of 1inch clearance below base will result when supported equipment has been installed and loaded for operation.

3. Housekeeping Pads shall be constructed and installed per ASHRAE's "A Practical Guide to Seismic Restraint". They shall be a minimum of .5" thicker than the maximum embedment required of any anchor but not less than 6". They shall be

sized to provide minimum edge distances for all installed anchors. They must be anchored to the floor structure in an approved manner.

K. Application of Seismic Restraints:

1. All floor mounted isolated equipment shall be protected with type SB or type C unitized isolator and restraint or with separate type SL restraints (minimum of 4).

2. Floor mounted non-isolated equipment shall be protected by properly sized anchor bolts with elastomeric grommets provided by the isolation manufacturer.

3. All suspended equipment and vessels shall be protected with specification SC restraints. Cables shall be installed to prevent excessive seismic motion and so arranged that they do not engage during normal operation.

L. Ductwork:

Ductwork shall be protected in all planes by SC restraints. Locations shall be determined by the isolator / seismic supplier.

M. Air Distribution Devices:

1. Ceiling mounted air terminals or services weighing less than 20 lbs shall be positively attached to the ceiling suspension main runners or cross runners with the same carrying capacity as the main runners.

2. Air terminals or services weighing more the 20 lbs but not more than 56 lbs shall have, in addition to the requirements listed above, two No. 12 gage hangers connected from the terminal or service to the ceiling system hangers or to the structure above. These wires may be slack.

3. Air terminals or services weighing more than 56 lbs shall be supported directly from the structure above by approved hangers.

N. Equipment Isolation and Seismic Restraint Schedule:

EQUIPMENT ISOLATION AND SEISMIC RESTRAINT SCHEDULE

Fa = If Site Class is unknown, use the value for Site Class D
Project Seismic Factors: Ss = 0.60 (Columbia, SC)

Equipment Tag	Component Ip	Isolation Specification	Seismic Rest. Spec.	Isolation Deflection
Air Handlers	1.0	by mfgr.	Note 1	2”
Air Handlers (floor mounted)	1.0	Spec SB	Spec SB	1”
VAV (w/fan)	1.0	Spec D	Spec SC	0.5”

In-line Pumps	1.0	None	Spec SC	N/A
ICF's	1.0	NONE	Spec SC	N/A

Notes:

1. Anchor bolts for non-isolated and internally isolated equipment shall be sized by the seismic restraint supplier. If required, Spec. SL snubbers or Spec. SC cable kits shall be provided.
2. Roof curbs provided by others must be certified by a professional engineer for the required seismic loads.

O. All life safety equipment and all equipment in Occupancy Category III buildings shall have an Ip of 1.5.

2.07 DUCTWORK:

A. Ductwork shall be run in space above ceilings and below joists as indicated on drawings. Verify actual conditions and space constraints before fabricating any ductwork. Careful coordination with General Contractor and other trades shall be made to avoid conflicts with sprinkler piping, plumbing piping, conduits, cable trays, computer wiring, steel joists, beams, trusses, etc.

B. Low Pressure Ductwork:

1. Unless otherwise noted all supply, return, exhaust, transfer and outside air ductwork shall be constructed of galvanized steel. Seams, joints, and reinforcing for ductwork shall be in accordance with ASHRAE Guide and SMACNA HVAC Duct Construction Standards for 2-inch duct pressure classification. All transverse joints and longitudinal seams shall be thoroughly sealed with gaskets or mastics; pressure sensitive tapes shall not be used as the primary sealant. Sheet metal ductwork shall conform to the minimum gages tabulated below.

2. Outside air ductwork shall be externally insulated with duct wrap insulation as specified hereinafter. All return, transfer, and supply air ductwork shall be internally lined with duct liner insulation as specified hereinafter.

Largest Duct Dimension	Galvanized Steel Gage
Round ductwork	26 USS gage
12" or less	26 USS gage
13" to 30"	24 USS gage
31" to 54"	22 USS gage
55" and greater	20 USS gage

3. Round flexible ductwork shall be THERMAFLEX CO. Type M-KE or FLEXMASTER Type 8M insulated double air seal round flexible "Fiberglas" air duct with bi-directional reinforced metallized vapor barrier with triple ply stand-up seam, acoustically rated black CPE liner permanently bonded to a coated spring steel wire helix that supports the "Fiberglas" R-6 blanket insulation. Provide round duct diameters as specified on plans, and duct lengths as required to meet job conditions. Flexible ductwork run outs shall be limited to a maximum length of 6 feet with any

additional length made-up of round sheet metal ductwork with duct wrap insulation specified hereinafter. Attach round flexible ductwork to rectangular ductwork with "Twist-Lok" takeoff fittings with air scoops and balancing dampers. All flexible ductwork connections to "Twist-Lok" fittings and air distribution equipment shall be made using stainless steel worm gear clamps. Plastic panduit straps are not acceptable. Provide a FlexFlow elbow support at the round neck connection to each ceiling diffuser. Elbow supports shall be constructed of a durable composite material, fully adjustable to support flexible duct diameters from 6” to 16” and UL listed for use in return air plenums.

C. Medium Pressure Ductwork:

1. All ductwork serving the variable air volume (VAV) systems from air handling units to the VAV boxes shall be medium pressure round or oval pre-fabricated spiral locked seam conduit with pre-fabricated fittings as indicated on plans and as manufactured by HAMLIN SHEETMETAL CO., or approved equal by SEMCO CO., EASTERN SHEETMETAL CO., MONROE METALS CO., UNITED SHEETMETAL CO. Fittings shall be manufactured to published standards for dimensions and construction details. Installation manuals shall be supplied to the contractor to provide detailed instructions on methods and procedures for assembly. All seams in the pressure shell of all fittings shall be continuously welded. Galvanizing that has been damaged by welding shall be coated with corrosion resistant aluminum paint. All fittings shall have continuous welds along all seams. All divided flow fittings shall be manufactured as separate fittings and not as tapped collars welded into spiral duct sections. Fittings shall be conical where indicated on plans.

2. Wherever acoustically lined ductwork is specified on plans for the VAV systems, construction shall be pre-fabricated spiral ductwork as specified above with an airtight outer pressure shell, 1" insulation layer with “DURA-LAR” polyester film covering, and perforated metal liner that completely covers the insulation. Outer shell shall be galvanized steel conforming to ASTM A-527-67. Fittings shall have a solid inner lining. Inner liners of both ducts and fittings shall be adequately supported by metal spacers welded in position to maintain spacing and concentricity. Provide inner couplings to align the inner linings in order to maintain proper air flow conditions equivalent to standard round medium pressure duct joints.

3. Lining inside medium pressure ductwork shall meet the Erosion Test Method described in UL Publication No. 181. Linings including coatings, polyester film, adhesives, etc. shall have a flame-spread rating of not more than 25 and a smoke developed rating of not more than 50 in accordance with ASTM Standard E-84.

4. All other medium pressure ductwork shall be unlined single wall round and oval medium pressure ductwork and shall be insulated externally as specified hereinafter. All pressure tests on duct system shall be performed and passed prior to installing insulation.

5. Each of the medium pressure duct systems shall be pressure tested. The Contractor shall demonstrate to the Engineer or his representative that each system shall have a duct leakage of less than 2% at 6” static pressure using manometers, fan and calibrated orifice plate. If the systems do not pass the initial test, the

Engineer at his discretion may require additional testing of some or all of the remaining systems.

D. Install double vane type turning vanes at all square elbows in all ductwork. Dampers, turning vanes, and other items to be installed in conjunction with the ductwork are specified in subsequent paragraphs.

E. All interior or exterior ductwork exposed to view shall be painted a color as selected by the Architect.

F. Follow duct dimensions indicated on drawings as closely as possible. Provide offsets, vary shape or alter run if required to meet structural or other interference's. Where shape of duct is varied, alter dimensions to provide cross sectional area and static pressure drop per unit length equal to ductwork shown on drawings.

G. Duct dimensions shown on drawings are inside dimensions. Adjust accordingly where interior insulation is applied.

H. Duct to be air tight, smooth on inside and neatly finished on outside.

I. Cover or otherwise protect all fan and duct openings from dirt and rubbish during construction. Clean all systems prior to final inspection.

2.08 FLEXIBLE DUCT CONNECTORS:

Where equipment is supplied with internal flexible duct connectors, external flexible duct connectors are not required. Otherwise, all sheet metal ductwork connections to each piece of air handling equipment and exhaust fan shall be made with a glass fabric flexible duct connector equal to "Ventglas" for indoor applications and "Ventlon" for outdoor use as manufactured by VENTFABRICS CO. Each flexible duct connector shall be non-combustible, double-coated with fire retardant neoprene, airtight, waterproof, heat resistant to 200°F, cold resistant to -10°F., designed for medium pressure ductwork, and complies with UL Standard #214 for fire retardancy.

2.09 FIRE DAMPERS:

A. Furnish and install fire, smoke and combination dampers labeled for use in dynamic systems in the ductwork at all locations as indicated on the drawings. Fire dampers for all walls rated two hour and less shall have a 1-1/2 hour rating. Three and four hour fire walls require 3 hour fire dampers. All fire, smoke and combination dampers believed to be required by NFPA pamphlet No. 90A in the opinion of the Engineers are shown on the plan. Any additional dampers that may be required by the authorities exercising jurisdiction over this job will be furnished and installed as an extra to the contract.

B. Fire dampers shall be curtain type factory fabricated dampers, and each damper shall be furnished complete with a sheet metal sleeve of length as required around fire damper assembly, UL-555 label for entire damper assembly, UL approved replaceable type fusible link, designed for horizontal or vertical air flow as applicable, and constructed in accordance with NFPA Pamphlet No. 90A. Fire dampers shall be field installed in strict accordance with the manufacturer's recommendations, NFPA Pamphlet No. 90A, and as detailed in the SMACNA manual. Seal all openings around fire damper

sheet metal sleeves located in fire partitions, walls, and floors using 3M Brand fire protection products or equal by Hilti specifically approved for the particular usage and fire rating, and installed in strict accordance with the manufacturer's recommendations. Damper installations shall meet the approval of the authorities exercising jurisdiction.

C. Fire dampers in low pressure ductwork located in partitions and walls 5" and less in thickness, and dampers located behind air distribution equipment shall be thinline RUSKIN MFG. CO. Model IBDT dampers or equal by LEADER INDUSTRIES, NAILOR, NCA, PREFCO or POTTORFF.

D. Fire dampers located in all other low-pressure ductwork shall be RUSKIN MFG. CO. Model IBD-2 dampers Style A & B as applicable or equal by LEADER INDUSTRIES, NAILOR, NCA, PREFCO or POTTORFF.

E. Combination fire/smoke dampers located in low pressure ductwork shall be RUSKIN MFG. CO. Model FSD-31 dampers or equal by LEADER INDUSTRIES, NAILOR, NCA, PREFCO or POTTORFF. Each damper shall be furnished complete with all welded construction, Type C housing with rectangular, round or oval connections as applicable, airfoil blades, jamb and blade seals, sheet metal sleeve of length as required, UL approved replaceable type fusible link, 3 hour fire rated for a 4 hour fire wall, 250°F. temperature rating, designed for 4" static pressure, Leakage Class II, UL 555S classification, UL label, 24 volt normally closed electric actuator, and other items as applicable.

F. Install an insulated (R-6) access door in the ductwork adjacent to each fire, smoke or combination damper to provide ready access for replacing and/or inspecting fusible links and dampers. Access doors shall be a minimum of 16" x 12" in size where applicable. All access points shall be permanently identified on the exterior by a label having letters not less than 0.5 inches in height reading: SMOKE DAMPER or FIRE DAMPER. Access doors located in low-pressure ductwork shall be as manufactured by RUSKIN MFG. CO., VENTFABRICS CO., or approved equal.

G. Furnish and install where indicated on drawings ceiling radiation dampers and blankets on air distribution equipment installed in fire rated ceilings. Seal all openings around damper/duct sleeves in gypsum board ceilings. Radiation dampers and blankets shall be equal to RUSKIN MFG. CO. Model CFD and CFD(R) dampers as applicable with radiation blankets, or approved equal. Install all dampers in strict accordance with manufacturers and UL listed instructions.

2.10 BALANCING DAMPERS:

A. Install balancing dampers in the ductwork where indicated on drawings for primary balancing of the air distribution systems. Balancing dampers shall be opposed blade proportioning type volume dampers with locking type quadrants and indicating dials where applicable.

B. Balancing dampers shall be RUSKIN MFG. CO. Model MD-35 dampers or equal by ARROW UNITED, LEADER INDUSTRIES, NAILOR, NCA or POTTORFF.

2.11 ROUND DUCT BALANCING DAMPERS:

A. Install balancing dampers in all round ductwork run outs to sidewall or ceiling grilles for primary balancing of the air distribution systems. Balancing dampers shall be 20 gage galvanized steel single blade volume damper with locking hand quadrant, 2” standoff bracket and indicating dials.

B. Round duct balancing dampers shall be RUSKIN MFG. CO. Model MDRS-25 dampers or equal by ARROW UNITED, LEADER INDUSTRIES, NAILOR, NCA or POTTORFF.

2.12 PARALLEL BLADE SHUT-OFF DAMPERS:

A. Install parallel blade shut-off dampers in the ductwork where indicated on drawings. Parallel blade dampers shall have multiple blades, neoprene gasket blade edges, and shaft extensions for attaching damper motors where applicable. Damper motors for these dampers will be furnished by the Control Contractor as specified hereinafter.

B. Parallel blade shut-off dampers shall be RUSKIN MFG. CO. Model CD-35-PBE dampers or equal by ARROW UNITED, LEADER INDUSTRIES, NAILOR, NCA or POTTORFF.

C. Install insulated parallel blade low leakage shut-off dampers behind the intake louvers where indicated on the drawings. Parallel blade dampers shall have multiple blades, low-leakage neoprene gasket blade edges, and shaft extensions for attaching damper motors where applicable. Damper motors for these dampers will be furnished by the Control Contractor as specified hereinafter.

D. Insulated parallel blade low leakage shut-off dampers shall be RUSKIN MFG. CO. Model CD40x2 dampers or equal by ARROW UNITED, LEADER INDUSTRIES, NAILOR, NCA or POTTORFF.

2.13 AIR DISTRIBUTION EQUIPMENT:

A. Furnish and install air distribution equipment for the building as indicated on the plans. Air distribution equipment shall be METAL AIRE models, types and finishes as scheduled on the drawings, or equals by PRICE, AIR GUIDE, KRUEGER, CARNES, NAILOR, TUTTLE & BAILEY or TITUS. Air distribution equipment scheduled as aluminum construction shall be all aluminum construction including opposed blade damper.

B. Install turning vanes equal to BARBER-COLMAN CO. "Airturns" at all square elbows in the low-pressure ductwork. Also install air turning devices equal to BARBER-COLMAN CO. "Deflectrols" or KRUEGER MFG. CO. "Extractors" in the ductwork at all low-pressure duct takeoffs, registers, and diffusers as applicable.

C. Paint the interior of all ductwork located behind the air distribution equipment that is visible through grille, using two coats of flat black paint.

D. Metal back pans of all supply diffusers and sidewall register boots shall be insulated as specified hereinafter to reduce the possibility of condensation.

2.14 CONDENSATE DRAIN PIPING:

A. Provide galvanized steel pipe sleeves for piping wherever it passes through masonry partitions, walls, and floors. Seal openings between sleeves and pipes using 3M Brand fire protection products specifically approved for the particular usage, and installed in strict accordance with the manufacturer's recommendations. Where pipes pass through fire rated partitions seal penetrations as indicated on the details on the drawings.

B. Install chrome plated floor and ceiling plates around piping wherever it passes through walls, floors, ceilings, partitions, and equipment cabinets in exposed locations. Floor and ceiling plates shall be CRANE CO. No. 10-BC and No. 13-BC plates, or equals by GRINNELL CO. or BEACON AND CADWELL CO.

C. Condensate Drain Piping:

1. Condensate drain piping located inside the building, above ceilings, in walls and exposed above grade shall be Type “L” hard drawn copper. Connections shall be made with soldered wrought copper fittings, using 95-5 solder. Each drain line shall be full size of the drain connection on the unit (minimum) and shall have a 2-inch deep trap with a water seal. Provide cleanouts with removable threaded plugs in piping where indicated on drawings. Extend the condensate drain line to the nearest roof drain, floor drain, janitor’s closet as indicated on the plans. Drain piping shall maintain a minimum 1” per 10’ pitch.

2.15 HYDRONIC PIPING:

A. General:

1. Install 3/4" drains (minimum size) at all low points of water lines.

2. Pipe all equipment drains, blow-down lines, relief valve drains, condensate drains, etc., to floor drains in Equipment Rooms or as otherwise indicated on plans. Each drain shall terminate over a floor drain with an elbow turned down. Do not allow horizontal drain lines to rest on floors; provide pipe stanchions to support pipes.

3. Provide automatic air vents at all high points of the heating water and chilled water lines. Run drains from air vents to outside of building or to floor drains in Equipment Rooms, using ¼" copper tubing with ¼” copper elbow turned down.

4. Install ground joint unions in all water lines at each piece of equipment. Provide dielectric unions in piping where connecting dissimilar piping materials.

5. Provide for expansion of pipes by installing all necessary expansion fittings, swing joints, expansion loops, pipe anchors, guides, etc., as required. All runouts to equipment shall be made through swing joints in order to permit expansion of pipes without exerting any strain on the equipment.

6. Pitch all heating water and chilled water piping upward in direction of flow, unless otherwise indicated.

7. All takeoffs from heating water and chilled water mains for up-fed equipment shall be made from top of mains at 45° angles above the horizontal. Takeoffs for down-

fed equipment shall be made from bottom of mains at 45° angles below the horizontal.

8. Check water piping for leaks at two times the operating pressure but not less than 100 psi hydrostatic pressure, for 2 hours without any loss in pressure, before pipe insulation is applied or piping is concealed. Isolate all items of equipment not designed for the test pressure before pressure tests are put on systems.

9. All welded piping connections shall be made by competent welders, and shall comply with the latest codes and recommendations of the American Welding Society.

B. Above Grade Piping:

1. 2½" and larger heating water and chilled water piping located outside the building and within the building, shall be Schedule 40, seamless black steel pipe, ASTM A-106A with welded, ASTM A105 3000# fittings equal to Tube Turns.

2. 2" and smaller heating water and chilled water piping located outside the building and within the building shall be seamless Schedule 40 black steel piping, ASTM A-106A with screwed or welded, ASTM A105 3000# fittings at the option of the Contractor.

3. At the Contractor's option heating water and chilled water piping inside the building may be Type "L" hard drawn rigid copper pipe with soldered wrought copper fittings, using 95-5 solder.

4. Drain, overflow, and bleed-off piping for the cooling towers shall be Schedule 40 galvanized steel with either screwed galvanized malleable iron fittings or welded galvanized fittings.

C. Cleaning: The heating water and chilled water piping systems shall be cleaned per the following procedure.

1. After all testing and construction is complete and prior to the introduction of the chemical cleaner, each system shall be flushed, including mud and drip legs.
2. Remove, clean and replace all strainers.
3. Fill each system with the highest quality of water available.
4. Verify that all manual, electrical, air and thermostat operated valves are in full open position.
5. Verify all dead end runs have been looped together with piping not less than 1/3 size of run.
6. Verify that system has drain valves at all low points.
7. Add recommended quality of chemicals directly to each system to form a cleaning solution formulated to remove light grease, cutting oils, loose mill scale, organic and extraneous construction debris.
8. Circulate the system for 16 to 24 hours as recommended by the chemical manufacturer.
9. Blow off strainers, open and drain mud legs and low points every three (3) hours during cleaning process.

10. Completely drain the system, open all mud and drip legs, open all low point drains, remove, clean and replace all strainers.
11. Refill system with clean potable water, circulate for 6 to 10 hours.
12. Blow off strainers, open and drain mud legs and low points every three (3) hours during cleaning process.
13. Completely drain the system, open all mud and drip legs, open all low point drains, remove, clean and replace all strainers.
14. Refill system with clean potable water. Water treatment representative shall test water prior to the addition of corrosion inhibitor.
15. Add corrosion inhibitor within 48 hours of completion of cleaning.

2.16 PIPE HANGERS AND SUPPORTS:

A. Furnish and install pipe hangers and supports as specified below, or similar products as manufactured by GRINNELL CO., FEE AND MASON CO., ELCEN CO., or approved equal.

B. Support horizontal copper condensate drain piping at 6 foot intervals with pipe stanchions.

C. Support horizontal steel pipes and insulated copper pipes by means of split ring pipe hangers with adjustable swivels equal to GRINNELL CO. Figure 104 or FEE AND MASON CO. Figure 199, furnished in black malleable iron.

D. All hangers for horizontal pipes shall be spaced as follows:

Pipe Sizes	Max. Hanger Spacing	Pipe Sizes	Max. Hanger Spacing
1¼" and smaller	6 Ft. O.C.	4” to 6”	14 Ft. O.C.
1½" to 2"	8 Ft. O.C.	8" to 10”	18 Ft. O.C.
2½" to 3”	10 Ft. O.C.	12" & larger	22 Ft. O.C.

E. Support vertical steel risers and insulated copper risers at 8-foot intervals with GRINNELL CO. Figure 139 split ring extension hangers or Figure 261 riser clamps, furnished in black malleable iron.

F. Support vertical bare copper risers at 8-foot intervals and as otherwise required with split ring extension hangers equal to GRINNELL CO. Figure CT-130 or ELCEN Figure 398, furnished with a copper plated finish.

G. Where pipes must be run tight against steel beams and structural members provide trapeze type hangars with pipe clamps to secure pipes. Spacing for trapeze hangars shall be same as listed above for smallest pipe on trapeze.

H. Provide a protector saddle equal to FEE AND MASON CO. Figure 80 at each pipe hanger location for all insulated piping. Oversize pipe hangers so that they will extend around the pipe insulation and the protector saddles.

I. Support pipe hangers from the members of the floor construction where applicable, using hanger rods of sizes as recommended by the pipe hanger manufacturer. Furnish

and install all supplementary steel, framing members, beam clamps, hanger rods, inserts, etc., as required to properly support all pipe hangers and piping.

2.17 VALVES:

A. Valves shall be designed for 125 psi steam working pressure minimum, and valves bodies shall be stamped accordingly. Install all valves with stems above the horizontal.

B. Valves shall be JENKINS BROTHERS figure numbers as tabulated below, or similar products as manufactured by CRANE CO., LUNKENHEIMER CO., R. P. AND C. CO., or approved equal.

Type	Size	Screwed or Flanged	Body Materials	JENKINS Figure No.
Check Valves	2" and smaller	Screwed	Bronze	92A
Globe Valves	2" and smaller	Screwed	Bronze	106A
Gate Valves	2" and smaller	Screwed	Bronze	47

C. Ball valves shall be APOLLO CO. Model 77C bronze full port valves, with solid chrome-plated ball and multi-fill PTFE seats and seals.

D. Provide copper pipe adapters as required when going from screwed valves to soldered copper piping.

E. Label all valves in Equipment Rooms with Bakelite or bronze nameplates attached to valve handles with bronze chains and "S" hooks.

H. Provide a valve tag schedule framed under glass in the Main Mechanical Room listing all valve numbers and describing the valve function.

2.18 HOT WATER AND CHILLED WATER SPECIALTIES:

A. Furnish and install where indicated on the plans, heating water and chilled water specialties as specified below, or similar products as manufactured by TRANE CO., BELL AND GOSSETT CO., WATTS REGULATOR CO., HOFFMAN SPECIALTY CO., TACO CO., or approved equal.

1. Strainers	TRANE CO. "Y" basket type (with water baskets)
2. A.S.M.E. pressure relief valves	Watts Regulator Co. No. 174A
3. Automatic air vents	Hoffman Specialty Co. No. 79
4. Manual air vents	B&G No. 17 Sr.
5. Balancing valves	Rockwell Co. Fig. 142 and 143 "Permaturn" valves
6. Circuit setters	B&G Model CB
7. Expansion Joints	KEFLEX pipe expansion joints or equal by Metraflex.

8. Flow Control Valve	Griswold wafer type automatic flow control valve.

2.19 PRESSURE GAUGES:

Furnish and install pressure gauges in water lines where indicated on piping diagrams on the drawings. Gauges shall be stainless steel, high quality liquid filled type equipped with 4½" dials, pigtail siphons, shut-off cocks and appropriate dial graduations. Pressure gauges shall be ASHCROFT Model No. 1009 pressure gauges or similar products as manufactured by MARSHALTOWN MFG. CO., TAYLOR INSTRUMENT CO. or approved equal.

2.20 THERMOMETERS:

Furnish and install thermometers in water lines where indicated on piping diagrams on the drawings. Thermometers shall have a large digital readout, scale ranged as applicable for type fluid, clear acrylic plastic display cover, stem with adjustable angle hinge assembly for easy reading at any angle. Thermometers shall be solar type OMEGA series SPT10 or approved equal.

2.21 PIPE SLEEVES:

Wherever pipes pass through masonry walls, floors, and partitions, furnish and install galvanized steel pipe sleeves of sufficient size to allow bare pipes, or pipes plus insulation if applicable, to pass through easily. Seal openings between sleeves and pipes located in fire walls, floors, and partitions using DOW CORNING 3-6548 Silicone RTV Foam installed in strict accordance with the manufacturer’s recommendations. Seal openings between sleeves and pipes located in all other walls and partitions with approved waterproof compound.

2.22 INSULATION:

A. All insulation shall be installed in a workmanlike manner by qualified insulation mechanics in regular employ of a licensed Insulation Contracting Firm working in the capacity of a subcontractor under the H&AC Contractor. Install all insulation in strict accordance with the manufacturer's recommendations, using approved type laggings, adhesives, mastics, and other materials as applicable.

B. General:

1. Unless otherwise indicated, all insulation materials shall have a flame spread index of 25 or less and a smoke developed index of 50 or less when tested in accordance with the latest revision of ASTM E 84.

2. Laggings, adhesives, and mastics for the various insulating materials shall be as specified below, or similar products as manufactured by LION OIL CO., INSULMASTIC CO., BENJAMIN FOSTER CO. or approved equal.

3. Insulation shields are required at all hangers supporting piping. Wherever required to prevent pipe hangers from crushing the fiberglass insulation, install a

short section of cellular glass insulation at each pipe hanger location. Vapor seal joints between fiberglass and cellular glass insulation with vapor barrier mastic.

C. Pipe Insulation Materials:

1. The thermal conductivity of all insulation materials shall range from 0.22 to 0.28 Btu-in / (hr-sf-°F.). For insulating materials outside the conductivity range, the minimum thickness shall be increased to provide an equivalent overall “U” value.

2. Armaflex type pipe insulation shall be ARMSTRONG INSULATION’s “AP Armaflex SS”, or approved equal, a flexible closed-cell elastomeric foam. Joints and seams shall be sealed with Armstrong 520 Adhesive. Whenever possible, slide un-slit sections of insulation over the taped off open end of piping. Insulate all elbows and fittings with mitered segments of pipe insulation sealed with adhesive specified above. Insulation shall not be stretched (under tension) at joints and seams.

3. Fiberglass type pipe insulation shall be OWENS-CORNING’s SSL-II, UL rated "Fiberglas 25 ASJ", or approved equal, consisting of a fiberglass heavy density sectional pipe insulation with a noncombustible vinyl coated embossed vapor barrier laminate all service jacket secured with a pressure sealing double adhesive lap seal. Vapor seal end joints with joint sealing strips secured with pressure sealing adhesive. Insulate all elbows and fittings with mitered segments of fiberglass pipe insulation or molded insulation covers. Secure insulation to fittings as required and finish with insulating cement, "Fiberglas" reinforcing cloth, and fitting mastic as recommended by the manufacturer.

4. Cellular glass thermal type pipe insulation shall be PITTSBURGH CORNING’s “Foamglas” or approved equal with two layers of glass fabric jacket secured with 16 gauge copper wire on 9" centers. Insulate all elbows and fittings with mitered segments of pipe insulation. Vapor seal all seams and joints and cover glass fabric jacket with two heavy coats of LION OIL CO. "Seal-Kote" mastic, or equal, as required for a watertight installation.

D. Condensate Drain Piping Insulation:

Insulate condensate drain piping in all locations within the building using 1” thick fiberglass.

E. Hydronic Piping and Equipment Insulation:

1. Chilled Water Piping (CHW):

Insulate chilled water piping in all locations within the building using 1½" thick fiberglass pipe insulation for pipes up to 5” and 2” thickness for pipes 6” and larger.

2. Heating Water Piping (HHW):

Insulate heating water piping in all locations within the building using 1" thick fiberglass pipe insulation for pipes up to 1½” in diameter and 2” thickness for pipes larger than 1½” diameter.

F. Duct Insulation:

1. Fiberglass duct wrap: OWENS-CORNING SoftR duct wrap, Type 100, 1 lb./cu.ft. density with 2 mil thick reinforced foil/kraft (FRK) vapor retarder facing (0.05 perm maximum), or equal by KNAUF, CERTAINTEED or MANVILLE. The manufacturer's name, installed thickness, "R" value, flame spread and smoke developed indexes of the insulation shall be printed at 36" intervals on the exposed surface of the insulation.

a. Insulate around the exterior of all concealed medium pressure sheet metal supply (not double wall sections) air and outside air ductwork as well as all rigid round sheet metal ductwork run outs and all associated sheet metal transitions, fittings, etc., using 2" thick duct wrap insulation (minimum installed R-value of 6.0).

b. Apply insulation to ductwork with 4" strips of insulation bonding adhesive at 8" on centers. Adjacent sections of duct wrap insulation shall be tightly butted with the 2" stapling and taping flap overlapping. Seams shall be stapled on 6" centers with 1/2" steel outward clinching staples. All seams and joints as well as any tears, penetrations or punctures shall be sealed with glass fabric tape and fire resistant vapor barrier mastic equal to MM-225. Duct tapes shall not be used to seal joints and seams.

c. Where rectangular ducts are 24" in width or greater, duct wrap insulation shall be additionally secured to the bottom of the duct with mechanical fasteners such as pins and speed clip washers, spaced on 18" centers to prevent sagging of insulation.

2. Closed cell foam duct liner: ARMACELL "AP Armaflex SA black" closed cell elastomeric foam duct liner or approved equal.

a. For low pressure supply, return and transfer air ductwork located inside the building the duct liner shall be 1" thick, R-4.0 type insulation.

b. All duct liner insulation shall be formaldehyde-free, fiber free and resistant to mold and mildew.

c. Apply duct liner to interior of thoroughly cleaned sheet metal ductwork using self adhesive as recommended by the insulation manufacturer. Butt joints require the use of compression joints to prevent the possible opening of seams.

d. Closed cell foam duct liner shall meet ASTM C 177 or C 518 for thermal conductivity, UL 181 for mold growth, ASTM G21 for fungi resistance, ASTM G22 for bacteria resistance and NFPA 90A and 90B for duct coverings and linings.

e. Ductwork shall be oversized to accommodate duct liner insulation. Liner shall be interrupted at the area of operation of a fire damper and 6" upstream and 6" downstream of electric-resistance and fuel-burning heaters in the duct system. Metal "nosings" or sleeves shall be installed over exposed duct liner

edges that face opposite the direction of airflow as recommended by the insulation manufacturer. Provide duct wrap type insulation at all interruptions in the duct liner installation.

G. Air Distribution Equipment Insulation:

Insulate the back pan (top) side of all supply diffusers and sidewall registers using 2" thick, 1 lb density duct wrap insulation.

2.23 PAINTING:

H. & A.C. Contractor shall thoroughly clean insulation jackets on all applicable mechanical equipment and on new insulated piping in the existing Basement Mechanical Room, and he shall apply two coats of SHERWIN-WILLIAMS CO. No. 29-34 industrial enamel of colors selected by the Architect, or approved equal by GLIDDEN CO. Thoroughly clean all bare exposed piping, pipe hangers and other unfinished metal work in the Mechanical Rooms and prime and paint as specified above.

PART 3 - EXECUTION

3.01 LABELING OF EQUIPMENT:

A. Label all piping in mechanical rooms, above "lay-in" ceilings and all other accessible locations using SETON NAMEPLATE Setmark "Snap-Around" pipe markers, or equals by T&B/WESTLINE PRODUCTS, BRIMAR or BRADY. Pipe markers shall conform to Scheme for Identification of Piping Systems (ANSI A13.1-1956). Each marker shall show the name of the fluid in the pipe and a directional flow arrow, both superimposed on one of the five basic background colors. Pipe markers shall be installed at each service valve, at each mechanical item of equipment, at 15 foot intervals on horizontal runs of piping and at midpoints of risers on vertical piping.

B. All mechanical items of equipment installed under this contract shall be permanently labeled with Bakelite or bronze nameplates for identification purposes. Nameplates shall be securely attached to the respective items of equipment and the numbering sequence of the various items shall correspond with the numbering sequence used on the mechanical drawings. Unit mounted labels for refrigerant containing equipment shall comply with the Standard Fire Prevention Code Chapter 28. Approved manufacturers are SETON NAME PLATE, T&B/WESTLINE PRODUCTS or BRADY.

C. All mechanical items of equipment installed under this contract shall have the area(s) they serve permanently labeled on the unit next to the nameplate provided above.

D. Equipment installed above "lay-in" type ceilings shall have their locations identified with nameplates secured to the ceiling grid bars. Type of nameplates and labeling shall be approved by the Architect.

E. All valves shall be labeled as specified under paragraph entitled "Valves". Install a Valve Tag Schedule framed under glass in the Main Mechanical Equipment Room listing each valve and its function.

3.02 AS-BUILT DRAWINGS:

The H&AC Contractor shall maintain on the job site one complete set of the mechanical prints for this project. All changes relating to the locations, sizes, etc., of piping, ductwork and other mechanical equipment shall be indicated in red pencil on the mechanical prints as the work progresses. The set of “As-Built" prints shall be delivered to the Architect at project close out.

3.03 ELECTRICAL WORK:

A. The Electrical Contractor will provide the following for the mechanical equipment:

1. A source of power as required for each electric motor and for each electrical heating and cooling item of equipment installed under the mechanical contract, including final wiring connections to motor terminals or to terminals in a control panel mounted on each respective unit.

2. Circuit breaker protection as required for each electric motor and for each electrical heating and cooling item of equipment installed under the mechanical contract.

3. Wiring each electric motor and each electrical heating and cooling item of equipment (where applicable) through a magnetic starter or a magnetic contactor furnished by the H&AC Contractor.

4. A 120 volt source of power at a panel box in the electrical room for control circuits.

5. A 120 volt source of power for each damper motor.

6. Wiring each exhaust fan motor through a firestat, wall switch, thermostat and/or a magnetic starter (as applicable) furnished by the H&AC Contractor.

B. Should the H&AC Contractor propose to use any item of mechanical equipment that has different electrical requirements from those specified on the schedules on the drawings or elsewhere, the Contractor shall be responsible for coordinating these changes with the Electrical Contractor, and he shall reimburse the Electrical Contractor for all additional costs necessitated by these changes.

C. In general, the Electrical Contractor will do all power wiring for the mechanical equipment as described above, and the H&AC Contractor shall do all control and interlock wiring, unless otherwise specified or indicated on the drawings.

D. Consult the electrical drawings to determine the exact extent of electrical work provided for the mechanical equipment. Verify the current characteristics with the Electrical Contractor before ordering any equipment for this project. Failure to confirm voltage requirements for mechanical equipment with the electrical contractor shall result in the H&AC Contractor bearing any cost associated with changes stemming from incorrect voltages on this project.

E. H&AC Contractor shall furnish and install all other wiring, not covered above, that is necessary for a complete and operating heating and air conditioning system for the building(s), including all control wiring, interlock wiring, conduit, relays, controls, starters, disconnect switches, circuit breakers, control conduit and outlet boxes, wiring of all applicable control items of equipment, and other electrical work as required.

F. All wiring shall be run in galvanized or sherardized rigid electrical conduit or in EMT where allowed under the Electrical section of the specifications, and shall be concealed in finished areas and occupied spaces, unless otherwise approved by the Architect. Wiring shall have Type THW insulation, and shall be No. 12 AWG minimum for power wiring and No. 16 AWG minimum for control wiring. Seal all openings around electrical conduit located in partitions, walls and floors using 3M Brand fire protection products specifically approved for the particular usage and fire rating (where applicable), and installed in strict accordance with the manufacturer's recommendations.

G. All electrical work required under this contract shall comply with the latest edition of the National Electrical Code, and shall meet all local requirements. All electrical equipment shall bear UL labels where applicable.

H. All starters for the mechanical equipment shall be furnished with "Hand-Off-Automatic" devices so that the various items of equipment may be operated manually or automatically as desired. Each starter shall also be furnished with motor overload protection in each electrical power phase to provide full protection for the respective electric motor.

3.04 HVAC CONTROLS:

A. Furnish and install a complete system of web based Metasys DDC controls as manufactured by JOHNSON CONTROLS for all new mechanical equipment installed under this contract as specified below. No exceptions for using an alternative controls contractor will be allowed. All new controls shall tie into the campus wide energy management system.

B. Sequence of Operations:

1. Central Station VAV Air Handling Unit:

a. Occupied Mode

1. The AHU shall be controlled by the EMS for start/stop of fan, temperature control and scheduling. The units shall be started through the EMS by operator command. After starting, the units shall operate based on TOD schedule in EMS software.

2. Supply Fan - When the AHU is in the Occupied Mode, the supply fan will operate continuously with varying supply airflow (via the VFD) to maintain the necessary differential pressure in the medium pressure ductwork to provide the proper airflow through the VAV boxes. The sensor to detect the duct static pressure shall be 3/4 the way down the medium pressure duct (see the location indicated on the drawings). The EMS software shall continuously monitor the S.P. setpoint and adjust the value for this control (to increase

airflow, when required). The flow shall be increased if periodic polling of all VAV's in the system determine that air valves in the VAV's are at full open, the AHU is receiving 45°F chilled water, and the VAV's are not achieving their design airflow or their thermostat settings.

3. Cooling Controls - In the Cooling Mode the CHW control valve shall control cooling capacity by modulating the flow through the cooling coil to maintain a constant chilled water coil LAT set point based on a chilled water coil LAT sensor. The EMS shall reset the LAT upwards in l°F increments, as required, if terminal units are not requesting additional cooling (for an operator defined period of time) if the supply air flow at terminals are at testing values and the thermostat set point cannot be maintained.

4. Heating Controls - Heating by the AHU occurs at the reheat coil and is only performed in the cold weather when all spaces are demanding heating and the outdoor ambient conditions cause the mixed air temperature to fall below 55°F. In the Heating Mode the HHW control valve shall control heating capacity by modulating the flow through the heating coil to maintain a constant air handling unit LAT set point of 90°F based on an air handling unit LAT sensor.

b. Filter: A differential pressure switch across the filter shall initiate a filter alarm when the pressure drop across the filter reaches the setpoint as shown.

c. Unoccupied Mode

1. When the zone will be unoccupied the EMS shall control the AHU to provide setback (or setup) temperature setpoints for unoccupied periods to allow control at 82°F (adjustable) in the summer and 60°F (adjustable) in the winter. Scheduling shall be with non-volatile, 30 minute battery backed up memory based on the night/weekend/holiday software schedule.

2. Include appropriate warm up and cool down routines to return the building to normal temperatures before occupants return to the building.

3. The AHU control sequence, with the exception of the setpoint adjustments indicated in Unoccupied Mode paragraph "1." herein, shall be similar to the Occupied Mode, as appropriate.

d. Dehumidification

1. When the building relative humidity rises above 62% (adjustable), the chilled water coil leaving air temperature shall be reset to 55°F and the air handling unit leaving air temperature shall be reset to 70°F until the relative humidity drops below 54% (adjustable) or the VAV thermostat begin calling for cooling.

e. Fire Alarm Override

1. When the smoke detector in the return air duct senses smoke, the unit shall shut down by the EMS and a fire alarm signal shall be sent to the Fire Alarm Panel.

f. Freeze Protection Override

1. A freeze stat (provide averaging type sensor) shall be provided upstream of the cooling coil. If this sensor detects a fall in air temperature below 38°F the EMS shall deactivate the unit fan, open the chilled water valve to the coil and send an alarm signal to the BCS operator. Upon a return to ambient temperatures above 42°F the override shall be deactivated.

2. VAV Boxes: The fan powered VAV boxes shall operate in conjunction with the two modes of operation defined for the AHU. In the heating mode the air valves shall be closed to the minimum supply air position (refer to the mechanical schedule for this value) and the VAV box fan shall be energized.

a. During the Occupied Mode of operation

1. The cooling set point temperature of the wall mounted temperature sensor shall be maintained by varying the quantity of primary air.

2. The heating set point temperature of the wall mounted temperature sensor shall be maintained by positioning the primary air valve to the minimum set point, energizing the VAV box fan and opening the heating coil control valve to maintain the set point temperature.

b. During the Unoccupied Mode of operation the primary air valve shall be positioned to the minimum set point position and the fan shall cycle to maintain the wall mounted sensor set point temperature.

1. Cooling is provided only when the AHU is energized to satisfy the set up sensor temperature set point of 82°F. (fully adjustable).

2. Heating is provided to maintain the set back sensor temperature set point of 60°F. (fully adjustable) by positioning the primary air valve to zero, energizing the VAV box fan and opening the heating coil control valve to maintain the set point temperature.

3. Variable air volume terminal units shall modulate the primary air valve in response to the wall mounted temperature sensor setpoint temperature. Air valves shall return to the minimum airflow position when there is no demand for cooling.

3. Smoke Detectors:

Install a duct type ionization smoke detector furnished by the Electrical Contractor in the return ductwork (prior to dilution by outside air) of each heating and cooling system. Provide control wiring as required to shut down the unit fan motor and system within 10 seconds if combustion gases or smoke is detected in the return ductwork.

4. Fans:

a. All exhaust fans shall be manually controlled from their respective wall switch, light switch or thermostat installed in the space the fans are serving unless indicated otherwise on drawings.

C. General:

1. Five (5) copies of complete submittal data including equipment specifications, control wiring diagrams, schematic or ladder diagrams, internal connections, and sequences of operation shall be furnished to the Architect for approval before the control installation is begun.

2. All control wiring required for this installation is included in this contract, and shall be color-coded and run in conduit. Conduit, wiring sizes, and type of insulation shall be in accordance with paragraph entitled "Electrical Work", and shall conform to the latest National Electrical Code. All control equipment shall bear UL labels where applicable. Control circuits shall be run from the control panels to all controls as required, and each control circuit shall be protected by a circuit breaker of the proper size.

3. Install all room thermostats and switches 4’ - 0” above finished floors as set forth in ADA requirements. All room thermostats shall have thermometers, set point adjusters calibrated in degrees Fahrenheit, tamper-proof features, and adjustable dead bands between the heating and cooling cycles where applicable.

4. The Control Contractor shall be a licensed authorized franchised dealer for the control manufacturer whose controls he proposes to use on this project.

5. Control installation shall be made by trained mechanics in the regular employ of the Control Contractor.

6. The Control Contractor shall install, adjust, calibrate, and place in satisfactory operation the entire control system furnished by him. Label all items of control equipment with bakelite nameplates.

7. "As-Built" control drawings shall be included in the Operation and Maintenance Manuals, and shall also be framed under glass and posted where directed by the Architect and/or the Owner.

3.05 REMOVAL OF EXISTING MECHANICAL EQUIPMENT:

A. The H&AC Contractor shall remove all existing mechanical equipment and materials located within the building that are not to remain in place under this contract as indicated on the drawings and as applicable. Equipment and materials to be removed from the building shall include through the water piping, fin tubes, valves, fittings, ductwork, VAV boxes, controls and other associated equipment and materials as indicated on the drawings, as applicable, and as required. Drain water from any piping not removed that may be subjected to freezing. Cap all piping that is to remain in place as required, capping piping above ceilings, below floors, and in equipment spaces as applicable.

B. The contractor shall deliver to the Owner in re-usable condition any mechanical equipment and materials removed that the Owner wants. These items shall be delivered

to sites on the campus as designated by the Owner. Any equipment and materials that the Owner does not want shall be promptly removed from the premises by the Contractor.

C. Schedule all work with the Owner well in advance so as not to interfere with the normal operation of the existing building.

D. The contractor is urged to visit the job site prior to submitting a bid for this work, in order to familiarize himself with the existing mechanical equipment to be removed, and to verify all existing conditions that are related to this contract.

3.06 PERFORMANCE TESTS:

A. Testing and balancing of the air and water systems shall be done by an independent test and balance agency as specified in a subsequent paragraph.

B. The contractor shall furnish competent personnel and necessary testing instruments and equipment to check, test, operate and balance the mechanical systems as installed. Tests shall be of sufficient duration to prove adequacy and satisfactory performance of all items of equipment.

C. Clean all equipment and nameplates, and lubricate all motors and bearings as required.

D. The H&AC contractor shall provide temporary air filters in all equipment upon initial start-up. These filters shall be replaced or cleaned regularly for as long as the equipment is in operation. One clean set of air filters furnished by the various equipment manufacturers shall be installed inside the respective mechanical items of equipment just prior to final inspection, and all extra sets of air filters shall be delivered to the Owner prior to final acceptance of the project.

E. Have the Control Contractor adjust and set all thermostats and other control items of equipment as required, and submit to the Engineer record copies of the Control Contractor's certification that all specified control items of equipment have been installed, calibrated, programmed and are operating properly.

F. Furnish to the Architect and the Engineers record copies of Testing and Balancing Agency's reports and the factory start-up service reports.

G. Adjust and set with instruments the specified air quantity at each register, grille and diffuser in the building as applicable and as required to maintain relatively uniform space temperatures throughout the areas of each zone. Record data and submit copies of test and balance reports to the Architect for review.

H. Adjust and set with instruments the specified air quantity at each exhaust grille and exhaust fan. Record data and submit copies of test and balance reports to the Architect for review.

I. Check all safety relief valves, high limit and low limit controls, freeze protection controls, low water cut-offs, electronic relays and all other safety devices to determine if they are functioning properly.

J. Thoroughly clean, flush, fill and test all water piping systems as specifically recommended by the various equipment manufacturers, as required, and as specified above. The H&AC Contractor shall furnish and install chemical treatment as necessary. Treatment shall include chemicals to control algae and corrosion. Contractor shall monitor system chemicals and submit reports to Architect and Engineer at 3-month intervals during first year warranty. Contractor shall add/adjust chemicals as required during warranty period at no cost to Owner.

3.07 TRAINING OWNER'S PERSONNEL:

A. The contractor shall furnish the services of a competent engineer or mechanic to thoroughly train and instruct the Owner's personnel in the proper operation and maintenance of all mechanical items of equipment installed under this contract.

B. The contractor shall obtain and deliver to the Engineer copies of the following statement signed by the Owner's maintenance Superintendent or his authorized representative:

> "This is to certify that our personnel have been thoroughly trained and instructed in the proper operating and maintenance procedures for all mechanical equipment installed under this contract for the new buildings."

Signed: _____

Title: _____

Date: _____

3.08 TESTING AND BALANCING OF MECHANICAL SYSTEMS:

A. The H&AC Contractor shall employ the services of a licensed independent Testing and Balancing Agency, which is NEBB or AABC certified, to do all testing and balancing of the air and water systems installed under this contract as specified below and as required. Test and Balance procedures shall comply with ASHRAE Standard 111. Testing and Balancing Agency shall be Carolina Air and Water Balancing Co., Hall Technologies, Palmetto Air and Water Balancing Co., Hilton Services or approved equal.

B. Work to be performed by the Testing and Balancing Agency shall include but is not necessarily limited to the following items:

1. Adjust and record the supply air, return air and outdoor air quantities for the air handling unit

2. Check and record the inlet and outlet static pressures for the air handling unit.

3. Adjust and record the air quantities for all air distribution equipment, supply, return, exhaust, etc. in accordance with the air quantities specified on the drawings within +/- 10 %).

4. Check and record static pressures at the inlet and discharge of each VAV terminal box.

5. Adjust and record the exhaust air quantity and the static pressure for each exhaust fan.

6. Record the entering and leaving air temperatures for each the air handling unit. Record these temperatures in both the heating and cooling cycle.

7. Adjust circuit setters for all hot water heating coils and chilled water cooling coils in accordance with the water quantities specified on plans, and record GPM`s, entering and leaving water temperatures.

8. Adjust balancing valves and/or circuit setters in the various water piping systems in accordance with the water quantities specified on plans, and record GPM`s.

C. Testing and balancing report for each mechanical unit shall include the equipment manufacturer, model number, serial number, nameplate amperage and actual running amperage for each motor, design and actual air quantities, temperatures and static pressures as listed above, spaces served by the mechanical unit and other pertinent data as applicable.

D. Submit record copies of all testing and balancing reports for the air and water systems to the Architect. Copies of these reports shall also be included in the Operation and Maintenance Manuals.

3.09 OPERATION AND MAINTENANCE MANUALS:

A. The contractor shall furnish the Owner through the Architect two complete sets of Operation and Maintenance Manuals containing the following data neatly compiled and indexed in hard cover 3-ring binders:

1. Shop drawings, specification sheets and/or descriptive literature on all equipment and materials installed under this contract.

2. Operating and maintenance instructions for all mechanical items of equipment installed under this contract. Compile manufacturer’s information into a weekly/monthly/yearly maintenance and lubrication schedule for all mechanical equipment. Include information such as bearing type, lubrication type, belt sizes, filter sizes, etc. and safety precautions where applicable.

3. Name, address and telephone number of supplier for each mechanical item of equipment.

4. Name, address and telephone number of persons to contact for service on mechanical equipment.

5. Manufacturers' written warranties for all applicable mechanical items of equipment.

6. "As-Built" control drawings.

7. Control Contractor's certificate.

8. Start-up service reports.

9. Test and balance reports.

10. Valve Directory.

11. Nameplate Directory for all mechanical equipment.

3.10 GUARANTEES:

A. Unless otherwise specified above, the H&AC Contractor shall guarantee that all equipment, materials and workmanship covered by this contract shall be free from defects of any nature for a period of one year from the date of acceptance of the installation by the Architect. He shall guarantee that all equipment and materials as installed by him meet specified capacities, ratings and quality standards.

B. The contractor shall service all equipment installed by him under this contract for a like period of one year.

C. The contractor shall guarantee the mechanical system as installed by him to operate quietly, safely and efficiently.

END OF SECTION