SECTION 15800

HEATING VENTILATING AND AIR CONDITIONING

1. PART 1 GENERAL

1.1. SUMMARY

1.1.1. Work under this section includes providing material and equipment related to Heating, Air Conditioning and Refrigeration systems.

1.1.2. Provide complete Mechanical Submittals and Shop drawings. Refer to Section 15010 paragraph 1.4 Submittals - Shop Drawings/Product Data/Material Certifications.

1.2. RELATED SECTIONS

1.2.1. Section 15010 General Provisions

1.2.2. Section 15250 Mechanical Insulation

1.2.3. Section 15400 Plumbing

1.2.4. Section 15900 Controls

1.3. DEFINITIONS

1.3.1. Ductwork Sizes: Inside clear dimensions. For acoustically lined and internally insulated ductwork, maintain ductwork sizes inside lining or insulation.

1.3.2. Low Pressure: Static pressure in duct 2" water gauge or less, velocity 2000 fpm or less.

1.4. EQUIPMENT AND COMPONENTS REVIEW

1.4.1. Only equipment and components of those manufacturers indicated in this specification are acceptable.

1.4.2. Products of manufacturers which have not previously been thoroughly reviewed and accepted by the Mechanical Engineer before the bidding period will not be considered.

1.5. SUBMITTALS

1.5.1. Comply with specification Section 15010 General Provisions.

1.5.2. Required Complete Submittals

1.5.2.1. Duct work fittings and accessories.

1.5.2.2. Sealant.

1.5.2.3. Access panel and doors.

1.5.2.4. Grilles, registers, and diffusers.

1.5.2.5. Filters.

1.5.2.6. HVAC units.

1.5.2.7. Exhaust fans.

1.5.2.8. Fire/smoke dampers and smoke detectors.

1.5.2.9. Vibration Isolation products.

1.5.2.10. Refrigeration piping and piping supports.

1.5.2.11. heating water piping, pumps and accessories.

1.5.2.12. VAV boxes.

1.5.2.13. Water treatment equipment. Manufacturer's catalog information and recommended chemicals and their application for each system.

1.5.2.14. Provide LEED commissioning of HVAC systems.

1.5.3. Required Shop Drawings

1.5.3.1. Routing of all duct and piping systems.

1.5.3.2. Equipment layout with vibration isolation.

2. PART 2 - PRODUCTS

2.1. SHEET METAL

2.1.1. Unless otherwise specified, sheet metal used for duct and plenum construction shall be G90 coated galvanized steel of lock forming grade conforming to ASTM standards A-653-94. All duct work and supports shall be galvanized. All sheet metal round duct shall be round spiral lock-seam construction. "Knock down" (KD) duct is not acceptable.

2.1.2. The gauge of the duct and its construction shall be based on low pressure or medium pressure or low or medium velocity. The velocities can obtained by the duct size and CFM values listed on the drawings. The static pressure for various systems is listed on the mechanical equipment schedule. Refer to the SMACNA standards for the correct duct construction based on the velocities and static pressures involved.

2.1.3. Sealing of Duct Work: All supply and return duct work from mechanical units, all exhaust duct work and all outside air duct work shall have a high pressure Class A seal per SMACNA.

2.1.4. Alumiflex type duct will not be permitted on this project. All duct is to be rigid galvanized sheet metal.

2.1.5. Exposed round ductwork shall be equal to United McGill Round Uni-Light spiral duct, manufactured from G90 galvanized sheet steel meeting ASTM A-653-94 (lock forming quality) or equal. The duct and fittings shall be assembled with United Uni-Ramp joints or equal, using sheet metal screws.

2.1.6. All ductwork, fittings, transitions, and hangers exposed to view shall be painted. Provide primer and final coat on all exposed to view ductwork. The color of the final coat of paint shall be selected by the Architect.

2.1.7. All fittings shall be standard design fittings of the same manufacturer as the duct. Branch takeoffs shall be set at 45° to the trunk duct in the direction of the air flow, with factory made fittings. All reductions in duct size shall be made in factory fabricated reducing fittings. Elbows with heel taps are not acceptable.

2.1.8. All factory fabricated fittings and joints must be joined using sheet metal screws and duct sealing compound. Ducts made up with sealer shall have a minimum of 2" overlap and sealed with duct sealing compound applied to both parts for the full length of the overlap.

2.1.9. Clothes dryer exhaust ducts to be constructed of galvanized steel duct. Clothes dryer exhaust ducts shall not have fasteners or other projections into the air stream.

2.2. FLEXIBLE DUCT

2.2.1. Flexible duct shall only be permitted in concealed tee bar ceilings and at the end of duct run-outs to diffusers or grills. No flex duct shall be exposed to view. The maximum flex length shall be 7 feet.

2.2.2. Flexible ducts shall be installed in as straight a manner as possible. Avoid bends with inside radius of less than one duct diameter. Cut ducts to length required, rather than using bends to take up slack.

2.2.3. Flexible duct shall comply with the UL 181 Class I requirements of the current edition of the California Mechanical Code with a flame spread rating 25 or less and smoke developed rating not higher than 50.

2.2.4. All flexible ducts shall be insulated. Insulation shall be fiberglass with "R" value of 8.

2.2.5. Flexible Ductwork – Manufactured with a fiberglass scrim reinforced, metallized polyester jacket and polymer water proof liner. Duct shall be factory made and consist of an interior liner that is moisture proof. Interior liner material shall polymer type. Interior liner shall be air and water tight.

2.2.6. Flexible Ductwork shall be ATCO UPC #031 (R-8) UL 181, Class 1 Air Ducts or equal. Flex duct shall have R-8 double-layer core of each product is wrapped in multiple thicknesses of fiberglass insulation. Jacket shall have rugged and durable fiberglass scrim reinforced, metallized polyester jacket.

2.2.7. Flexible Duct work - All thermal performance (R-Values) are classified by Underwriters Laboratories in accordance with ADC Flexible Duct Performance and Installation Standard (1991) using ASTM C-518 (1991), at installed wall thickness, on flat insulation only. Rated Positive Pressure: 10" w.g. per UL-181 (UL Listed pressure) ratings are determined in straight lengths @ ambient temperatures.) Recommended Operating Pressures: (Determined in a 90° bend at elevated temperatures in accordance with ADC FD 72-R1 Test Code.) Maximum Positive: 6" w.g. - 4" thru 12" Dia. 4" w.g. - 14" thru 20" Dia. (With factory installed metal collars, 2" w.g. - all diameters). Maximum Negative: 3/4" w.g. - all diameters. Maximum Velocity: 5,000 FPM.

2.3. ROUND DUCT TAKE-OFF FITTINGS

2.3.1. Take-off fittings for all rigid round ducts shall be at 45 degree angles to the main duct or use bellmouth fitting. Provide quadrant damper at duct take-off fitting unless otherwise specified.

2.4. DUCT SEALANT

2.4.1. Acceptable manufacturers are Ductmate - PROseal and FIBERseal and Sealing System by Hardcast, Inc.

2.4.2. Metal to Metal - Duct sealer shall be flexible and self-curing and comply with UL723 and UL 181B.

2.4.3. Flex Duct - Duct sealer shall be flexible and self-curing and comply with UL723 and UL 181B-M.

2.4.4. Sealant shall be have a flame spread less than 25 and the smoke developed less than 50 when dry.

2.5. ACCESS PANELS AND DOORS

2.5.1. Acceptable manufacturers are Vent fabrics, Inc., C. E. Sparrow Co. and Elmdor MFG.

2.5.2. Access panels in sheet metal work shall consist of three one-piece stampings: the door frame, the door itself and the pan. Space between door and pan shall be filled with 1" thick insulation. The door shall be hung with loose pin hinges.

2.5.3. Access panel sizes shall be as follows unless otherwise specified on drawings:

Size of Duct to be Accessed	Panel Size	Metal Gauges of Frame	Door	Pan
6" - 8"	6" X 8"	24	26	28
10" - 12"	10" X 12"	22	24	28
12" - 16"	12" X 16"	20	24	28
18" and over	16" X 24"	20	22	28

2.5.4. Access doors shall be fabricated in accordance with the details in the SMACNA Duct Construction Standards. Latches and hinges shall be equal to Ventlok of appropriate type and size.

2.6. TURNING VANES

2.6.1. Acceptable manufacturers are Tuttle & Bailey, Barber-Colman and Aero/Dyne.

2.6.2. Turning vanes shall be double-walled and formed to assure that any point on one blade is equidistant from the same point on an adjacent blade.

2.7. BACKDRAFT DAMPERS

2.7.1. Gravity backdraft dampers shall be fabricated multi-blade, parallel action, gravity balanced backdraft dampers of galvanized steel or extruded aluminum, with center pivoted blades linked together; with sealed edges, steel ball bearings, and plated steel pivot pin.

2.8. FIRE/SMOKE DAMPERS

2.8.1. Acceptable manufacturers are Pottorff, Ruskin, Air Balance Inc. or Greenheck.

2.8.2. Provide combination fire/smoke dampers where shown on the drawings.

2.8.3. WALL AND CONCRETE FLOOR INSTALLATIONS

2.8.3.1. TYPE 1: SMOKE CLOSURE "MOTOR", FIRE CLOSURE "FUSIBLE LINK"

2.8.3.1.1. Combination fire/smoke dampers will be louver bladed type. Dampers must be tested and listed under both UL 555 and UL 555S. Units must be factory supplied assemblies that consist of damper, sleeve and 1 cycle/year actuator. Dampers must have a minimum class II leakage and dynamic closure rating under UL 555S. Provide units as power-open unless otherwise noted. Actuators to have a minimum operating temperature of 350° F. Seals should be metal to metal without the use of synthetic gasket. Fusible links shall be rated for 212° F, unless otherwise noted. Install in accordance with manufacture's installation instructions provided with units. Provide suitable access for inspection and servicing of each damper. Provide integrated CSFM listed duct smoke detector model 2151 or DH-100 AC/DC "except in the city of LA".

2.8.3.1.2. Motor actuators must be by ISO 9000 recognized control manufacturer and certified by ETL laboratories for 1 year continuous power applications such as Invensys, Siemens and Honeywell. Inexpensive stall motors will not be accepted.

2.8.3.1.3. Provide units with dual position indicator switches for remote annunciation. Pottorff model FSD 142, CSFM No. 3225-0368:110 & 3230-368: 111 or equal.

2.8.3.2. TYPE 2: FIRE/SMOKE CLOSURE "MOTOR W/ BIMETAL LINKS"

2.8.3.2.1. Combination fire/smoke dampers will be louver bladed type. Dampers must be tested and listed under both UL 555 and UL 555S. Units must be factory supplied assemblies that consist of damper, sleeve and 1 cycle/year actuator. Dampers must have a minimum class II leakage and dynamic closure rating under UL 555S. Provide units as power-open unless otherwise noted. Actuators to have a minimum operating temperature of 350° F. Seals should be metal to metal without the use of synthetic gasket. Dual temperature thermal switches (DRS-30) rated for 212° F & 350° F , unless otherwise noted. Install in accordance with manufacture's installation instructions provided with units. Provide suitable access for inspection and servicing of each damper. Provide integrated CSFM listed duct smoke detector model 2151 or DH-100 AC/DC "except in the city of LA".

2.8.3.2.2. Motor actuators must be by ISO 9000 recognized control manufacturer and certified by ETL laboratories for 1 year continuous power applications such as Invensys, Siemens and Honeywell. Inexpensive stall motors will not be accepted. Dual temperature thermal switches shall be equipped with auxilery contacts for remote annunciation. Pottorff model FSD 142, CSFM No. 3225-0368:110 & 3230-368: 111 or equal.

2.8.4. Each combination fire/smoke damper shall meet all requirements specified for fire dampers and additionally shall include an operating shaft which, when rotated 90 degrees, causes damper to operate between closed and open. Operating shaft and damper combination shall be suitable for linking to an operation by any standard low voltage electric damper operator having sufficient torque characteristics.

2.8.5. Provide a duct smoke detector and provide control wiring and conduit for each combination fire/smoke damper per California Uniform Building Code requirements.

2.9. DUCT MOUNTED SMOKE DETECTORS

2.9.1. HVAC combined systems with over 2,000 CFM serving a single space.

2.9.1.1. Provide a duct mounted smoke detector in supply air plenum or in main supply air duct (before any branch ducts) in accordance with current California Mechanical Code Section 609.

2.9.1.2. Provide a duct mounted smoke detector that will upon detection of smoke shut down the supply fan of HVAC or HV unit when smoke is detected in the supply air duct.

2.9.1.3. Provide control wiring and conduit from smoke detector to the HVAC unit controls.

2.9.1.4. The smoke detector shall be provided by the Fire Alarm Contractor with a set of auxiliary contacts.

2.9.2. Fire/Smoke Damper

2.9.2.1. Provide a duct mounted smoke detector for each fire/smoke damper that will upon detection of smoke shut the fire/smoke damper and shut down the HVAC or HV associated with this fire/smoke damper when smoke is detected in the supply air duct.

2.9.2.2. The smoke detector shall be provided by the Fire Alarm Contractor with a set of auxiliary contacts.

2.9.2.3. Duct mounted smoke detectors for fire/smoke dampers shall include as additional key controller test and reset switches plus an easily accessible test jack shall be provided. The key controller test unit shall have self-contained power supply requiring 120 volt or 24volt. Coordinate type and voltage with Division 16.

2.9.3. Smoke detector - Shall be listed by Underwriter's Laboratories, Inc. for use in air handling systems. Smoke detectors shall be duct work type and approved for this type of installation. They shall be designed to provide detection of combustion gases and fire and smoke in air conditioning and ventilating duct systems in compliance with the National Fire Protection Association and Underwriter's Laboratories, Inc. Standard U.L. 167. Further, they shall contain an ionization type detector and air sampling chamber with sampling tubes extending through the width of the air duct. Alarm status indicating lights shall be visible on the front of the detector. The smoke detector shall include alarm relay contacts (DPDT) with an extra set of contacts for connection to the fire alarm panel. The duct mounted smoke detector shall be 120 volt or 24volt. Coordinate type and voltage with Division 16 and Fire Alarm Contractor.

2.10. GRILLES, REGISTERS AND DIFFUSERS

2.10.1. Acceptable manufacturers are Krueger, Titus or Price.

2.10.2. All diffusers, grilles and other associated air distribution items shall be aluminum. This project is a high moisture environment.

2.10.3. All units must be factory finished. Provide white color finish. Unit ratings shall be approved by ADC.

2.10.4. Air flow tests and sound level measurement shall be made in accordance with applicable ADC equipment test codes and ASHRAE standards. Manufacturer shall certify catalogued performances and ensure correct application of air outlet types.

2.10.5. Positions indicated are approximate only. Check location of supply, return and exhaust grilles and make necessary adjustments in position to conform with architectural features, symmetry and lighting arrangement. See architectural reflected ceiling plans and interior elevations for additional information.

2.10.6. Provide splay wires from air distribution to structural building members. Splay wires are used for seismic restraint and shall be attached at each corner with a minimum of 4 splays for each grill.

2.10.7. For dry wall ceilings use aluminum "Rapid Mount" frames for access to volume dampers and other items.

2.10.8. Supply Air Distribution - Provide the sizes listed below unless otherwise noted on the drawings.

2.10.8.1. Supply Diffuser - 24" X 24" Lay in Tee-Bar and Modular Core Type. All aluminum with exposed blades with 4 modular cores that can be removed and repositioned to provide one-way to four-way blow pattern. Square neck type. Krueger model with frame style 23. Cores shall be put in four-way blow pattern unless other wise noted. Include square to round transition for duct connection. Standard white color.

CFM	FACE SIZE	NECK SIZE
0 - 100	24" X 24"	6" x 6"
101 - 175	24" X 24"	8" X 8"
176 - 250	24" X 24"	10" X 10"
251 - 400	24" X 24"	12" X 12"
401 - 500	24" X 24"	14" X 14"
501 - 700	24" X 24"	16" X 16"

701 - 850	24" X 24"	18" X 18"

2.10.8.2. Supply Diffuser - 24" X 24" Surface Mounted and Modular Core Type. All aluminum with exposed blades with 4 modular cores that can be removed and repositioned to provide one-way to four way blow pattern. Square neck type. Krueger model with frame style 22. Cores shall be put in four-way blow pattern unless other wise noted. Include square to round transition for duct connection. Standard white color.

CFM	FACE SIZE	NECK SIZE
0 - 100	11" X 11"	6" x 6"
101 - 175	13" X 13"	8" X 8"
176 - 250	15" X 15"	10" X 10"
251 - 400	17" X 17"	12" X 12"
401 - 500	19" X 19"	14" X 14"
501 - 700	21" X 21"	16" X 16"
701 - 850	23" X 23"	18" X 18"

2.10.8.3. Supply Grill - Surface Mounted Sidewall Type Diffuser, Krueger model with extruded aluminum and double deflection. Include transition from duct size to diffuser size. 2 way blow. Standard white color.

CFM	FACE SIZE	NECK SIZE
0 - 75	11 3/4" X 5 3/4"	10" X 4"
76 - 150	11 3/4" X 7 3/4"	10" X 6"
151 - 175	13 3/4" X 7 3/4"	12" X 6"
176 - 225	15 3/4" X 7 3/4"	14" X 6"
226 - 350	19 3/4" X 9 3/4"	18" X 8"
351 - 600	21 3/4" x 11 3/4"	20" X 10"

2.10.9. Return and Exhaust Air Distribution - Provide the sizes listed below unless otherwise noted on the drawings.

2.10.9.1. Return and Exhaust Grill - 24" X 24" All aluminum perforated or fixed bar lay in Tee-Bar type, Krueger frame style 23. Concealed hinges. Include square to round transition for duct connection. Standard white color.

CFM	FACE SIZE	NECK SIZE
0 - 100	24" X 24"	6" x 6"
101 - 175	24" X 24"	8" X 8"
176 - 250	24" X 24"	12" X 12"
401 - 500	24" X 24"	14" X 14"
501 - 700	24" X 24"	16" X 16"
701 - 850	24" X 24"	18" X 18"

2.10.9.2. Return and Exhaust Grill - Surface mounted type, All aluminum Krueger model with frame style 22. Concealed hinges. Include square to round transition for duct connection. Standard white color.

CFM	FACE SIZE	NECK SIZE
0 - 100	13" X 13"	6 x 6"
101 - 180	15" X 15"	8" X 8"
181 - 225	16" X 16"	9" X 9"
226 - 280	17" X 17"	10" X 10"

281 - 400	19" X 19"	12" X 12"
401 - 600	22" X 22"	15" X 15"
601 - 800	25" X 25"	18" X 18"

2.10.9.3. Return and Exhaust Grill - Surface Mounted Sidewall Type Return Grill, Krueger model with extruded aluminum fixed bar type and 3/4" centers. Include transition from duct size to grill size. 35 degree angle blades. Standard white color.

CFM	FACE SIZE	NECK SIZE
0 - 100	11 3/4" X 7 3/4"	10" X 6"
101 - 150	13 3/4" X 7 3/4"	12" X 6"
151 - 200	19 3/4" X 7 3/4"	18" X 6"
201 - 350	19 3/4" X 11 3/4"	18" X 10"
351 - 450	19 3/4" X 13 3/4"	18" X 12"
451 - 600	25 3/4" x 13 3/4"	24" X 12"

2.11. FLEXIBLE CONNECTIONS

2.11.1. Provide flexible connections at inlet and discharge connections of fans and air handling equipment to prevent mechanical noises from being transmitted to connecting ductwork.

2.11.2. Acceptable manufacturers are Vent fabrics, Inc and Durodyne MFG. UL listed, fire-retardant, neoprene-coated woven glass fiber fabric to NFPA 90A and crimped into metal edging strip.

2.11.3. Ventglas shall be used for flexible duct connections when not exposed to the weather.

2.11.4. Ventlon shall be used for flexible duct connections exposed to the weather.

2.12. VOLUME CONTROL DAMPERS

2.12.1. Acceptable manufacturer are Penn Ventilator Co., Metal Form Manufacturing Co. and Durodyne MFG.

2.12.2. Provide tight close-off dampers at locations indicated on drawings or as needed for control of the air distribution system.

2.12.3. Dampers shall have air loss (leakage), when closed, less than 1% of the full flow rate (based on approach velocity of 2,000 fpm) with a pressure differential across damper 4" static pressure or less.

2.12.4. Construction shall be of No. 22 gauge galvanized blades.

2.12.5. All control rods for volume dampers shall be continuous through-out blade and duct work. Provide locking quadrants and bronze end bushings.

2.12.6. Provide locator flags at each damper adjusting arm consisting of a 12" length of yellow or orange engineering tape.

2.13. FILTERS

2.13.1. Acceptable manufacturers are Farr Co. or American Air Filter.

2.13.2. Provide two sets of air filters for each HVAC unit.

2.13.2.1. The first set of air filters shall be installed during construction and used during the air balance portion of the project.

2.13.2.2. The second set of air filters shall be installed after the air balance portion of the project is finished and prior to the mechanical final punch list site visit.

2.13.3. Air filters for rooftop HVAC units shall be equal to MERV 13 Farr 2" high efficiency type filters.

2.13.4. Each filter shall consist of a non-woven cotton fabric media support grid and enclosing frame. Provide Farr Holding Frames factory fabricated of 16 gauge galvanized steel and be equipped with gaskets and four heavy-duty positive sealing fasteners. Each fastener shall be capable of withstanding 25 lbs. pressure without deflection. They shall be capable of being attached or removed without the use of tools. Filters shall be capable of being installed or removed without any movement of equipment or duct work.

2.13.5. Filters shall have a composite fire hazard rating as tested by ASTM E-84, NFPA 255, or UL 723 not to exceed 25 flame spread and 50 smoke developed. Materials labeled accordingly.

2.13.6. Air Filters shall be a California State Fire Marshal approved and listed type. Preformed filters having combustible framing shall be tested as a complete assembly. Air filters in all occupancies shall be Class 2 or better (as shown in the State Fire Marshal Listing). Air filters shall be accessible for cleaning or replacement.

2.13.7. Filters shall conform to ASHRAE 90A-1980 and NFPA 90.

2.14. ROOFTOP PACKAGED HEATING, VENTILATING AND AIR CONDITIONING (HVAC) UNITS AND ACCESSORIES

2.14.1. Acceptable manufacturer of rooftop package HVAC units is AAON.

2.14.2. Curbs for HVAC and HV units - Provide a minimum of 16 gauge custom pitched roof curb for each HVAC and HV rooftop unit. The roof curb shall be a single type pitched curb with the slope of the roof curb field measured. The roof curb shall be supported by roof structural support members. Align the roof curb with these support members. The roof curb shall provide a level surface for the installation of the rooftop unit. All curbs shall be rated for seismic zone 4. Provide structural seismic overturning calculations for curbs in submittal. All structural calculations in submittals shall be stamped and signed by a State Certified Structural Professional Engineer.

2.14.3. Vibration Isolation for HVAC units - Provide full perimeter spring vibration isolation rails for rooftop package HVAC and Heat and Vent units as called for on the mechanical schedule. Provide seismic motion restraints as required by California Mechanical and Building Codes. All vibration isolation shall be rated for seismic zone 4. Provide structural seismic overturning calculations for vibration isolation in submittal. All structural calculations in submittals shall be stamped and signed by a State Certified Structural Professional Engineer.

2.14.4. HVAC Rooftop Units

2.14.4.1. The casing shall be constructed of coated steel meeting SMACNA or ASHRAE Standards. Internal insulation shall meet the requirements of NFPA Bulletin 90-A and UL 181.

2.14.4.2. Provide ultraviolet light for the evaporator coils

2.14.4.3. Whole Cabinet and Evaporator and Condenser Coil Protection

2.14.4.3.1. Provide Surface Protection Treatment Adsil MicroGuard Corrosion and Mold protection, with energy enhancing characteristics for both evaporator and condenser coils.

2.14.4.3.2. Scope: Provide surface protection to HVAC components, that seals the surface against moisture intrusion, prevents oxidation and corrosion of surface material and provides a final surface that will not support the growth of mold, fungus, or algae. Protection must include coils, fans, piping, compressors, dampers and cabinet.

2.14.4.3.3. Product Description: The surface protection treatment must be an inorganic product. Performance characteristics must include: • passing the ASTM B117 Corrosion test • resistant to U.V. radiation and chemicals between pH of 3 to 11 • independent lab certification for ASTM G21 Mold Growth • covalent bonding (chemical bond) • anti-static surface • enhanced heat transfer of both evaporator and condenser coils. (products supported by PUC energy rebate programs are recommended)

2.14.4.3.4. Product Application Process: Surface treatment may be applied by roller, brush, spray, or wiping. The use of a certified applicator is required. Acceptable Surfaces Materials: Surface treatments must be capable of adhering to and performing on exterior paint, aluminum, copper, anodized metal, painted metal, brass, bronze, stainless steel, and galvanized steel. Curing Times and Conditions: The surface treatment must cure in ambient air temperatures between 60F to 95F where the difference between dew point temperature and ambient temperature is greater than 5 F. Tacky cure must occur within 4 hours and the surface must be dry to use within 6 hours after application.

2.14.4.3.5. Physical Characteristics: The surface treatment must be clear, have a viscosity less than 1, be hydrophobic and olephobic when dry, and have a pencil hardness of 6H+.

2.14.4.3.6. Warranty: Product application must include a minimum 5 year replacement warranty for new coils.

2.14.4.4. The unit manufacturer shall furnish, when requested, certified sound power levels for both discharge sound and casing radiated sound, tested in accordance with ASHRAE Standard 36-72.

2.14.4.5. Controls: The units shall be equipped for and shall interface with DDC (Direct Digital Controls) systems.

2.14.4.6. Arrangement and configuration as indicated on drawings and as described on the equipment schedule. Condensing section shall be designed for outdoor duty. Performance shall be certified in accordance with Air Conditioning and Refrigeration institute (ARI) Standard for rooftop HVAC units. Fans to be rated by AMCA.

2.14.4.7. Provide and flex connections on supply and return duct plenums for the isolation of mechanical equipment . These flex connections are for the avoidance of excessive noise or vibration in the building due to the operation of equipment.

2.15. FAN COIL UNITS

2.15.1. Acceptable manufacturers Mitsubishi or Sanyo.

2.15.2. Provide factory assembled and tested fan coil unit design with insulated casing, blower, motor, coils, drain pan and accessories indicated.

2.15.3. Blower shall be direct drive with three speeds.

2.15.4. Units shall be equipped and designed for low voltage controls systems.

2.15.5. Units shall be mounted to wall with factory wall bracket.

2.16. CONDENSING UNITS

2.16.1. Acceptable manufacturers Mitsubishi or Sanyo.

2.16.2. Arrangement and configuration as indicated on drawings and as described on the equipment schedule. Condensing units shall be weatherized for outdoor duty. Condensing unit performance shall be certified in accordance with Air Conditioning and Refrigeration institute (ARI) Standards.

2.16.3. Provide roof curb platform with 1" thick neoprene pads for the isolation of mechanical equipment. This isolation equipment is for the avoidance of excessive noise or vibration in the building due to the operation of equipment.

2.16.4. The units shall be equipped and designed for low voltage controls systems.

2.16.5. Provide seismic motion restraints as required by California Mechanical and Building Codes.

2.17. EXHAUST FANS AND ACCESSORIES

2.17.1. Acceptable manufacturers are Greenheck, Cook or Penn. Exhaust fans shall meet AMCA standards.

2.17.2. Provide a custom pitched roof curb for all roof mounted exhaust fans. The roof curb shall be a single type pitched curb with the slope of the roof curb field measured. The roof curb shall be supported by roof structural support members. Align the roof curb with these support members. The roof curb shall provide a level surface for the installation of the roof mounted exhaust fans. Roof mounted exhaust fans and motors shall be designed for outdoor duty.

2.17.3. The casing shall be constructed of coated steel meeting SMACNA and ASHRAE Standards.

2.17.4. The exhaust fan's manufacturer shall furnish, when requested, certified sound power levels for both discharge sound and casing radiated sound, tested in accordance with ASHRAE Standard 36-72.

2.17.5. Arrangement and configuration as indicated on drawings and as described on the equipment schedule. Performance shall be certified in accordance with Air Conditioning and Refrigeration Institute (ARI) Standard for rooftop HVAC units. Fans to be rated by AMCA.

2.17.6. Provide and flex connections on exhaust inlet and outlet for the isolation of exhaust fans. These flex connections are for the avoidance of excessive noise or vibration in the building due to the operation of equipment.

2.17.7. Exhaust fan motors that are 208/230 volt 1 or 3 phase and 460 volt 3 phase shall be provided with motor starters. Provide correct size and voltage characteristics per electrical requirements. Motor starters shall be coordinated with Control Systems. Section 15900 Controls.

2.17.8. Controls: The units shall be equipped and designed for DDC (Direct Digital Controls), low voltage controls and line voltage controls as specified in the mechanical schedule.

2.18. PIPING AND FITTINGS

2.18.1. Refrigeration System

2.18.1.1. Piping: Type ACR L Hard Copper. Joints: Solder for copper using 95% tin - 5% antimony. Provide wrought copper fittings.

2.18.1.2. Fittings: Provide wrought copper fittings.

2.18.1.3. Refrigeration Specialties: Provide in line filter dyers at all condensing units in suction piping. Provide shut off valves at each condensing unit. Provide suction line accumulators.

2.18.2. Heating Water System

2.18.2.1. Piping: Type L Hard Copper. Joints: Solder for copper using 95% tin - 5% antimony.

2.18.2.2. Fittings: Provide wrought copper fittings.

2.18.2.3. Provide pumps, expansion tank, air separator and accessories as noted in isometrics and on the drawings.

2.18.2.4. Shut Off Valves:

2.18.2.4.1. 1/2" pipe size to 2" pipe shall be Nibco T-595-S6-R-66. (T=treaded, S6= Stainless Steel, R=Reinforced TFE seat and 66=Stainless Steel Ball). Provide stainless steel handle and nut.

2.18.2.4.2. 2 1/2" size size and larger shall be Nibco. Class 300 Flanged Ball Valve or equal. Body, stem and ball shall be Stainless Steel A743 GR. CF8M. Ball Valve shall be rated 300 PSI working pressure. Pack gland and stop plate shall be stainless steel. Provide stainless steel handle and nut.

2.18.2.4.3. Gate valves shall not be installed in chilled water and heating water systems.

2.18.3. Piping Supports:

2.18.3.1. Supports shall secure pipes in place, shall prevent pipe vibration and maintain required grading of proper adjustment, and shall provide for expansion and contraction.

2.18.3.2. Hangers and roof supports shall be located near or at changes in piping direction and shall provide vertical adjustment to maintain pitch required. All piping mechanically attached to metal studs or bracing shall be attached with approved isolator devices. These isolation devices are for the avoidance of excessive noise or vibration in the building due to the operation of equipment, and/or due to interconnected piping, ductwork or conduit.

2.18.3.3. Hangers and roof supports shall be of strength and rigidity to suit loading and service and in a manner which will not unduly stress the building construction.

2.18.3.4. Hangers and roof supports shall be of adequate size to fit outside the insulation.

2.18.3.5. Provide seismic motion restraints as required by current California Mechanical Code and current California Building Code.

2.18.3.6. Hangers:

2.18.3.6.1. Copper pipe: horizontal - insulated and uninsulated: Adjustable steel clevis of sufficient size to fit outside of insulation.

2.18.3.6.2. Copper pipe: vertical - insulated and uninsulated: Tubing riser clamp carbon steel with copper finish; or figure with plastic coating on formed portion.

2.18.3.7. Hanger Spacing:

2.18.3.7.1. Copper pipe: 1/2" to 2" pipe every 6'- 0" or less.

2.18.3.7.2. Copper pipe: 2" and larger pipe every 8'- 0" or less.

2.18.3.8. Pipe Supports on Roof:

2.18.3.8.1. Roof pipe supports shall be Pipe Pier, flexible resilient closed-cell polyethlene foam (ETHAFOAM brand - trade mark of the Dow Chemical Company), with strut system built into foam block.

2.18.3.8.2. Foam block size:

4" high X 4" wide for 1/2" to 2" pipe diameter pipe

4"high X 6" wide for 2" and larger pipe diameter

2.18.3.9. Pipe Support Spacing on Roof

2.18.3.9.1. Copper pipe: 1/2" to 2" pipe every 6'- 0" or less.

2.18.3.9.2. Copper pipe: 2" and larger pipe every 8'- 0" or less.

2.19. WATER TREATMENT FOR HEATING WATER SYSTEMS (CLOSED SYSTEMS)

2.19.1. Provide water treatment equipment and chemicals for heating water systems.

2.19.1.1. Heating water - Shall be manual type with "pot" filler.

2.19.2. Codes and Standards

2.19.2.1. All built-in wiring controls shall be UL-approved and in accordance with all governing codes.

2.19.2.2. Chemical used shall not contain any ingredients which are harmful to systems materials of construction and shall have approval of all governing authorities.

2.19.3. The water treatment and service supplier shall be a recognized specialist, active in the field of industrial water treatment for at least 10 years, whose major business is in the field of water treatment, and shall have regional water analysis laboratories, development facilities and service department, plus full-time service personnel located within the trading area of the job site.

2.19.4. Water treatment chemicals: The water treatment chemicals for the various systems shall be the most effective recommended by the water treatment company.

2.19.5. Feeding and control equipment: Contractor shall install a One-Shot Feeder, minimum 3-gallon capacity, designed to meet pressure requirements of the specific system. A feeder shall be supplied for each separate system.

2.19.6. Water treatment chemicals: Furnish one year's supply of the recommended formula for control of scale, sludge and corrosion in the closed recirculating system. Formulation shall not contain any ingredients which are harmful to system materials of construction.

2.19.7. Testing equipment: The water treatment chemical and service supplier shall furnish basic water test equipment, including carrying case and reagents for use with the supplier's products. To include apparatus for determination of treatment residual. Where specialized or supplementary equipment is required, it shall be furnished as a part of the offering.

2.20. VARIABLE AIR VOLUME BOXES

2.20.1. Acceptable manufacturers are EnviroTec or Greenheck.

2.20.2. Units to consist of fully insulated welded 26 gauge galvanized steel casing, with round or oval inlet collars. Calibrated volume setting mechanism to permit accurate field adjustment of maximum or minimum air volume. Leakage through casing not to exceed 2% at 0.5 inch water gauge.

2.20.3. The casing shall be constructed of coated steel meeting SMACNA or ASHRAE Standards. Internal insulation shall meet the requirements of NFPA Bulletin 90-A and UL 181.

2.20.4. Volume regulators to be of the electric type with instantaneous compensation for system static pressure fluctuations, completely independent of the volume setting mechanism. The regulator shall maintain plus or minus 5% of constant set-point volume. Volume dampers will not meet this performance criteria and are not acceptable.

2.20.5. Discharge sound levels shall not exceed NC-30 at .5 inch water gauge inlet static pressure. An allowance of 10db for room absorption is included in the NC requirements.

2.20.6. Radiated sound with 10db allowance for ceiling absorption shall not exceed NC 30 at .5 inch water gauge inlet static pressure.

2.20.7. The unit manufacturer shall furnish, when requested, certified sound power levels for both discharge sound and casing radiated sound, tested in accordance with ASHRAE Standard 36-72. Sound data based on prior ASHRAE Standards will not be acceptable.

2.20.8. The tests shall be conducted in an American Diffuser council (ADC) approved sound facility and shall include the second through sixth octave bands for unit sizes with inlet static pressures. Attenuation factors shall be clearly defined.

2.20.9. Controls: The units shall be equipped for variable volume operation with variable volume normally closed electric dampers and direct acting direct digital control sensors. Dampers and linkage shall be furnished and installed by the unit manufacturer. A calibrated minimum air volume adjustment mechanism shall be provided, accessible through a quick-openings panel. Refer to Section 15900 Controls for Additional Requirements.

2.20.10. Variable air volume boxes are to be complete with hot water heating coil with right or left hand coil connections as required. The heating coil shall be mounted integral with casings.

3. PART 3 - EXECUTION

3.1. DUCT CONSTRUCTION AND INSTALLATION

3.1.1. Ductwork construction and installation including sheet metal gauges, reinforcement, joint sealing, air leakage and details not specifically shown on the drawings shall be in accordance with SMACNA Publication HVAC Duct Construction Standards - Meal and Flexible current edition and SMACNA Publication Seismic Restraint Manual: Guidelines for Mechanical Systems current edition.

3.1.2. Use Ductmate Duct Connection System for all transverse joints in ducts.

3.1.3. Seal seams, joints, duct connections, elbow gores with Hardcast high pressure Class A SMACNA sealant.

3.1.4. Radius elbows shall have a center line radius equal to 1-1/2 times the duct width. Square throats will not be permitted on radius elbows. Square elbows shall have double thick turning vanes. Job fabricated turning vanes will not be accepted without prior approval.

3.1.5. Provide all necessary dampers as required for proper adjustment and control of air distribution. All dampers shall have rigid bearings and locking quadrants which allow no rattling. All damper rods shall be marked to indicate the relative position of the damper blade with respect to the rod. Install fire dampers in accordance with their UL listing and the manufacturers recommendations.

3.1.6. All grilles, registers, and diffusers shall be set flush and true to the wall or ceilings to prevent air leakage around the edges. Provide plaster frames for all outlets in plaster or gypsum board.

3.1.7. Provide 1" angle collars for all exposed ducts passing through roofs, ceilings, floors and walls. Anchor collars in position after installation is complete.

3.1.8. At all places where inside of duct will be visible through return air grilles, louvers, etc., paint normally visible inside portion of duct with flat black paint.

3.1.9. Install hinged doors on ductwork and housing to provide access to all parts of every automatic damper, fire damper and all other items requiring maintenance or inspection.

3.1.10. Transitions in ductwork, in changing shapes and sizes, shall be made with angles not exceeding 15° wherever possible. Maximum divergence upstream of equipment shall be 30° and maximum convergence downstream shall be 45°.

3.1.11. Where horizontal ducts pass through walls and vertical ducts pass through roof or floors, supporting angles shall be rigidly attached to ducts and to the wall, roof or floor. Angles shall be galvanized and of approved sizes to properly support the ductwork. The supporting angles shall be placed on at least two sides of the duct.

3.1.12. Where horizontal ducts pass through walls and vertical ducts pass through roof or floors, the openings shall be tightly sealed off so as to provide a air and sound tight seal between duct and opening.

3.1.13. Contractor shall not provide holes in the duct systems for the installation of hangers, conduits, etc. Coordinate work of all other trades so this will not be necessary.

3.1.14. Ensure that interior of ducting is kept clean during building construction. Install plastic film over exposed duct openings as soon as ducts are installed.

3.1.15. Locate duct with sufficient space around equipment to allow normal operating and maintenance activities.

3.1.16. All supply air, return air, outside air and exhaust air ductwork joints and seams to be sealed through their entirety with high pressure Class A SMACNA duct sealant.

3.1.17. Complete metal ducts within themselves with no single partition between ducts. Where width of duct exceeds 18 inches, cross break for rigidity. Open corners are not acceptable.

3.1.18. Lap metal ducts in direction of air flow. Hammer down edges and slips to leave smooth duct interior.

3.1.19. Construct tees, bends and elbows with radius of not less than 1-1/2 times width of duct on center line. Where not possible and where rectangular elbows are used, provide approved type airfoil turning vanes.

3.1.20. Clothes dryer exhaust ducts shall be fabricated with no screws or other penetrations into the air stream.

3.2. FLEXIBLE DUCTWORK

3.2.1. Connect flexible ducts to metal ducts with metal draw bands plus sheet metal screws. Use crimp joints with bead for joining round duct sizes with crimp in direction of airflow.

3.3. FLEXIBLE CONNECTIONS

3.3.1. Provide flexible connections at inlet and discharge connections of fans and air handling equipment to prevent mechanical noises from being transmitted to connecting ductwork. Align sheet metal duct with fan or fan casing opening in all three dimensions prior to installation of flexible connection, so that duct opening nearly coincides and are almost equally spaced from one another all around. Do not install flexible connection until above requirements are met. Fans or fan casings and ducts shall be able to move 1" in any direction relative to each other without short-circuiting metal to metal or stretching taut the flexible connection.

3.4. ROOFTOP HVAC UNITS, FAN COIL AND CONDENSING UNITS AND EXHAUST FANS

3.4.1. Install equipment in accordance with manufacturer's recommendations, good industry standards and SMACNA Installation Standards for Heating, Air Conditioning and Solar systems.

3.4.2. Provide high pressure air seal around ducts and units.

3.4.3. Coordinate with other work, including ductwork, floor construction, and electrical work as necessary to interface installation of air handling equipment with other work.

3.4.4. Ensure equipment is wired properly, with rotation in direction indicated and intended for proper performance. If there is no rotation arrow supplied by the manufacturer, install a correct rotation arrow.

3.4.5. Inlet and outlet connections to all equipment shall be made with neoprene coated glass fabric flexible connection not less than four inches full length with one inch slack. Weather exposed connections shall be same as above except to be hypalon coated in lieu of neoprene.

3.4.6. Connect motor starters at equipment to DDC control system, on/off light switches or "on temperature rise thermostats"

3.5. ACCESS DOORS

3.5.1. Provide access doors as specified for inspection and cleaning before and after coils, at fire dampers, at fire/smoke dampers, at volume dampers, and elsewhere as indicated or as required. Review locations prior to fabrication.

3.5.2. Locate access doors for easy access. Doors should be located above accessible ceilings, whenever possible. Where access is required above gypsum board ceilings, coordinate location of access panel with Contractor. Coordinate location of access doors with other trades such that conduit and pipe does not prevent or interfere with access to ductwork.

3.6. FIRE/SMOKE DAMPERS

3.6.1. Install fire/smoke dampers in accordance with current California Mechanical Code and current California Building Code requirements, manufacturer's recommendations and State Fire Marshal recommendations.

3.6.2. Provide a smoke detector up stream of the fire/smoke dampers that will upon detection of smoke close the fire/smoke damper.

3.6.3. Provide wiring and conduit from smoke detector to the fire/smoke damper so that the fire/smoke damper will close.

3.7. SMOKE DETECTORS

3.7.1. HVAC units over 2,000 CFM - Provide smoke detectors in supply air plenum or in main supply air duct (before any branch ducts) in accordance with current California Mechanical Code.

3.7.1.1. Provide a duct mounted smoke detector that will upon detection of smoke shall shut down the supply fan of HVAC unit when smoke is detected in the supply air duct.

3.7.1.2. Provide control wiring and conduit from smoke detector directly to the HVAC unit controls.

3.7.1.3. Provide wiring and conduit so that alarm signal can be connected to the DDC control panel and to the fire alarm panel.

3.7.2. Fire/Smoke Dampers - Furnish and install a smoke detector up stream of each fire/smoke damper.

3.7.2.1. Provide a duct mounted smoke detector that will upon detection of smoke shall close fire/smoke damper.

3.7.2.2. Provide control wiring and conduit from smoke detector directly to the fire/smoke damper.

3.7.2.3. Provide wiring and conduit so that alarm signal can be connected to the DDC control panel and to the fire alarm panel.

3.8. REFRIGERATION PIPING AND HEATING WATER PIPING INSTALLATION

3.8.1. All piping shall be concealed in walls, furred spaces, pipe spaces, or above suspended ceilings. Piping shall be grouped wherever practical and shall be installed uniformly in straight parallel lines in either vertical or horizontal positions and at right angles with beams, walls, ceilings or other building lines. Install all exposed piping as close as practical to walls, columns or overhead construction to provide maximum head room and minimum interference with usable building space. Where interference develops in the field, piping shall be offset or routed as required.

3.8.2. Pipe shall be installed to eliminate sagging.

3.8.3. All pipe, fittings and valves shall bear manufacturer's name and trademark, and valves shall have service and pressure rating cast in bodies.

3.8.4. Copper piping passing through poured concrete floors shall be sleeved and wrapped with plastic foam or fire stop material as appropriate with 50% overlap.

3.9. PIPE SUPPORT SPACING AND LOCATIONS

3.9.1. Hangers shall adequately support the piping system and shall be located near or at changes in piping direction and concentrated loads.

3.10. PIPE TESTING

3.10.1. All piping system shall be tested and proven tight prior to concealment.

3.10.2. Insure that the test pressure which might damage equipment does not reach such units by valving them off or otherwise isolating them during the test.

3.10.3. All air tests shall be held for a minimum of four hours without loss of pressure.

3.11. HEATING WATER EQUIPMENT

3.11.1. Mount pumps on neoprene pads and bolt down to concrete floor. Provide a welded structural frame for the expansion tank and air separator. The structural frames shall be bolted to the concrete floor and to wall structural members.

3.12. WATER TREATMENT INSTALLATION

3.12.1. Supervision of start-up: Provide qualified engineer to check over installation, adjust controls, and test entire system.

3.12.2. Water management program: The chemical supplier shall provide a water management and service program for a period of one year from start-up of the system, to include the following: Initial water analysis and recommendations, system start-up assistance, training of operating personnel, periodic field service and consultation, all performed by a qualified full-time local representative, plus laboratory and technical assistance from the engineering staff.

3.12.2.1. A water analysis and inspection of all systems to be made at time of each visit.

3.12.2.2. A written report to be submitted to plant operator which includes a recommendation for treatment required during the next month.

3.13. DUCTWORK TESTING

3.13.1. For LEED acceptance provide leak test supply air ductwork during construction and prior to installation of duct wrap. Leakage shall not exceed of the reuirements established by LEED.

3.13.2. Notify Mechanical Engineer 24 hours in advance of test. Keep field records of tests and submit to Mechanical Engineer three copies of results.

3.13.3. Retesting: Retest ductwork failing initial tests following correction of defective work. Requirements of initial tests shall apply.

3.14. BALANCING AND ADJUSTING

3.14.1. This section covers testing and balancing of environmental systems including air distribution systems, hydronic distribution systems, and the equipment and apparatus connected thereto. The testing and balancing of all environmental systems shall be the responsibility of one Testing, Balancing and Adjusting (TBA) firm. The minimal standards to be met are those set forth in Chapter 40 in the latest edition of the ASHRAE Systems Handbook.

3.14.2. The balancing, testing and adjustments of the complete mechanical systems shall be the direct responsibility of the Contractor and he shall engage the services of an independent firm specializing in this work. The definition of independent shall mean the firm is not associated with any contracting or manufacturing firm and derives its income solely from testing, adjusting and balancing mechanical systems. Acceptable testing, adjusting and balancing firms are those which are AABC certified. NEBB firms must also be AABC certified.

3.14.3. The balancing work, including air and hydronic portions, shall be performed by the same firm having total professional responsibility for the final testing, adjusting, and balancing of the entire system.

3.14.4. Testing and balancing work shall be directly supervised and the results confirmed by a Registered Professional Mechanical Engineer who shall represent the TBA firm in progress meetings as requested, and shall be available for interpreting all material found in the balance report.

3.14.5. The balancing firm shall provide all tools, equipment and instruments required and shall take all readings, and make all necessary adjustments.

3.14.6. After all adjustments are made, prepare a detailed written report and submit for review. Report shall bear the Registered Professional Mechanical Engineer's Stamp of the person supervising the work. Final acceptance of this project will not be made until a satisfactory report is received.

3.14.7. Verify the following conditions before proceeding with work:

3.14.7.1. Conduct site observations during construction to determine the location of required balancing devices and confirm that they are properly located and installed. Submit a written report of these observations to the Architect.

3.14.7.2. Installation of the designated system is complete and in full operation.

3.14.7.3. Outside temperature conditions, occupant loads, lighting loads, special equipment requiring extra sensible or ventilation requirements, and solar conditions are within a reasonable range relative to design conditions or provide for acceptable simulation of loads and conditions that will result in a properly balanced system.

3.14.8. All thermal overload protection shall be observed and noted on the data sheets. If the starter equipment is furnished and installed by the Contractor and thermal overload protection is incorrect, such information shall be tabulated, including required size thermal overloads, and included in the report. If thermal overload protection is incorrect, it shall be the responsibility of the Contractor to see that proper overload protection is installed.

3.14.9. Measure and set any special conditions such as minimum outside air quantities; check and adjust outside and return air intakes so that the system will deliver substantially the same volume on either; make tests and record data as required in the "Balancing Report" section. All balancing devices such as dampers and valves shall be clearly marked as to the final balanced position. Plug all test holes, replace access doors and belt guards.

3.14.10. Provide temperature recorders for spaces as necessary to verify acceptable space temperature conditions.

3.14.11. Upon request of the Mechanical Engineer, a representative of the balancing firm performing the work shall demonstrate fluid flow quantities shown in the report by re-measuring outlets or terminals selected at random by the Mechanical Engineer to verify accuracy of settings.

3.14.12. Requirements for balancing air systems are as follows:

3.14.12.1. Before any adjustments are made; the major items of equipment shall have been checked to assure all bearings have proper lubrication; all belt drives shall have been adjusted for proper alignment and tension; and the systems shall have been checked for such items as dirty filters, duct leakage, filter leakage, damper leakage, equipment vibrations, correct damper operations, etc.

3.14.12.2. Adjust fan systems, major duct sections, registers, diffusers, etc., to deliver design air quantities within plus or minus 5%. Individual air outlets, when more than one serve a space, may have a tolerance of 10% from the average. Design CFM is based on filters being approximately 50% loaded. Pressure drop across filters during balancing shall be simulated to that condition. After balancing is completed, verify that motor is not overloaded with the filters clean.

3.14.12.3. Check and adjust CFM settings. Check and adjust minimum and maximum CFM settings on VAV boxes to design values regardless of factory presetting of these devices.

3.14.12.4. Adjust distribution systems to obtain uniform space temperatures free from objectionable drafts and noise within the capabilities of the system.

3.14.12.5. Exchange and pay for sheaves and/or belts as required to adjust the rpm of fans to handle specified air quantity.

3.14.13. Requirements for balancing hydronic systems are as follows:

3.14.13.1. Before any adjustments are made systems shall have been pressure tested as specified elsewhere. Strainers shall have been cleaned, temperature control valve operation checked, pump rotation checked, pressure reducing valves adjusted, etc.

3.14.13.2. Using system flow meters and contact pyrometer where necessary, adjust the quantity of fluid handled by each pump and supplied to each coil, heat exchanger, etc., to meet design requirements.

3.14.14. Provide four copies of a "Balancing Report" to the Architect. The Mechanical Engineer shall review this report. This report shall contain a general information sheet listing instruments used, method of balancing, altitude correction calculations, manufacturer's grille, register, and diffuser data. Report shall contain the following additional data.

3.14.14.1. Equipment data sheets listing make, size, serial number, rating, operating data, etc., of all mechanical equipment including fans, pumps, motors, starters, and drives. Operating data shall include rotational speed, inlet and outlet pressures, pressure drop across filters, coils and other system components, pump heads, and measured motor current and voltage.

3.14.14.2. Balancing data sheets listing the required and actual CFM of all supply, return, and exhaust outlets or inlets, and totals summarized by systems.

3.14.14.3. A reduced set of contract drawings with outlets marked thereon for easy identification of the designation used in the data sheets.

3.14.14.4. Listing of any abnormal or notable conditions not covered in the above.

3.14.14.5. Hydronic balancing data sheets listing the required temperature or pressure differentials used for balancing coils, convectors, etc. Sheets shall show in comparison final as-balanced versus design values.

3.14.15. Even though it is the responsibility of the balancing firm to check the physical operation of each operating piece of equipment, the control contractor must assure the balancing firm that all controls are accurately calibrated and must cooperate with him during the balancing work period.

3.14.16. The agency performing the system balance and performance test, shall personally verify that all system control functions and interlocking do in fact provide the desired results as stated. The agency shall provide a written statement within the air balance report verifying this fact.

3.15. COMMISSIONING

3.15.1. Provide LEED commissioning of HVAC systems.

3.15.2. Provide all equipment and resources required to perform the LEED required commissioning of the HVAC systems.

3.15.3. Follow LEED guidelines for commissioning.

END OF SECTION