1 General

1.01 Submittals

.1 Submit shop drawings/product data sheets for following:

.1 all control system components;

.2 identified schematic control diagrams with component identification, catalogue numbers, and sequence of operation for all systems;

.3 certified wiring diagrams for all systems.

.2 Submit following samples for review:

.1 control damper section with linkage, operator, and certified flow and leakage data;

.2 wall mounting control system flow diagram as specified in Part 2 of this Section;

.3 each type of thermostat to be used, each identified as to intended use.

1.02 Closeout Submittals

.1 Submit a site inspection and start-up report from manufacturer’s representative as specified in Part 3 of this Section.

.2 Submit written confirmation from control component manufacturer that site installation personnel are qualified and experienced in installation of components, and have parts and service availability on a 24/7 basis.

1.03 Quality Assurance

.1 Control systems are to be installed by control component manufacturer or by licensed personnel authorized by control component manufacturer. Submit written confirmation from control component manufacturer.

.2 Control wiring work is to be performed by licensed journeyman electricians, or under direct daily supervision of journeyman electricians.

2 Products

2.01 Automatic Control Valves and Operators

.1 Each control valve must be suitable in all respects for the application, including system pressure, and must have design output and flow rates with maximum pressure drops as follows:

.1 heating water/glycol solution valves for coils: 345 kPa (50 psi);

.2 Body and trim materials selected in accordance with specification for globe valves, ball valves, or high performance butterfly valves, and in accordance with manufacturer's recommendations for design conditions and service.

.3 Size control valves for pressure drops and heating and cooling loads as scheduled with same pressure rating as globe valves under same service and pressure conditions.

.4 Size valves for two port and three port, two position service;

.1 line size,

.2 ball valves, sizes NPS 1-1/2 and smaller,

.3 butterfly valves, sizes NPS 2 and larger.

.5 For two port and three port modulating service;

.1 use globe valves for CV rating 160 and smaller,

.2 use butterfly valves for CV rating above 160.

.6 Select butterfly valves based on CV rating at 70° rotation

.7 Valve actuators for service other than radiation, radiant panel and reheat coil valve applications;

.1 sized and selected in accordance with manufacturer's specifications,

.2 electric/electronic for two position, or proportional control action, coupled to valves with linkage,

.3 electronic interface control board, solid state drive, reversible motor, oil immersed gear train,

.4 electronic overload or digital rotation sensing circuitry to protect damper operator through entire range of rotation,

.5 span and zero travel adjustment,

.6 position feedback signal on actuators used for proportional control,

.7 provision for manual positioning of valve when actuator is not powered,

.8 spring return mechanism to return valve to "normal" position on power failure (i.e. Normally Open (NO), or Normally Closed (NC)),

.9 control signals:

.1 0-10 VDC or 0-20 mA,

.2 modulate damper position with 2 to 10 VDC or 4-20 mA input signal operating range when in proportional service.

.3 input type and range as suitable for interfacing to output of BAS controller.

.10 feedback signals:

.1 two independent adjustable travel limit switches and wiring to BAS for indication of valve position.

.11 general purpose, drip proof NEMA 2 die-cast housing with corrosion resistant steel cover for indoor applications, watertight NEMA 4 enclosure for outdoor use,

.12 electric actuators suitable for operation down to -35°C where installed outdoors.

.8 Valve actuators for service on radiation, radiant panel, and reheat coil valve applications;

.1 output shaft driven by gear train mechanism.

.2 reversible motor with automatic load limit,

.3 input type and range as suitable for interfacing to output of BAS controllers,

.4 adjustable span and offset travel,

.5 position feedback signal on actuators used for proportional control,

.6 general purpose, dustproof, die-cast aluminum housing,

.7 actuator rotation limit.

2.02 Control Dampers and Operators

.1 T. A. Morrison & Co. Inc. "TAMCO" 100 mm (4 in) deep, flanged, AMCA low leakage certified aluminium dampers. Dampers for modulating and mixing applications are to be parallel blade type. Dampers for open-shut service are to be opposed blade type. Maximum blade length is to be 1 m (4 ft). Dampers greater than 2 sections wide are to be complete with a jackshaft. Each damper is to be complete with:

.1 extruded 6063T5 aluminum frame and airfoil blades, each with an integral slot to receive a gasket;

.2 extruded TPE frame gaskets and extruded EPDM blade gaskets;

.3 slip-proof aluminium and corrosion resistant plated steel linkage of a metal thickness to prevent warping or bending during damper operation, concealed in frame, equipped with seal-sealing and self-lubricating bearings consisting of a Celcon inner bearing fixed on hexagonal blade pin and rotating in a polycarbonate outer bearing inserted in frame.

.2 For standard damper(s), Series 1000 as above.

.3 For insulated damper(s), Series 9000 as above but with all 4 sides of frame insulated with polystyrene, and blades thermally broken and insulated with expanded polyurethane foam.

.4 For stainless steel dampers, as above but constructed of type 316 stainless steel and equipped with Teflon blade bearings.

.5 Each damper motor is to be shaft mounted, spring return, fail safe in the normally open or normally closed position, sized to control damper against maximum pressure or dynamic closing pressure, whichever is greater, to suit sizes of dampers involved, and to provide sufficient force to maintain damper rated leakage characteristics. Each operator is to be complete with a damper position indicator, and external adjustable stops to limit length of stroke in either direction, and is to be mounted on a corrosion resistant adjustable bracket. Operating arms are to have double yoke linkages and double set screws for fastening to damper shaft. Operators for dampers to be connected to building fire alarm system or to freeze protection devices are to be equipped with additional relays to permit dampers to respond and go to required position in less than 15 s upon receipt of a signal. Operator enclosures are to be suitable in all respects for environment in which they are located.

.6 Electric damper operators are to be equal to Belimo EF Series 24 V or 120 VAC spring return, direct coupled electric motor operators for either modulating or 2-position control as required. Each operator is to be overload protected and complete with an enclosure to suit the mounting location.

.7 Pneumatic damper operators are to be replaceable elastomer diaphragm piston type, suitable in all respects for damper sequence.

2.03 Local Control Panels

.1 NEMA 1 (NEMA 2 in sprinklered areas) wall mounting, enamelled steel barriered enclosures sized to suit the application with 20% spare capacity, a perforated sub-panel, numbered terminal strips for all low and line voltage wiring, hinged door, and slotted flush latch.

2.04 Control System Components

.1 Components specified below are required for control of equipment and systems in accordance with drawing control diagrams and sequences of operation. Not all required components may be specified.

.2 Sensor/transmitter input devices must be suitable in all respects for the application and mounting location. Devices are as follows:

.1 unless otherwise specified, temperature sensors are to be resistance type, either 2-wire 1000 ohm nickel RTD or 2-wire 1000 ohm platinum RTD with accuracy (includes errors associated with sensor, lead wire, and A to D conversion), equipped with type 316 stainless steel thermowells for pipe mounting applications, as follows:

.1 chilled water, room temperature, and duct temperature points, ±1°C (±0.5°F);

.2 all other points, ±0.75°C (±1.3°F).

.2 room temperature sensors constructed to be selected in accordance with the following classifications:

.1 Type 1: Space temperature sensor (private/non-public areas);

.1 for measurement of space temperature only as shown on the floor plans and/or as described in the Sequence of Operation;

.2 set-point adjustment shall be accessible through the cover;

.3 sensor operating temperature range from 4°C to 60°C (40°F to 140°F);

.4 surface mounted plastic mono-chromatic guard with surface mounting plate and wall anchors;

.5 mono-chromatic guard secured to mounting plate by screws;

.2 Type 2: Space temperature sensor (public areas or secure areas);

.1 for measurement of space temperature of space temperature only in areas subject to vandalism as shown on the floor plans and/or as described in the Sequence of Operation;

.2 sensor operating temperature range from 4°C to 60°C (40°F to 140°F);

.3 stainless steel flat plate surface type with sensor epoxy-bonded to back of cover plate;

.4 tamperproof/secure concealed fasteners;

.5 set-point adjustment is to be concealed behind the cover.

.3 Type 3: Adjustable space temperature sensor with display (Private Areas, Office areas);

.1 for measurement and adjustment of space temperature as shown on the floor plans and/or as described in the Sequence of Operation;

.2 digital set point operating temperature adjustment range from 4°C to 60°C (40°F to 140°F);

.3 surface mounted plastic mono-chromatic guard with surface mounting plate and wall anchors;

.4 mono-chromatic guard secured to mounting plate by screws;

.5 on/off button to allow occupant override feature;

.6 three-digit LED digital temperature display with 0.2° display resolution;

.7 5% to 95% relative humidity, non-condensing;

.8 minimum/maximum limit set point values adjustable from the BAS operator interface and controller.

.9 set-point adjustment is to be accessible through the cover.

.3 outside air sensors designed and constructed for an ambient temperature of -25°C to 60°C (-13°F to 140°F) and 5% to 95% relative humidity, non-condensing, complete with a NEMA 3R enclosure, solar shield, a weatherproof seal at all wall penetrations, and a perforated plate surrounding sensor element where exposed to wind velocity pressure;

.4 insertion duct mounting sensors type with lock nut and mounting plate, designed to mount in an electrical box (weatherproof with gasket and cover where outside) through a hole in duct;

.5 for ducts greater than 1.2 m (4 ft) or for ducts where air temperature stratification occurs, averaging type sensors with multiple sensing points, and for plenums for applications such as mixed air temperature measurement to account for air turbulence and/or stratification, an averaging string of sensors with capillary supports on the sides of duct/plenum;

.6 Where both temperature and humidity are shown to be measured at same location or in same airstream, use of single measuring unit is permitted provided that features and performance of both temperature sensor and humidity sensor are in accordance with requirements of this specification.

.3 factory solid-state relative humidity sensors with an element that resists contamination, weather-proof with a NEMA 3R enclosure for outside air applications, supplied with a type 304 stainless steel probe with mounting bracket and hardware for duct mounting, each complete with a factory calibrated humidity transmitter which is accurate (including lead loss and analog to digital conversion) to 3% between 25°C to 60°C (-13°F to 140°F) and 5% to 95% relative humidity, non-condensing and complete with non-interactive span and zero adjustments, and a 2-wire isolated loop powered, 4-20 mA, 0 to 100% linear proportional output;

.4 carbon dioxide sensors for air quality control purposes having a maximum 20 s response time, suitable for operating conditions from 0°C to 50°C (32°F to 122°F) and 0 to 100% RH non-condensing, complete with a calibration kit (to be handed to Owner) and characteristics as follows:

.1 measurement range: 0 to 2000 ppm;

.2 accuracy: ±100 ppm;

.3 repeatability: ±20 ppm;

.4 drift: ±100 ppm per year;

.5 output signal: 0-10 VDC proportional over the 0 to 2000 ppm range.

.5 Pressure transmitters are to be constructed to withstand 100% pressure over-range without damage and to hold calibrated accuracy when subject to a momentary 40% over-range input. Pressure transmitters are to transmit a 0 to 5 VDC, 0-10 VDC, or 4-20 mA output signal. Differential pressure transmitters used for flow measurement are to be sized to the flow sensing device and supplied with a tee fitting and shut-off valves in the high and low sensing pick-up lines to allow permanent ease of use connection for balancing, etc. Transmitter housing is to suit mounting location. Standalone pressure transmitters are to be mounted in a minimum NEMA 1 (NEMA 2 in sprinklered area) by-pass valve assembly panel with high and low connections piped and valved, air bleed units, by-pass valves, and compression fittings. Transmitters are to be as follows:

.1 low differential water pressure, 0 to 5 kPa (0 to 20" wc): equal to Setra or Mamac industrial quality transmitter capable of transmitting a linear 4-20 mA output signal in response to variation of flow

meter differential pressure or water pressure sensing points, each complete with non-interactive zero and span adjustments adjustable from outside the cover, and performance as follows:

.1 maintain accuracy up to 20 to 1 ratio turndown;

.2 reference accuracy: +0.2% of full scale.

.2 medium to high differential water pressure, over 5 kPa (20" wc): equal to Setra or Mamac transmitters as specified above for low pressure transmitters but with a pressure range of from 2.5 kPa (10" wc) to 2070 kPa (300 psi), a reference accuracy of ±1% of full span (includes non-linearity, hysteresis, and repeatability);

.3 building differential air pressure: equal to Setra or Johnson Controls Inc. industrial quality transmitter with a range suitable for the application, capable of transmitting a linear 4-20 mA output in response to variation of differential pressure or air pressure sensing points, each complete with non-interactive zero and span adjustments adjustable from outside the cover, and performance as follows:

.1 maintain accuracy up to 20 to 1 ratio turndown;

.2 reference accuracy: +0.2% of full span.

.4 low differential air pressure, 0 to 1.25 kPa (0" to 5" wc): equal to Setra or Johnson Controls Inc. industrial quality transmitter with a range suitable for the application, capable of transmitting a linear 4-20 mA output signal in response to variation of differential pressure or air pressure sensing points, each complete with non-interactive zero and span adjustments adjustable from outside the cover, and performance as follows:

.1 maintain accuracy up to 20 to 1 ratio turndown;

.2 reference accuracy: +0.2% of full span.

.5 medium differential air pressure, over 1.5 kPa (5" wc): equal to Setra or Johnson Controls Inc. transmitters as specified above for low pressure air transmitters but performance requirements as follows:

.1 zero and span: (c/o F.S./°F); 0.04% including linearity, hysteresis, and repeatability;

.2 accuracy: 1% F.S. (best straight line); static pressure effect: 0.5% F.S.;

.3 thermal effects: less than +0.33 F.S./°F over 40°F to 100°F (calibrated at 70°F).

.6 Air and water flow monitoring stations and probes are to be Air Monitor Corp., Tek-Air Systems Inc., Ebtron, or Dietrich Standard products as follows:

.1 Fan Inlet Air Flow Measuring Station: At fan inlet and near exit of inlet sound trap, air flow traverse probes are to continuously monitor fan air volume and system velocity pressure, and traverse probes are to be as follows:

.1 each probe is to be of a dual manifold, cylindrical, anodized type 3003 extruded aluminium construction probe with sensors located along the stagnation plane of approaching air flow, and the static pressure manifold is to incorporate dual offset static tops on opposing sides of averaging manifold so as to be insensitive to flow angle variations for as much as ±20° in approaching air stream;

.2 each probe is not to introduce a measurable pressure drop, nor is sound level within duct to be amplified by its singular or multiple presence in air stream, and each probe is to contain multiple static and total pressure sensors places at equal distances along its length in accordance with ASHRAE Standards for duct traversing.

.2 Single Probe Air Flow Measuring Sensor: Duct mounting hot wire anemometer type which utilizes 2 temperature sensors, one is a heater element temperature sensor and the other is to measure downstream temperature, with temperature differential related directly to air flow velocity. Sensor insertion length is to be adjustable up to 200 mm (8 in), and transmitter is to produce a 4-20 mA or 0-10 VDC signal linear to air velocity.

.3 Duct Flow Measuring Stations: 14 gauge galvanized steel casing with duct connection flanges of a size to mate with connecting ductwork, and complete with an air directionalizer and a 98% free area parallel cell 20 mm (3/4") honeycomb profile suppressor across entering air stream to equalize velocity profile and eliminate turbulent and rotational flow from the air stream prior to measuring point, mechanically fastened to casing so as to withstand velocities of up to 1828 m (6000 ft) per minute. Additional requirements as follows:

.1 total pressure measurement side (high side) is to be designed and spaced to requirements of Industrial Ventilation Manual, 16th Edition, page 9-5, and self-averaging manifolding is to be constructed of brass and copper components;

.2 static pressure sensing probes (low side) is to be bullet-nose shaped, per detailed radius, as illustrated in Industrial Ventilation Manual referred to above, page 9-5;

.3 main take-off point from both total pressure and static pressure manifolds is to be symmetrical, and manifolds are to terminate with external ports for connection to control tubing;

.4 each station is to be equipped with a label on casing indicating unit model number, size, area, and specified air flow capacity;

.5 each station is to have a self-generated sound rating of less than NC 40, and sound level within duct is not to be amplified nor is additional sound to be generated.

.4 Static Pressure Traverse Probe: Duct mounting, complete with multiple static pressure sensors located along exterior surface of cylindrical probe.

.5 Shielded Static Air Probe: Indoor type or outdoor type as required, each with multiple sensing ports, an impulse suppression chamber, and air flow shielding.

.6 Water Flow Monitoring: Equal to Onicon microprocessor-based electromagnetic water flow meters with an accuracy of 0.25%.

.7 Power (amps) monitoring is to be performed by a combination of a current transformer and a current transducer with transformer sized to reduce full amperage of monitored circuit to a maximum 5 A signal which will be converted to a 4-20 mA DDC compatible circuit for use by building automation system. Current transformer and current transducer are as follows:

.1 equal to Veris Industries split core current transformer with an operating frequency of from 50 Hz to 400 Hz, 0.6 kV class, 10 kV BIL insulation, and 5 A secondary;

.2 equal to Veris Industries current to voltage or current to mA transducer with an accuracy of ±5%, a minimum load resistance of 30 kOhm, an input of 0 to 20 A and an output of 4-20 mA, and a 24 VDC regulated power supply.

.8 Duct mounting smoke detectors supplied as part of electrical work for mounting as part of control system work.

.9 Double contact switches to monitor equipment status and safety conditions, and generate alarms when a failure or abnormal condition occurs. Status and safety switches are to be as follows:

.1 current sensing switches: equal to Veris Industries self-powered dry contact output switches for sensing run status of motor loads, each calibrated to indicate a positive run status only when

motor is operating under load, and each consisting of a current transformer, a solid-state current sensing circuit, adjustable trip point, solid-state switch, SPDT relay, and a LED to indicate on or off status;

.2 air filter status switches: equal to Johnson Controls Inc. or Cleveland Controls automatic reset type differential pressure switches, each complete with SPDT contacts rated for 2 A at 120 VAC, a scale range and differential pressure adjustment appropriate for the service, and an installation kit which includes static pressure taps, tubing, fittings, and air filters;

.3 air flow switches: equal to Johnson Controls Inc. or Cleveland Controls pressure flow switches, bellows actuated mercury switch or snap-acting micro-switch type with an appropriate scale range and pressure adjustment;

.4 air pressure safety switches: equal to Johnson Controls Inc. or Cleveland Controls manual reset switches, each complete with SPDT contacts rated for 2 A at 120 VAC and an appropriate scale range and pressure adjustment;

.5 water flow switches: equal to Johnson Controls Inc. Model P74;

.6 low temperature limit switches: manual reset type equal to Johnson Controls Inc. Model A70, each complete with DPST snap acting contacts rated for 16 A at 120 VAC, a minimum 4.5 m (15 ft) sensing element for mounting horizontally across duct/plenum with sensing reaction from coldest 450 mm (18 in) section of element, and where sensing element does not provide full coverage of air stream, additional switches are to be supplied as required.

.10 Control relays as follows:

.1 control pilot relays: equal to Johnson Controls Inc. or Lectro modular plug-in design with snap-mount mounting bases, retaining springs or clips, DPDT, 3 PDT or 4 PDT as required for the application, with contacts rated for 10 A at 120 VAC;

.2 lighting control relays: latching type with integral status contacts rated for 20 A at 120 VAC, each complete with a split low voltage coil that moves the voltage contact armature to On or Off latched position, each controlled by a pulsed tri-state output (preferred) or pulsed paired binary outputs, and each designed so power outages will not result in a change-of-state and so multiple same state commands will simply maintain commanded state.

.11 Electronic signal isolation transducers equal to Advanced Control Technologies for installation whenever an analog output signal from building automation system is to be connected to an external control system as an input (i.e. equipment control panel), or is to receive as an input signal from a remote system, and to provide ground plane isolation between systems.

.12 Each manual override station is to be complete with contacts rated minimum 1 A at 24 VAC and is to provide following:

.1 integral H-O-A switch to override controlled device pilot relay;

.2 status input to building automation system to indicate whenever switch is not in the Auto position;

.3 status LED to illuminate whenever output is On;

.4 override LED to illuminate whenever H-O-A switch is in either the Hand or Off position.

.13 Electronic/pneumatic transducers equal to Johnson Controls Inc. transducers with an output of from 3 psig to 15 psig, an input of from 4-20 mA or 0-10 VDC, manual output adjustment, a pressure gauge, and an external replaceable supply air filter.

.14 Thermostats:

.1 Wall mounting adjustable set-point thermostats, each suitable in all respects for equipment (and operating sequence) they are provided for, equipped with a thermometer, a cover and any required mounting and connection accessories.

.2 Line voltage thermostats are to be 115 V.

.3 Low voltage thermostats are to be 24 V electronic type.

.4 Set-point adjustment for thermostats in public spaces is to be concealed behind cover. Set-point adjustment for other thermostats is to be accessible through cover.

.5 Covers are to be removable, tamper-proof covers with temperature set-point and thermometer displays.

.6 Guards for thermostats are to be clear, ventilated acrylic covers with Allen key locking hardware.

.15 Humidistats:

.1 Direct or reverse acting (to suit system), proportional type, adjustable humidity controllers, each corrosion resistant, suitable in all respects for the application and complete with a nylon element, replaceable cartridge type air filter, internally adjustable limit stops for maximum and minimum settings, a cover, and required mounting and connection accessories.

.2 Electric humidistats are to be line voltage (115 V), or 24 V electronic type.

.3 Wall mounting humidistats are to be complete with a tamper-proof display type cover.

.16 Hardware to permit building automation system control and monitoring of input/output points in accordance with Section 25 05 02 – Building Automation System, points schedule, and drawing control diagrams and operation sequences. All such hardware is to be suitable in all respects for interface with the building automation system.

2.05 System Wiring Materials

.1 System wiring, conduit, boxes, and similar materials are to be in accordance with requirements specified in appropriate Section(s) of Electrical Work specification.

2.06 Control Air Filter and PRV Assemblies

.1 Combination filter/PRV assembly with quantities to suit control system capacity requirements, each assembly complete with:

.1 oil/particle filter with drain port and replaceable coalescing filter element in a transparent polycarbonate bowl with perforated metal shield;

.2 adjustable pressure reducing valve with inlet and outlet pressure gauges and outlet safety pressure relief valve;

.3 wall mounting bracket.

.2 Each filter is to remove both 0.08 micron diameter particles and 0.01 micron diameter oil aerosol, and filter elements are to be removable without disconnecting any piping.

2.07 Control Air Piping and Tubing

.1 High pressure piping mains are to be Type M hard drawn seamless copper with forged copper soldering type fittings and 95% tin / 5% Antimony solder joints.

.2 Low pressure tubing is to be:

.1 seamless hard drawn phosphorized copper tubing with proper soldering type copper fittings and 50% lead / 50% tin solder joints;

.2 annealed soft copper with Garlock compression fittings;

.3 type "FR" plenum rated flame retardant polyethylene control tubing, single, twin or bundled as required, and colour coded.

3 Execution

3.01 General Re: Installation of Controls

.1 Provide complete systems of control and instrumentation to control and supervise building equipment and systems in accordance with this Section and drawings.

.2 Control systems are to generally be as indicated on drawing control diagrams and are to have all the elements therein indicated or implied.

.3 Control diagrams show only the principal components controlling the equipment and systems. Supplement each control system with all relays, transformers, sensors, etc., required to enable each system to perform as specified and to permit proper operation and supervision.

3.02 Installation of Control Air Piping and Tubing

.1 Provide required control air piping and tubing.

.2 Piping/tubing is to be as follows:

.1 for piping mains and branches, type "M" seamless copper;

.2 for exposed connections to control components, hard or soft copper tubing;

.3 for tubing in accessible ceiling spaces, plenum rated polyethylene, neatly bundled with plastic ties and properly supported;

.4 for connections to control components within control cabinets, soft copper or plenum rated polyethylene tubing.

.3 Properly install and support piping and tubing. Provide suitably sized trap legs with drain valves at all low points to prevent condensation pockets.

.4 Solder all copper joints except at instruments or panels where compression fittings are to be used.

3.03 Supply of Control Air Dampers and Operators

.1 Unless otherwise specified, supply required control dampers. Hand dampers to sheet metal trade at site in location where they are required for installation as part of sheet metal work. Ensure each damper is correctly located and mounted.

.2 Unless otherwise specified or scheduled, insulated dampers to be provided for all outdoor air intake and exhaust air applications.

.3 Provide linkage and operators for dampers. Wherever possible locate damper operators so they are accessible from outside duct, plenum, and equipment casings. Bracket mount operators on ducts or plenums clear of insulation where applicable.

.4 Where sequence operation is indicated, or where multiple operators drive a series of dampers, provide pilot positioners to couple their action.

.5 Ensure dampers located in ductwork other than galvanized steel are constructed of type 316 stainless steel.

3.04 Supply of Automatic Control Valves and Operators

.1 Unless otherwise specified, supply required automatic control valves. Hand valves to appropriate piping trades at site in locations they are required for installation as part of piping work. Ensure each valve is properly located and installed.

.2 Provide an operator for each valve.

3.05 Installation of Thermostats

.1 Unless otherwise noted, provide required thermostats.

.2 Provide a ventilated clear acrylic cover for each thermostat located in finished areas, and a wire type guard for each thermostat located in unfinished areas and in areas such as mechanical rooms where thermostat is subject to damage.

.3 Unless otherwise indicated, mount room thermostats 1.5 m (5 ft) above finished floor level. Thermostats intended to be used by building occupants in a barrier-free path of travel to be mounted at 1.2 m (4 ft). Confirm exact location of all thermostats prior to roughing-in.

.4 Provide stand-off mounting and an insulated sub-base for thermostats on outside walls.

.5 Perform control wiring associated with installation of electric or electric-electronic thermostats.

3.06 Installation of Control System Components

.1 Provide required control system components and related hardware. Refer to drawing control diagrams and sequences.

.2 Where components are pipe, duct, or equipment mounted supply components at proper time, coordinate installation with appropriate trade, and ensure components are properly located and mounted.

3.07 Control Wiring

.1 Perform required control wiring work for control systems except:

.1 power wiring connections to equipment and panels, except as noted below;

.2 control wiring associated with mechanical plant equipment and systems whose control is not part of work specified in this Section;

.3 starter interlock wiring.

.2 Except as specified below, install wiring in conduit. Unless otherwise specified, final 600 mm (2 ft) connections to sensors and transmitters, and wherever conduit extends across flexible duct connections is to be liquid-tight flexible conduit.

.3 Control wiring in ceiling spaces and wall cavities may be plenum rated cable installed without conduit but neatly harnessed, secured, and identified.

.4 Wiring work is to be in accordance with certified wiring schematics and instructions, and wiring standards specified in appropriate Sections of Electrical Work Specification.

3.08 Installation of Control Air Compressor Set and Dryer

.1 Provide a duplex air compressor set. Secure set in place on vibration isolation on a concrete housekeeping pad. Install flexible piping connections supplied with set and connect with required piping, including drain piping extended and terminated at nearest drain.

.2 Wall mount power and control panel(s) adjacent to equipment. Connect compressor set panel pressure switch with copper tubing to compressor set.

3.09 Identification and Labelling of Equipment and Circuits

.1 Refer to identification requirements specified in Section 20 05 00 – Common Work Results for Mechanical.

.2 Identify equipment as follows:

.1 enclosures and components: engraved laminated nameplates with wording listed and approved prior to manufacture of nameplates;

.2 wiring: numbered sleeves or plastic rings at both ends of conductor, with numbering corresponding to conductor identification on shop drawings and "as-built" record drawings.

3.10 Testing, Adjusting, Certification, Start-Up, and Training

.1 When control work is complete, check installation of components and wiring connections, make any required adjustments, and coordinate adjustments with personnel doing HVAC testing, adjusting, and balancing work.

.2 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.

.3 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.

.4 Include for 2 full, 8 hour days on-site operation demonstration and training sessions. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

.5 Include for 2 follow-up site training and troubleshooting visits, one 6 months after Substantial Completion and other at end of warranty period, both when arranged by Owner and for a full, 8 hour day to provide additional system training as required, and to demonstrate troubleshooting procedures.

End OF Section