

SECTION 23 09 23**TEMPERATURE CONTROLS****1. GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 01, Division 23 and Division 26 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Work included under this Section consists of replacement of and modifications to a pneumatic electric temperature control system for the heating, ventilating and air conditioning systems, as well as addition of DDC components in accordance with the Temperature Control Drawings. Furnish and install as required all hardware/ software/ labor/ materials for the extension of DDC controls for new RTU's and AHU's to the existing Building Management System (BMS) as necessary for a complete and operable system of controls on all HVAC equipment as shown on plans, specifications, point lists, and sequence of operation. Any new HVAC equipment, DDC controls, interface communication cards or communication devices, required for integration into the existing BMS, that requires the manufacturer to field commission, program or startup shall have those services (inclusive of all labor, materials, expenses, etc) included in the cost of their HVAC equipment. All new DDC controls shall connect to and integrate seamlessly with the existing BMS.
- B. All sensors, valves, operators, dampers, control air tubing, wiring, conduit, and other necessary devices for a complete and operable system shall be provided under this bid.
- C. The controls subcontractor shall submit proof, upon request, they have maintained an established office within 50 miles of the project site for a minimum continuous five year period prior to this installation and are adequately equipped with personnel and service stock to render emergency service in the event of a customer warranty or service call. The system shall be installed and commissioned by factory-trained technicians under the direct employment of the system manufacturer.
- D. Related Work: The following items of related work are specified in other Sections:
 - 1. All Division 23 Sections.
 - 2. All Division 26 Sections.
 - 3. Mechanical Subcontractor shall provide the following:
 - a. Install all automatic dampers; except those provided as part of air handling units.
 - b. Assemble multiple section dampers with required interconnecting linkages and extend required number of shafts through duct for external mounting of damper motors.
 - c. Provide access doors or other approved means of access through ducts for service to control equipment.
 - d. Install immersion wells, pressure tapping and any associated shut-off cocks.
 - e. Install automatic control valves and dampers.
 - f. Furnish automatic valve flanges and flange nuts as required.
- E. The temperature control contractor shall provide all hardware and software necessary to implement the functions and sequence of operations specified.

- F. All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the regular employment of the approved manufacturer's local field office.

1.03 SUBMITTALS

A. Submittal Data Brochures:

1. For inclusion in the submittal data brochures, the temperature control manufacturer shall submit a minimum of five (5) copies of complete temperature control diagrams showing existing temperature control system and components being replaced or added. Provide with written "sequence of control" and factory-printed specification data sheets, covering each control device proposed to be used, for the Engineer's approval prior to installation of any equipment or part of system.
2. Submittal data shall include a schedule of all devices to be installed. Deviations from the existing sequence of control will not be permitted without prior approval of the Engineer.

B. Operating and Maintenance Manuals:

1. For inclusion in the operating and maintenance manuals, provide three sets of complete operating and maintenance instructions with drawings, typewritten instructions and operating sequences, and descriptive data sheets. Assemble each set in a hard cover binder with "Temperature Controls" title placed on front cover and binding.

1.04 QUALITY ASSURANCE

- A. The temperature controls subcontractor shall perform a "quality check" of the entire control system with an Owner's representative immediately after completion of the installation of the control system. This shall involve inspection and validation of all points, control loops, features, etc., of the control system, and will also serve as hands-on training for the Owner's personnel. Provide minimum 8 hours training with Owner's maintenance staff.

1.05 SYSTEM MAINTENANCE

- A. Perform temperature control system preventative maintenance and support for a period of 1 year (beginning the date of substantial completion).
 1. Make a minimum of 2 complete temperature control system inspections, in addition to normal warranty requirements. Inspections to include:
 - a. System Review – Review the temperature control system to correct errors, failed points, points in alarm, and points that have been overridden manually.
 - b. Seasonal Control Loop Tuning – Control loops are reviewed to reflect changing seasonal conditions and/or facility heating and cooling loads.
 - c. Sequence of Operation Verification – Systems all verified to be operating as designed and in automatic operation. Scheduling and setpoints are reviewed and modified.
 - d. Operator coaching.

2. PRODUCTS

2.01 AIR FLOW CONTROL DAMPERS AND SMOKE DAMPERS

- A. Temperature control contractor shall provide control dampers of types indicated other than those provided with air handling units, dampers for miscellaneous use only are to be furnished hereinunder.
- B. Frames shall not be less than 13 gauge galvanized steel. Blades must not be over 8 inches wide nor less than 16 gauge galvanized steel roll formed. Bearings shall be iolite, ball bearing or nylon with ½ inch shafts. Side seals shall be stainless steel of the tight-seal spring type. Dampers and seals shall be suitable for temperature ranges of -40 to 200 degrees F.
- C. All proportional control dampers shall be opposed or parallel blade type and all two-position dampers shall be parallel-blade types.
- D. Dampers shall be minimum leakage type to conserve energy and the manufacturer shall submit leakage and flow characteristic data for all control dampers with the temperature control submitted. Maximum leakage shall be 3% at static pressure of 3 inches of w.c.
- E. All control dampers shall be factory-manufactured. Local fabrication of dampers is not allowed.
- F. Smoke dampers shall meet the requirements of the U.L. 555S. Leakage class I. Rated pressure and velocity shall exceed design airflow conditions.

2.02 CONTROL VALVES

- A. All modulating two-way water valves shall be provided with equal-percentage contoured throttling plugs. All three-way valves shall be provided with linear throttling plugs such that the total flow through the valves shall remain constant regardless of the valve's position.
- B. Valves 2 inches and smaller shall be screwed type; valves 2-1/2 inches and larger shall be flanged. Valves shall be factory-rated to withstand the pressure encountered. Valves shall have stainless steel stems and spring-loaded Teflon packing.
- C. Water valves shall be sized for a pressure drop equal to the coil they serve but not to exceed 5 psi. Valves shall have replaceable seats and disc.

2.03 ACTUATORS

- A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action under all environmental conditions (temperature, low power voltage fluctuations, tight seal damper design, maximum air and water flow forces).
 - 1. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
 - 2. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2": Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
 - 3. Spring-Return Motors for Valves Larger Than NPS 2-1/2": Size for running and breakaway torque of 150 in. x lbf.
 - 4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.

5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
- B. Electronic Damper and Valve Actuators: Direct-coupled type non hydraulic designed for minimum 100,000 full-stroke cycles at rated torque. The actuator shall have rating of not less than twice the thrust needed for actual operation of the damper or valve
1. Coupling: V-bolt and V-shaped, toothed cradle.
 2. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 3. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
 4. Actuators shall have the ability to be tandem mounted.
 5. All spring-return actuators shall have a manual override. Complete manual override shall take no more than 10 turns.
 6. Power Requirements (Two-Position Spring Return): 24V ac or dc, Maximum 10VA.
 7. Power Requirements (Modulating): Maximum 15 VA at 24V ac.
 8. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
 9. Temperature Rating: -22°F to 140°F.
 10. Run Time: 200 seconds open, 40 seconds closed.
 11. All actuators shall have a 5 year warranty
 12. Valves:
 - a. Size for torque required for valve close-off at maximum pump differential pressure (regardless of water loop system pressures).
 - b. Valve and Actuators shall come from the factory fully assembled.
 - c. Spring Return Manual Override shall come with a 10 Degree Valve Preload to assure tight close off.
 13. Dampers:
 - a. Size for running torque calculated as follows:
 - 1) Parallel-Blade Damper with Edge Seals: 7 inch-pounds/sq. ft. of damper.
 - 2) Opposed-Blade Damper with Edge Seals: 5 inch-pounds/sq. ft. of damper.
 - 3) Parallel-Blade Damper without Edge Seals: 4 inch-pounds/sq. ft. damper.
 - 4) Opposed-Blade Damper without Edge Seals: 3 inch-pounds/sq. ft. of damper.
 - 5) Dampers with 2 to 3 Inches wg. of Pressure Drop or Face Velocities of 1000 to 2500 FPM Multiply the minimum full-stroke cycles above by 1.5.
 - 6) Dampers with 3 to 4 Inches wg. of Pressure Drop or Face Velocities of 2500 to 3000 FPM Multiply the minimum full-stroke cycles above by 2.0.
 - b. Spring Return Manual Override actuators shall a factory set 5 Degree Damper Preload.

2.04 SENSING AND CONTROL DEVICES

- A. Start/stop relays shall provide maintained switching action as appropriate for the motor being controlled. All relays shall be plug-in, interchangeable, mounted on a circuit board or base and wired to numbered terminal strips.
- B. Differential pressure transmitters for air service shall be equal to those existing to be replaced. Scales and ranges shall be determined by the application. Ranges shall be sized as to operate in the middle of the control range under normal operation.
- C. New control panels shall be NEMA 1.
- D. Duct mounted pneumatic temperature controllers shall be provided as indicated. Controllers shall be direct or reverse acting (field selectable) as required by the application and shall function with 20 psig supply pressure. Controllers shall incorporate adjustable sensitivity and

- differential for field fine-tuning, and operate between -20 and 150 deg. F. Element and capillary shall be copper, and be installed in the duct at a location where accurate sensing of the airstream is accomplished. Minimum capillary length shall be 4 ft. Controller shall be equipped with integral output signal gauge to indicate output pressure.
- E. Pneumatic receiver controllers shall be provided as indicated. Controllers shall be direct or reverse action (field selectable), and shall be provided in single or dual input models with auxiliary reset as required. Controllers shall incorporate proportional or PI control (field selectable), and have adjustable gain, ratio, and integral time values. Controllers shall be installed in local control panels, and be equipped with integral output signal gauge to indicate output pressure. Controller body shall be a non-corrosive plastic enclosed in a clear, dustproof protective cover.
 - F. Duct low limit thermostat: Normally closed SPST contacts shall be provided to facilitate AHU shutdown upon detection of a temperature below setpoint in any one foot section of its 20 foot sensing element. Sensing element to be installed at the entering side of the AHU chilled water coil.
 - G. Capillary thermostats shall be of the liquid-filled type with stainless steel capillary tubing. The thermal system shall be field detachable and shall be of sufficient length to meet the control problem involved. A separable socket shall be furnished for each thermostat bulb that enters a liquid line. Capillary thermostats in air streams shall have averaging elements.
 - H. Electronic Temperature Sensors: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
 - 1. Resistance Temperature Detectors: Platinum, thermistor, or Balco
 - a. Accuracy: Plus or minus 0.2 percent at calibration point; thermistors shall have a maximum 5 year drift of no more than .225°F maximum error of no more than .36°F
 - b. Wire: Twisted, shielded-pair cable
 - c. Insertion Elements in Ducts: Single point, 6 inches long; use where not affected by temperature stratification or where ducts are smaller than 4 sq. ft.
 - d. Averaging Elements in Ducts: 60 inches, long, flexible for use where prone to temperature stratification or where ducts are larger than 4 sq. ft.; 264 inches long, flexible for use where prone to temperature stratification or where ducts are larger than 16 sq. ft; length as required.
 - e. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
 - f. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
 - g. Room Security Sensors: Stainless steel cover plate with insulated back and security screws.
 - I. Humidity Sensors: Bulk polymer sensor element.
 - 1. Accuracy: 2 percent at 10-90% RH with linear output.
 - 2. Room Sensors: Range of 0 to 100 percent relative humidity
 - 3. Duct and Outside-Air Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.
 - J. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
 - 1. Accuracy: +/- 1 percent of full scale with repeatability of 0.5 percent.
 - 2. Output: 4 to 20 mA, 0-5 vDC, 0-10 vDC.

3. Building Static-Pressure Range: -.1 to .1, -0.25 to 0.25, -.5 to .5, -1.0 to 1.0 IN WC., jumper selectable.
 4. Duct Static-Pressure Range: 0 to 1, 0 to 2.5, 0 to 5, 0 to 10 IN WC., jumper adjustable
- K. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; proportional output 4 to 20 mA

2.05 MISCELLANEOUS

- A. Equipment and components not listed shall be equal to the existing equipment and components being replaced.

3. EXECUTION

3.01 EXAMINATION

- A. Examine installation instructions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Control equipment and connecting piping shall be installed in a neat and workmanlike manner by trained mechanics in the direct employ of the control manufacturer. Install in accordance with manufacturer's instructions.

3.03 WIRING

- A. Temperature control subcontractor shall perform any and all wiring necessary for the operating sequence herein described with properly licensed personnel. Interlock or power wiring for control devices furnished under this section or furnished with mechanical equipment will be by Division 26 only where indicated on the electrical drawings.
- B. All wiring in mechanical rooms and other areas without ceilings shall be installed in conduit. All wiring for Air Handling Units and VAV terminal Units that are used for smoke control shall be installed in conduit.
- C. All conduit shall use threaded fittings. Screw type fittings are not allowed.
- D. Coordinate all control signals with equipment manufacturers. Hardware or software required for use of signal shall be provided by Section 23 09 00.
- E. All control and interlock wiring shall comply with the National, Local Electrical Codes, and Division 26 of these Contract Document specifications. Where the requirements of this section differ with those in Section 26000, the requirements of this section shall take precedence.
- F. Where Class 2 wires are in concealed and accessible locations; including ceiling return air plenums, approved cables outside of electrical raceway can be used provided that the following conditions are met:
1. Circuits meet NEC Class 2 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)

2. All cables shall be UL listed for application (i.e., cables used in ceiling plenums shall be UL listed specifically for that purpose).
- G. Do not install Class 2 wiring in conduits containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two via control relays and transformers.
- H. Where Class 2 wiring is run exposed, wiring shall be run parallel along a surface or perpendicular to it, and bundled, using approved wire ties at no greater than 10 ft. intervals. Such bundled cable shall be fastened to the structure, using industry approved fasteners, at 5 ft. intervals or more often to achieve a neat and workmanlike result.
- I. All wire-to-device connections shall be made at a terminal blocks or terminal strip. All wire-to-wire connections shall be at a terminal block, or with a crimped connector. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- J. Maximum allowable voltage for control wiring shall be 120Vac. If only higher voltages are available for use, the temperature control contractor shall provide step-down transformers to achieve the desired control voltages.
- K. All control wiring shall be installed as continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.
- L. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations in accordance with Contract Documents and National and/or Local Codes.
- M. Conduit and wire sizing shall be determined by the temperature control contractor in order to maintain manufacturer's recommendation and must meet National and Local Codes.
- N. Control and status relays are to be located in pre-fabricated enclosures that meet the application. These relays may also be located within packaged equipment control panel enclosures as coordinated. These relays shall not be located within Class 1 starter enclosures.
- O. Adhere to Division 26 requirements for installation of electrical raceways.
- P. Temperature control contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.
- Q. Flexible metal conduits and liquid-tight flexible metal conduits shall not exceed 3' in length and shall be supported at each end. Flexible metal conduit less than 1/2" electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal conduits shall be used.

3.04 PNEUMATIC TUBING INSTALLATION

- A. The control equipment and connecting piping shall be installed in a neat and workmanlike manner by trained mechanics in the direct employ of the control manufacturer.
- B. All tubing shall be enclosed in conduit. Conduit shall be run parallel to or at right angles to the building structure and shall be concealed in all finished spaces. Tubing shall be run in hard conduit in mechanical rooms or areas where other piping is exposed. Tubing shall not be strapped to ducts, pipes, conduits, ceiling support system, ceiling grid, etc.

- C. Non-metallic tubing used shall be virgin polyethylene, meeting stress-crack test ASTM D1693-60T. Tubing shall be self-extinguishing under ASTM D635, flammability test. This tubing shall be run within adequately supported rigid metallic raceway or electrical tubing.
- D. Short run final terminations shall be made with flexible polyethylene in lengths no longer than one foot.
- E. Number-coded polyethylene shall be used inside control cabinets. Flexible connections bridging the cabinet and its door shall be neatly fastened along the hinge-side and protected against abrasion.

3.05 IDENTIFICATION

- A. Install labels on control components. Labels shall match those shown on control drawings.

3.06 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
 - a. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
 - b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment, and retest.
 - c. Calibration and test electric/electronic thermostats by disconnecting input sensors and stimulating operation with compatible signal generator.
- B. Replace damaged or malfunctioning controls and equipment.
 - a. Start, test, and adjust control systems.
 - b. Demonstrate compliance with requirements, including calibration and testing, and control sequences.
 - c. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.
- C. Verify DDC as follows:
 - a. Verify software including automatic restart, control sequences, scheduling, reset controls, and occupied/unoccupied cycles.
 - b. Verify local control units including self-diagnostics.

3.06 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain control systems and components.
- B. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
- C. Provide operator training on understanding control system architecture and configuration, understanding system operation, logging on & off the system, adjusting and chaining system setpoints, changing time schedules, data display, alarm and status descriptors, requesting data, executing commands, calibrating and adjusting devices, resetting default values, and requesting logs. Include a minimum of 16 hours dedicated instructor time on-site.
- D. Review data in maintenance manuals.
- E. Schedule training with Owner with at least seven days' advance notice.

3.06 ON-SITE ASSISTANCE

- A. Occupancy Adjustments: Within one year of date of Substantial Completion, provide up to three Project site visits, when requested by Owner, to adjust and calibrate components and to assist Owner's personnel in making program changes and in adjusting sensors and controls to suit actual conditions.

END OF SECTION