

SECTION 23 09 00 – DIRECT DIGITAL CONTROL (DDC) SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes control equipment for HVAC systems and components, including control components, wiring and piping for equipment not directly controlled by the control system.
- B. Entire control system and components shall be UL Listed for application.

1.2 RELATED WORK

- A. Refer to Division 23 Section “Testing, Adjusting, and Balancing.”

1.3 SYSTEM DESCRIPTION

- A. Control system shall be [**pneumatic**][**direct digital control (DDC)**] and shall be 100% compatible with controls in the surrounding spaces.
- B. Control system consists of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories connected to controllers to operate mechanical systems according to sequences of operation indicated or specified.

1.4 SUBMITTALS

- A. Product Data for each type of product specified. Include manufacturer's technical Product Data for each control device furnished, indicating dimensions, capacities, performance characteristics, electrical characteristics, finishes of materials, installation instructions, and startup instructions.
- B. Shop Drawings (AutoCAD 2000, AutoCAD 14 or latest version) from manufacturer detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.
- C. Shop Drawings containing the following information for each control system:
 - 1. Schematic flow diagram showing fans, coils, dampers, valves, and control devices.
 - 2. Each control device labeled with setting or adjustable range of control.
 - 3. Diagrams for all required electrical wiring. Clearly differentiate between factory-installed and field-installed wiring. Label/tag all field installed wiring.
 - 4. Details of control panel faces, including controls, instruments, and labeling.
 - 5. Detailed written description of control sequence of operation.

- D. Provide point-to-point test and field quality control and testing plans as described in Part 3, Execution. Test plans shall be used in final acceptance to verify operation of all points and control functions specified.

1.5 COORDINATION

- A. Ensure installation of components is complementary to installation of similar components in other systems.
- B. Coordinate installation of control system components and control wiring and piping with installation of mechanical systems equipment such as fans and dampers.
- C. Ensure each system is completed and commissioned.
- D. Coordinate and support test/balance contractor for all balancing requirements.

1.6 OPERATION AND MAINTENANCE DATA

- A. Maintenance data for control systems equipment to include in the Operation and Maintenance Manual specified in Division 01 Section "Closeout Procedures." Include the following:
 - 1. Maintenance instructions and spare parts list (including unit cost) for each type of control device.
 - 2. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
 - 3. Calibration records and list of set points.
- B. Field Test Reports: Procedure and certification of control system.
- C. Project Record Documents:
 - 1. Accurately record actual location of control components, including panels, controllers, thermostats, and sensors.
 - 2. Revise shop drawings to reflect actual installation and operating sequences.
 - 3. Include data specified in "Submittals" in final "Record Documents" form.
 - 4. Perform and document results of field test plan.
 - 5. Certificate stating that control systems have been tested and adjusted for proper operation.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer specializing in control system installations.
- B. Startup Personnel Qualifications: Engage specially trained personnel in direct employ of manufacturer of primary control system.
- C. Comply with NFPA 70 and 90A.

- D. Comply with Underwriters Laboratories (UL).
- E. Electrical wiring shall comply with Division 16.
- F. Perform calibration, testing and execution of sequence of operations. Demonstrate to Owner or Owner's Representative each system operation.

1.8 SERVICE AND GUARANTEE

- A. After completion of the system, including software, submit a warranty in accordance with Division 01 Section "Warranties." Provide all services, materials and equipment necessary for the successful operation of the controls during the warranty period. Preventive maintenance shall be included.
- B. Provide inspection for opposite season to test, calibrate, and adjust controls; submit written report for each inspection.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Store equipment and materials inside and protected from weather.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following approved manufacturers / representatives: Johnson Controls, Siemens Building Technologies, or Alerton by ATS Automation.

2.2 CONTROLLERS

- A. Receiver Controllers: Single- or multiple-input models with control-point adjustment, direct or reverse acting with mechanical setpoint adjustment with locking device, proportional band adjustment, authority adjustment, and proportional control mode.
 - 1. Remote-control-point adjustment shall be plus or minus 20 percent of sensor span, input signal of 3 to 13 psig.
 - 2. Proportional band shall extend from 2 to 20 percent for 5 psig.
 - 3. Authority shall be 20 to 200 percent.
 - 4. Air-supply pressure of 18 psig, input signal of 3 to 15 psig and output signal 0 to supply pressure.
 - 5. Gages: 1-1/2 inches in diameter, 2.5 percent wide-scale accuracy, and range to match transmitter input or output pressure.

2.3 WIRING

- A. Provide complete electric wiring for temperature control apparatus, including transformer primaries. Control circuit conductors which run in the same conduit as power circuit conductors shall have the same insulation level as power circuit conductors.
- B. AC Control Wiring
 - 1. Control wiring for 24 V circuits shall be insulated copper 18 AWG minimum and shall be rated for 300 VAC service.
 - 2. Wiring for 120 VAC shall be 14 AWG minimum and shall be rated for 600 VAC service.

2.4 CONTROL COMPONENTS

- A. Pneumatic Transmitters: Vibration and corrosion resistant.
 - 1. Space-Temperature Sensors: Linear-output type, 50 to 100 deg F range, with blank locking covers matching room thermostats.
 - 2. Room Return-Air Temperature Sensors: Linear-output type with bimetal sensing element and corrosion-proof construction, 50 to 100 deg F range, designed to be mounted in light troffers.
 - 3. Duct-Mounted or Immersion-Type Temperature Sensors: 0 to 100 deg F range, 3 to 15 psig output signal.
- B. Actuators: Provide for all motor-operated dampers, valves and AHU Fan Flow Control Device of sufficient size and type, matched to application and operating temperature/pressures.
 - 1. Pneumatic actuators: Provide proportional or two position actuators with spring return to normal position on loss of control air. Positive positioning devices shall be provided for sequencing between controlled devices to prevent overlap and/or for controlled variable stability.
- C. Control Dampers: Provide low leakage control dampers where not furnished with package units. Damper leakage rate shall not exceed 0.5 percent (of damper based on 2000 fpm duct velocity) when closed against 4-inch water gage static pressure; complete with extruded aluminum, stainless steel or zinc-coated steel blades, with extruded vinyl or rubber edge seals: blade ends sealed with aluminum or stainless steel "arc" seals. External frame of heavy gage welded steel with 1/4 inch plate bearing bars and bronze insert bearings. Coordinate with Division 23 Sections "Metal Ducts" and "Air Duct Accessories" for installation provisions.
- D. Control Relays: Shall be rated for the application, with a minimum of two sets of Form C contacts, enclosed in a dustproof enclosure. Relays shall be rated for a minimum life of one million operations. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less. Relays should be equipped with coil transient suppression devices to limit transients to 150 percent of rated coil voltage.
- E. Low Limit Thermostat: DPDT, incremental bulb type; actuates if any 12 inch maximum increment is below its setting; adjustable setting, manual reset. Provide capillary element length of 2.14 equaling 2.14 square feet of coil area per foot capillary element. One DPDT contact shall shut down equipment and the second contact shall signal the DDC system.

- F. Contactors: Single coil electrically operated. Contacts shall be double break silver to silver. Number of contacts and rating shall be selected for the application intended. Operating and release times shall be 100 milliseconds or less. Contactors shall be equipped with coil transient suppression devices to limit transients to 150 percent of rated coil voltage.
- G. Transformer: Provide transformers shall conformance to UL 506. Power digital controllers on the primary communication trunk from dedicated circuit breakers. Provide a fuse cutout on the secondary side of the transformer.
- H. Nameplates: Laminated plastic 1/16 inch thick with neatly beveled edges and screwed to panel. Color shall be black with 0.375 inch white engraved block lettering.
- I. Temperature Indication: Provide Bimetal dial type indicator suitable for duct-mounted air sensing as indicated. If readability is not possible with duct-mounted thermometers, provide remote bulb dial type mounted for easy reading and labeled to identify temperature as indicated; 3 inch dial, range 0 to 160 deg F. Accuracy shall be 2 percent of full range.

2.5 PNEUMATIC CONTROL COMPONENTS

- A. I/P Transducer: Provide digital to pneumatic transducer to convert plus or minus 12 VDC pulse width modulation outputs or continuous proportional current or voltage to 0 to 20 psi.
- B. Control Air Piping:
 - 1. General: Control air supply is existing and shall be extended as required.
 - 2. Copper tubing: ASTM B75 or ASTM B88. Tubing 0.375 inch outside diameter and larger shall have a minimum wall thickness equal to ASTM B88, Type M. Tubing less than 0.375 inch outside diameter shall have a minimum wall thickness of 0.025 inch.
 - a. Concealed tubing shall be hard or soft copper: multiple tubing shall be racked or bundled.
 - b. Exposed tubing shall be hard copper; rack multiple tubing.
 - c. Fittings shall be solder type ASME B16.18 or ASME B16.22, using ASTM B32, 50/50 lead-tin solder, or compression type ASME B16.26.
 - 3. Polyethylene Tubing
 - a. Flame-resistant, single or multiple polyethylene tubing in extruded polyvinyl chloride (PVC) protective sheath.
 - b. Fittings shall be compression or barbed push-on type.
 - 4. Air Pressure Gauges: 1-1/2 inch minimum diameter, 0 to 30 psi scale. Provide on control signal tubing and main control air.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this section may properly commence.

- B. Notify the Owner's Representative in writing of conditions detrimental to the proper and timely completion of the work.

3.2 INSTALLATION (GENERAL)

- A. Install in accordance with manufacturer's instructions.
- B. Provide all miscellaneous devices, hardware installation required to insure a complete operating system in accordance with the sequences of operation.

3.3 LOCATION AND INSTALLATION OF COMPONENTS

- A. Locate and install components for easy accessibility; in general, mount 60 inches (panels measured from top edge) above floor with minimum 3'-0" clear access space in front of units.
- B. All instruments, switches, transmitters, etc., shall be suitably wired and mounted to protect them from vibration and high temperature.
- C. Identification: Provide permanently mounted tags to all instruments with point address designation, system reference and description. Label all wiring, tubing at each end to match control diagrams.
- D. Temperature Sensors: Provide temperature sensors in locations to sense the appropriate condition. Provide sensor where they are easy to access and service without special tools. Calibrate sensors to accuracy specified. In no case will sensors designed for one application be installed for another application.
 - 1. Room Temperature Sensors: Provide on interior walls to sense average room temperature conditions. Avoid locations which may be covered by office furniture. Room temperature sensors should not be mounted on exterior walls when other locations are available. Unless otherwise indicated, mount centerline of sensor at 5 feet above finished floor.
 - 2. Duct Temperature Sensors:
 - a. Select specific sensor location within duct to accurately sense appropriate air temperatures. Do not locate sensors in dead air spaces or positions obstructed by ducts or equipment. Install gaskets between the sensor housing and duct wall. Seal duct and insulation penetrations.
 - b. Install duct averaging sensors, freeze protection sensors, between two rigid supports in a serpentine position to sense average conditions. Thermally isolate temperature-sensing elements from supports. Provide duct access doors to averaging sensors.
- E. Damper Actuators: Actuators shall not be mounted in the air stream.

3.4 CONTROL WIRING AND CONDUIT

- A. All control wiring, all conduit for control wiring, and all miscellaneous accessory equipment for control wiring systems shall be provided by the control subcontractor as part of the control system. Conform to Division 26 requirements, NFPA 70, and all local code requirements.

- B. All wiring in or through mechanical rooms, finished spaces, on roofs, in walls, below grade and inside equipment (except within control wiring compartments or control panels) shall be installed in conduit and properly supported. Label wire groups to match corresponding wiring diagrams.

3.5 AIR PIPING

- A. Use copper tubing where subject to damage or temperatures in excess of 200 deg F, where adjacent to heating pipes passing through common sleeve, and where not readily accessible.
- B. Exposed or Inaccessible Areas: Copper or single/bundled plastic tubing shall be provided with a tray, conduit or raceway with suitable junction boxes. Attached directly to wall or ceiling, 4 feet on centers, using pipe clamps; or install in metal trays supported by steel rod hangers, installed within 6 inches of slabs. Do not attach any tubing to pipes and ducts.
- C. Concealed Accessible Areas: Flame resistant polyethylene tubing may be used when concealed in walls or above ceilings and within control panels. Attach directly to wall or slab on 4 foot centers, or support from ceiling suspension wires on 4 foot centers using bridle rings and Erico "Caddy" Cat. No. 2-1-2-4 spring clips. Do not install any tubing attached to pipes or ducts, or laid on ceilings.
- D. Tubing Identification: Tubing shall be provided with identification tags.
- E. Test: Compressed air piping at 30 percent over operating pressure. Blow out clean before attachment of any control instrumentation.

3.6 FIELD QUALITY CONTROL AND TESTING

- A. Demonstrate compliance of the HVAC control system with the contract documents. Calibrate instrumentation and controls and verify the specified accuracy using calibrated test equipment. Adjust controls and equipment to maintain conditions indicated, to perform functions indicated, and to operate in the sequence specified. Furnish personnel, equipment, instrumentation, and supplies necessary to perform calibration and site testing. Ensure that tests are performed by competent employees of the control system manufacturer regularly employed in the testing and calibration of control systems. Calibrate field equipment and verify equipment and system operation before placing the system on-line. Field testing will be witnessed by the Owner or Owner's Representative and shall include the following:
 - 1. System Inspection: Observe the HVAC system in its shutdown condition. Provide end-to-end wiring checkout. Check dampers and valves for proper normal positions. Document each position for the test report.
 - 2. Calibration Accuracy and Operation of Inputs Test: Check for proper calibration and operation of each input instrument. For each sensor (temperature), record the reading at the sensor, and using a traceable test equipment, and record the reading at the digital controller. Document each reading for the test report.
 - 3. Operation of Outputs Test: Check the operation of each output to verify correct operation. Command analog outputs to minimum range, such as 3 psig, and maximum range, such as 15 psig, measure and record commanded and actual output values. Document each command and result for the test report.

4. Actuator Range Adjustment Test: With the receiver controller, apply a control signal to each actuator and verify that the actuator operates properly from its normal position to full range of stroke position. Record actual spring ranges and normal positions for all modulating control valves and dampers. Include documentation in the test report.
- B. Document all tests with detailed results. Provide statement that all corrective action taken. Include test report in Operation and Maintenance Manuals.

PART 4 - SEQUENCE OF OPERATION

4.1 SEQUENCE OF OPERATIONS

- A. Sequence of Operation as indicated on Drawings.

END OF SECTION 23 09 00