

SECTION 230900 – INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish all labor, materials, equipment, and service necessary for a complete and operating building automation system.
- B. The Controls Contractor's work shall consist of the provision of all labor, materials, special tools, equipment, enclosures, power supplies, software, software licenses, project-specific software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, submittals, testing, verification, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, warranty, specified services and items required by the Contract that are required for the functional turn-key operation of the complete and fully functional Controls Systems. Documents are diagrammatic only. Equipment and labor not specifically referred to herein or on the plans, which are required to meet the functional intent, shall be provided without additional cost to the Owner.
- C. Related Sections include the following:
 - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
 - 2. Division 13 Section "Fire Alarm"
 - 3. Division 23 Section "Common Work Results for Mechanical"
 - 4. Division 23 Section "Sequence of Operation" for requirements that relate to this Section.
 - 5. Division 23 Section "Testing, Adjusting, and Balancing"
 - 6. Division 26

1.2 ACTION SUBMITTALS

- A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
 - 1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
 - 2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
 - 3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
 - 2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
 - 3. Wiring Diagrams: Power, signal, and control wiring.

4. DDC System Hardware:
 - a. Wiring diagrams for control units with termination numbers.
 - b. Schematic diagrams and floor plans for field sensors and control hardware.
 - c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.

5. Controlled Systems:
 - a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
 - b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
 - c. Written description of sequence of operation including schematic diagram.
 - d. List of I/O Points: Also known as a Point Schedule, provide for each input and output point physically connected to a digital controller: point name, point description, point type (Analog Output (AO), Analog Input (AI), Binary Output (BO), Binary Input (BI)), point sensor range, point actuator range, point address, BACnet object, associated BIBBS (where applicable), point connection terminal number. Typical schedules for multiple identical equipment are allowed unless otherwise requested in design or contract criteria.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and manufacturer.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals.
 1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
 2. Interconnection wiring diagrams with identified and numbered system components and devices.

1.5 QUALITY ASSURANCE

- A. All products used in this project installation shall be new and currently under manufacture and shall have been applied in similar installations for a minimum of two years. This installation shall not be used as a test site for any new products unless explicitly approved by the owner's representative in writing. Spare parts shall be available for at least five years after completion of this contract.
- B. 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 temperature control system manufacturer. Use only employees who are qualified, skilled, experienced, manufacturer trained and familiar with the specific equipment, software and configurations to be provided for this Project.
- C. Provide a complete, neat and workmanlike installation.
- D. All work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of the local, state, and federal authorities. Such codes, when more restrictive, shall take precedence over these plans and specifications.

- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- F. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."
- G. The contractor shall protect all work and material from damage by his/her work or employees. The contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The contractor shall protect any material that is not immediately installed. The contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

1.6 CONTRACTOR QUALIFICATIONS

- A. Qualified Bidders: System shall be as manufactured, installed and serviced by:
 - 1. Schneider Electric I/A, (Maine Controls)
 - 2. Johnson Controls, Inc.
 - 3. Honeywell
 - 4. Siemens
 - 5. Trane
 - 6. IB Controls
 - 7. Approved bidders. Bids from other vendors, franchised dealers, manufacturer's representatives, or from contractors who are authorized to represent the above named manufacturers must be pre-approved.
- B. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.
- C. The above list of manufacturers applies to operator workstation software, controller software, the custom application programming language, and controllers. All other products specified herein (e.g., sensors, valves, dampers, and actuators) need not be manufactured by the above manufacturers.
- D. Longevity: The Facilities Management System contractor shall have a minimum of ten years experience installing, and servicing computerized Building Automation Systems (BAS). All subcontractors utilized by the BAS contractor shall have a minimum of five-year experience within their appropriate trades.
- E. Past Projects: The BAS contractor shall have completed a minimum of ten projects within the last five years that are at least equal in dollar value and scope to this project. A list of similar projects, dollar volume, scope, contact name and contact number shall be provided by the BAS contractor if asked for by the owner.
- F. Personnel, Coverage and Response Capabilities: The BAS contractor shall have a minimum of ten full time electronic service personnel within a 120 mile radius of the project location. One of the five full time electronic service personnel must work within a 60-mile radius of the project location.
- G. The BAS contractor shall have an established 24-hour emergency service organization. A dedicated telephone number shall be provided to the owner for requesting emergency service. A maximum of four hour, electronic service technician on sight, response time shall be guaranteed by the BAS contractor.
- H. Parts Stocking: The BAS contractor shall have an independently verifiable inventory of electronic service parts. This electronic service parts inventory must have a worth of at least \$100,000 per year over the last five years.

1.7 COORDINATION

- A. Where the mechanical work will be installed in close proximity to, or will interfere with, work of other trades, the contractor shall assist in working out space conditions to make a satisfactory adjustment. If the contractor installs his/her work before coordinating with other trades, so as to cause any interference with work of other trades, the contractor shall make the necessary changes in his/her work to correct the condition.
- B. Coordinate and schedule work with all other work in the same area, or with work that is dependent upon other work, to facilitate mutual progress.
- C. Coordinate location of thermostats and other exposed control sensors with plans and room details before installation.
- D. Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the controls system specified in this section. These controls shall be integrated into the system and coordinated by the contractor.
- E. Electrical Subcontractor: Complying with the principle of "unit responsibility" all electrical work for automatic controls, except as otherwise specified, or shown on the electrical drawings shall be included in Division 23. Electrical work shall, in general, comply with the following, unless otherwise directed by Division 26:
 - 1. Power wiring.
 - 2. All control wiring shown on electric plans such as unit heater line-voltage room thermostats.
 - 3. Duct smoke detectors required for air handler shutdown are supplied under Section 237339.
 - 4. All electrical work shall comply with the N.E.C. and local electrical codes.
 - 5. All safety devices shall be wired through both hand and auto positions of motor starting device to insure 100% safety shut-off.
- F. Coordinate with controls specified in other sections of divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated by the BAS contractor as follows:
 - 1. All communication media and equipment shall be provided as specified hereinafter.
 - 2. Each supplier of a control product is responsible for the configuration, programming, start-up, and testing of that product to meet the sequences of operation described in this section.
 - 3. The BAS contractor shall coordinate and resolve any incompatibility issues that arise between the control products provided under this section and those provided under other sections or divisions of this specification.
 - 4. The BAS contractor is responsible for providing all controls described in the contract documents regardless of where within the contract documents these controls are described.
 - 5. The contractor is responsible for the interface of control products provided by multiple suppliers regardless of where this interface is described within the contract documents.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

1.9 WARRANTY

- A. Refer to Division 1 Requirements.
- B. The entire system shall be complete in every respect and guaranteed by the Contractor against original defects in workmanship or materials for a period of one year from date of final certificate, to control all valves so as to maintain temperature within one degree above or below any desired point. The Contractor shall maintain the equipment in perfect working order for the guarantee period without additional charge.
- C. At the end of the final start-up, testing, and commissioning phase, if equipment and systems are operating satisfactorily to the engineer, the engineer shall sign certificates certifying that the control system's operation has been tested and accepted in accordance with the terms of this specification. The date of acceptance shall be the start of warranty. All work shall have a single warranty date, even when the owner has received beneficial use due to an early system start-up.
- D. All components, system software, and parts supplied by the BAS contractor shall be guaranteed against defects in materials and workmanship for one year from acceptance date. The BAS contractor at no charge shall furnish Labor to repair, reprogram, or replace components during the warranty period. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software disks. The Contractor shall respond to the owner's request for warranty service within 24 hours during normal business hours.

PART 2 - PRODUCTS

2.1 BUILDING AUTOMATION SYSTEM

- A. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software.
- B. Install new wiring and network devices as required to provide a complete and workable control network.
- C. Provide open control, either:
 - 1. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
 - 2. LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA 709.1 datalink/physical layer protocol.

2.2 DDC EQUIPMENT

- A. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
 - 1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
 - 2. Functions include the following:
 - a. Capability to function in standalone mode or as part of a building automation network.
 - b. Removable electronics module mates with panel-mounted subbase.
 - c. Removable terminals for power and communications, to facilitate commissioning.
 - d. Integral MS/TP jack for direct connection of a programming laptop.

- e. MS/TP DIP switch addressable.
 - f. Service pin button for BACnet “I am” message broadcast.
 - g. Isolated EIA- 485 (formerly RS-485) transceiver for MS/TP communications.
 - h. MS/TP baud rate selection from 9.6 up to 76.8 kbaud.
 - i. LED indication of MS/TP and Ethernet IP communication activity, controller status, DO state, and UO state.
 - j. Application-programmable LED provides on/off indication of a user-defined application parameter.
 - l. Firmware upgradeable over the network.
 - m. 72 hour, battery-backed real time clock.
 - n. BBMD, remote connectivity across subnets.
 - o. Support for Remote I/O Modules
 - p. IP/Ethernet bridge.
 - q. BACnet router functionality.
- A. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
- 1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
 - 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse I/O.
 - c. Monitoring, controlling, or addressing data points.
- B. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
- 1. Binary Inputs: Allow monitoring of on-off signals without external power.
 - 2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
 - 3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
 - 4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation.
 - 5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA).
 - 6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
 - 7. Universal I/Os: Provide software selectable binary or analog outputs.
- C. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type.
- D. Power Line Filtering: Internal or external transient voltage and surge suppression for controllers.

2.3 SENSING DEVICES

- A. Resistance Temperature Detectors (RTDs): Provide RTD sensors with platinum elements compatible with the digital controllers. Encapsulate sensors in epoxy, series 300 stainless steel, anodized aluminum, or copper. Temperature sensor accuracy shall be 0.1 percent (1 ohm) of expected ohms (1000 ohms) at 32 degrees F. Temperature sensor stability error over five years shall not exceed 0.25 degree F cumulative.

Direct connection of RTDs to digital controllers without transmitters is preferred. When RTDs are connected directly, lead resistance error shall be less than 0.25 degrees F. The total error for a RTD circuit shall not exceed 0.5 degree F.

- B. Sensors shall be securely attached to a suitable base mounted on the wall or other building surface. Each sensor shall be located where shown or, if not shown, where it will respond to the average temperature in the room. Sensors generally shall be mounted 5 feet above floor and shall not be mounted on outside walls.

2.4 ELECTRICAL POWER AND DISTRIBUTION

- A. Transformers: Transformers shall conform to UL 506. For control power other than terminal level equipment, provide a fuse or circuit breaker on the secondary side of each transformer.
- B. Wiring: Provide complete electrical wiring for the DDC System, coordinate line of demarcation with Division 26. Unless indicated otherwise, provide all normally visible or otherwise exposed wiring in conduit. Where conduit is required, control circuit wiring shall not run in the same conduit as power wiring over 100 volts. Circuits operating at more than 100 volts shall be in accordance with Division 26. Run all circuits over 100 volts in conduit, metallic tubing, covered metal raceways, or armored cable. Use plenum-rated cable for circuits under 100 volts in enclosed spaces. Examples of these spaces include HVAC plenums, within walls, attics, or above suspended ceilings.
- C. Power Wiring: The following requirements are for field-installed wiring: Wiring for 24 V circuits shall be insulated copper 18 AWG minimum and rated for 300 VAC service. Wiring for 120 V circuits shall be insulated copper 14 AWG minimum and rated for 600 VAC service.
- D. Analog Signal Wiring: Field-installed analog signal wiring shall be 18 AWG single or multiple twisted pair. Each cable shall be 100 percent shielded and have a 20 AWG drain wire. Each wire shall have insulation rated for 300 VAC service. Cables shall have an overall aluminum-polyester or tinned-copper cable-shield tape.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the architect/engineer for resolution before rough-in work is started.
- B. The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started. Verify that duct-, pipe-, and equipment-mounted devices and wiring are installed before proceeding with installation.
- C. The contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate—or if any discrepancies occur between the plans and the contractor's work of others—the contractor shall report these discrepancies to the engineer and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect of the contractor to report such discrepancies shall be made by—and the expense of—this contractor.

3.2 INSTALLATION

- A. Install all components in accordance with the manufacturer's recommendations. Perform the installation under the supervision of competent technicians regularly employed in the installation of DDC systems.
- B. Install equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.
- C. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- D. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices. Contractor shall continually monitor the field installation for code compliance and quality of workmanship. Contractor shall have work inspected by local and/or state authorities having jurisdiction over the work.
- E. Temperature Sensors: Install temperature sensors in locations that are accessible and provide a good representation of sensed media. Installations in dead spaces are not acceptable. Calibrate sensors according to manufacturer's instructions. Do not use sensors designed for one application in a different application.
- F. Room Temperature Sensors: Verify location of thermostats and other exposed control sensors with plans and room details before installation. Mount the sensors on interior walls to sense the average room temperature at the locations indicated. Avoid locations near heat sources such as copy machines or locations by supply air outlet drafts. Mount the center of the sensor 48 inches above the floor to meet ADA requirements.

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install raceways, boxes, and cabinets according to Division 26.
- B. Install building wire and cable according to Division 26.
- C. Install signal and communication cable according to Division 26.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.
- B. Testing: A minimum of two technicians for at least two (2) days minimum for testing procedures. Prior to the final inspection, perform required tests and submit the reports and records along with final readings with technicians signed certification of compliance. The following shall be done as a minimum:
 - 1. Verify every point in the system and record findings with one technician at a D.C.C. panel to operate a point command and the other to observe the point and insure function has been carried out.
 - 2. Confirm and record all temperatures being correctly read within acceptable tolerance.

3.5 ADJUSTING

- A. On completion of the job, the Contractor shall completely adjust, ready for use, all sensors, valves, and relays provided under his contract.
- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.6 DEMONSTRATION & TRAINING

- A. The Contractor shall provide a complete instruction manual covering the function and operation of all control components on the job and a schematic control diagram. This manual shall be furnished to the Owner's operating personnel, and a competent technician shall be provided for instruction purposes for two (2) days minimum. Instructions shall be video taped in CD format and two copies provided to the Owner.

END OF SECTION 239000