

SECTION 23 09 23

DIRECT-DIGITAL CONTROL FOR HVAC

This document is intended to note the Owners Design Requirements (ODR) for the titled specification section. Design professional to review and integrate ODR into the project's technical specifications. This ODR document should not be viewed as a standalone technical specification.

PART 1 - GENERAL REQUIREMENTS

◆ SUMMARY

- All automation and control components shall be integrated into the existing Honeywell HVAC EBI communicating over a non-proprietary local area network. This system shall consist of all necessary hardware and all operating and applications software necessary to perform the control sequences of operation as called for in the Specifications and Drawings.
- The Drawings and Specifications are not intended to show all details. The Controls Contractor shall secure satisfactory information before submitting the proposal and include in the proposal a sum sufficient to cover all items of labor and material required or the complete installation for the devices and system described.

◆ COORDINATED WORK

- The Controls Contractor shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. Each Contractor shall consult the Drawings and Specifications for all trades to determine the nature and extent of others work. Controls contractor shall ensure that electrical contractor understands the line voltage and conduit requirements for the controls to be operational prior to contractors bid to the OWNER.
- CONTRACTOR RESPONSIBILITIES
- Contractor responsibilities shall include the following but shall not be limited to:
 - Controls Contractor:
 - Provide control devices, panels, transformers, and relays. All final connections to control devices and all programming.
 - Prior to submitting a BID to CCDOA, the controls contractor shall coordinate with Electrical Contractor; Controls contractor shall provide the location and routing of conduit/wire for all items provided by controls contractor that require line voltage.
 - Electrical Work for Controls:
 - 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 this Section.
 - Electrical work shall, in general, comply with the following:
 - All safety devices shall be wired through both hand and auto positions of motor starting device to ensure 100% safety shut-off.
 - All magnetic starters furnished by Electrical Contractor for mechanical equipment shall be furnished with integral 120 volt control transformers, sized to handle the additional VA needed for the controls - pilots, EP valves, etc.
 - The motor starter supplier shall provide auxiliary contacts as required for interlock by controls contractor, the supplier shall estimate an allowance of at least one auxiliary contact per starter. All interlock and control wiring shown on the electrical prints is by the Electrical Contractor.
 - Electrical Contractor:
 - Rough-in of all conduits and wall boxes in concrete and block walls for sensors, thermostats and temperature control devices, etc.
 - All control wiring at 50 volts and above shall be installed by a qualified Electrician.

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- Control wiring under 50 volts may be installed by the Contractor furnishing it.
- All interlock wiring such as exhaust fan interlocked to supply fan, regardless of voltage.
- All power wiring to mechanical equipment and temperature control cabinets.
- Mechanical Contractor:
 - Installation of immersion wells and pressure tapings.
 - Installation of flow switches.
 - Setting of automatic control valves.
 - Installation of pressure tapings and associated shut-off cocks.
- Sheet Metal Contractor:
 - Setting of automatic control dampers, smoke control dampers, and necessary blank off plates.
 - Access doors where and as required.
- ♦ CONTROL EQUIPMENT AND DEVICES
 - Control Dampers
 - Dampers required in the temperature and smoke control functions of the automatic control system shall be factory fabricated. All dampers shall be sized as shown on drawings or as specified.
 - All damper frames shall have a flange for duct mounting.
 - The blades shall be parallel or opposed, as required, and suitable for the air velocities to be encountered in the system.
 - Damper blades shall not exceed 6" in width. Blades are to be suitable for high velocity performance. Damper blades shall be a maximum of 48" long. Longer units shall be fabricated in sections.
 - Replaceable Butyl rubber seals are to be provided on damper blades and installed along with the top and bottom of the frame. Jamb seals shall be installed inside the frame sides. Seals and bearings shall be able to withstand temperatures ranging from -40°F to 200°F.
 - Dampers for control of outside air and relief air shall be Ruskin CD-50 or equivalent extruded aluminum, low leakage damper, with nylon bearings and blade and frame seals on all mating surfaces. Damper leakage shall not exceed 4.0 CFM/square foot in full closed position at 1" WG pressure differential across damper.
 - All other dampers shall be equal to Ruskin CD-35 or equivalent with 16 gauge steel blades, 16 gauge steel channel frame, oilite bronze bearings, cadmium plated shafts and blade and jamb seals.
 - Control Valves
 - Control Valves shall be furnished by the controls contractor and sized by the control manufacturer to meet the heating and cooling loads as specified. All control valves shall be suitable for the pressure conditions and shall close against the differential pressures involved.
 - The valve shall have flow balancing, isolation and a two-port control valve in the same body. The valve isolation should be achieved either by the control actuator or manually with a shut off cap.
 - Nominal body rating shall be not less than 125 PSI. However, the valve body and

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- packing selected shall be sized to withstand the system static head plus the maximum pump head and the maximum temperature of the control medium (i.e. chilled water, steam, hot water, etc.).
- The valve internals shall have a double plug and seat for balancing and controlling flow from the regulated position.
- The valve should be able to have a universal removable adjustment key for all the valves to preset Cv values in the conventional manner. The adjustment key can be removed to prevent any tampering by unintended personnel.
- Flow Characteristics: Valves for water service shall have equal percentage flow characteristics. Valves for steam service shall have linear flow characteristics.
- The valve body and the self-sealing pressure test points shall be made of dezincification resistant alloy
- The seat and spindle seal shall consist of EPDM and Stainless Steel or Ametal® material.
- Two-way modulating valves shall have close-off ratings exceeding the maximum pressure difference, at any load condition, between the outlet and inlet.
- Each valve shall be equipped with proper packing to assure there will be no leakage at the valve stem.
- Operators
 - A damper or valve operator shall be provided for each automatic damper or valve and shall be of sufficient capacity to operate the damper or valve under all conditions and to guarantee tight close-off of dampers or valves as specified against system pressure encountered.
 - Each operator shall be of "Fail-in-Place" design except as follows: Pre-heat coils, return air dampers and other devices needing fail safe operation to account for low temperatures shall be provided with spring-return for Fail-Open. Humidifiers, hot water generator steam valves, outside air dampers and other devices needing fail safe operation to account for freeze protection, power failure, overheating or moisture damage shall be provided with spring-return for Fail-Closed.
 - Damper and valve operators shall be manufactured by Bray, Belimo, Honeywell or approved equal.
- Solenoid-Operated Control Valves: Provide factory fabricated, bronze body, bronze trim, two-way, globe type control valve with replaceable plugs and seats, and threaded ends.
 - Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.
 - Sizing: 3-psig maximum pressure drop at design flow rate, to close against pump shutoff head.
 - Flow Characteristics: Valves for water service shall have equal percentage flow characteristics. Valves for steam service shall have linear flow characteristics.
 - Operator: Modulating sized for torque required for valve close off at maximum pump differential pressure and designed to operate with 24 volt ac power.
- Pressure Independent (PI) Control Valves: Provide PI control valve consisting of an integrated valve body that incorporates an adjustable Cv chamber and separate pressure regulating chamber to maintain a constant differential pressure across the control surface. PI Control Valves shall be able to have the valve flow characteristics modified without removing the valve from the piping system.

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- PI Control Valve shall be supplied with presets from the factory.
- Valve stroke shall not be limited in order to achieve design condition.
- The valve should be able to have a universal removable adjustment key for all the valves to preset Cv values in the conventional manner.
- Valve shall be Ametal® with an EQM plug made of EPDM rings. PI Control Valves larger than 2" shall be ductile iron or carbon steel body rated at minimum 150 psig working pressure with stainless steel flow regulator and EPDM or Teflon diaphragm.
- Valve shall have three integral ports factory installed capable of being used to measure pressure or temperature. The first port shall be installed at the inlet to the valve, the second shall be installed between the Cv chamber and the pressure regulating chamber and the third port shall be installed at the outlet of the valve.
- PI Control Valves shall be provided with electronic actuator driven by a 24V dc motor from a 0-10V dc or 4-20 ma signal. Valve shall be capable of a close-off rating of 1.25 working PSID.
- Manufacturer shall warrant each PI Control Valve for a minimum of 5 years from date of shipment.
- Manufacturers: Subject to compliance with requirements, provide PI Control Valves by one of the following:
 - Belimo.
 - Honeywell
 - Bray
- Sensors and Controllers: Install space sensors, thermostats and humidistats at 48" above finished floor to meet ADA requirements unless otherwise noted on the plans.
 - Differential Pressure Switch for water shall have a single-pole, single-throw (SPST) contact, adjustable setpoint, UL rated 6 amperes at 120 volts, 100 psig design, and shall be Johnson Controls P74 Series with automatic reset, or equivalent. Each switch shall be provided with isolation and drain valves.
 - Differential Pressure Switch for air shall have a single-pole, single-throw (SPST) contact, adjustable setpoint, UL rated 9.8 amperes at 120 volts, and shall be Johnson Controls P32 Series or equivalent.
 - Duct Type Temperature Transmitter shall be a general purpose sensing element, moisture resistant transmitter for mounting into a duct. The operating range shall be as indicated with an accuracy of + 1% over the full range. The output shall be compatible with the panel it serves.
 - Duct Averaging Type Temperature Transmitter shall be a general purpose sensing element, moisture resistant transmitter for mounting into a duct. The operating range shall be as indicated with an accuracy of + 1% over the full range. The output shall be compatible with the panel it serves. Transmitter shall be with 17 feet of sensor capillary.
 - Space Temperature Transmitter shall contain a sensing element to monitor room air temperatures in the range of 30°F to 90°F, unless indicated otherwise. The transmitter shall be factory calibrated to an accuracy of + 1%. The assembly shall be installed within a metal ventilated enclosure suitable for wall mounting. The output shall be a compatible with the panel it serves. Transmitter shall be factory calibrated to an accuracy of + 1% over the full range.

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- Pipe Temperature Transmitter shall contain a sensing element to monitor water temperature. The Contractor shall provide brass wells of sufficient size for the pipe to be installed. The output shall be compatible with the panel it serves. Transmitter shall be factory calibrated to an accuracy of + 1% over the full range.
 - Outdoor Air Temperature Transmitter shall contain a sensing element mounting in an enclosure rated for outdoor use. The output shall be compatible with the panel it serves. Transmitter shall be factory calibrated to an accuracy of + 1% over the full range.
 - Carbon Dioxide Sensors: Provide Veris, Toxalert, or approved equal carbon dioxide (CO₂) sensor where indicated on the drawings and as specified herein. Carbon dioxide sensors shall measure total percentage of CO₂ in PPM. Sensor shall have an accuracy of ± 50 PPM of CO₂. Sensors shall provide 4-20mA output signal. Sensors shall be duct or space mounted as indicated on the drawings.
 - Pressure Transducer for air, water or steam service shall have a stainless steel sensor. The device shall output a 4-20 ma signal which is linear in relation to the sensed pressure. Accuracy shall be + .05% of the full scale. Power shall be from the controller and range from 22-26 volts DC. The unit shall have temperature compensation so that thermal effects are no more than + .05% of the full scale from 0°F to 175°F. The unit shall be suitable for the media and pressure measured. On steam systems, provide pressure sensors with a pigtail siphon between the sensor isolation valve and sensor.
 - Differential Pressure Transducer for air or water service shall have a stainless steel sensor. The device shall output a 0-5 volt DC or 4-20 ma signal which is linear in relation to the sensed pressure. Accuracy shall be + .01% of full scale. The power shall be from the controller and shall be in the range of 22-26 volts DC. The unit shall have temperature compensation so that thermal effects are no more than + .05% of the full scale from 32°F to 100°F. The transducer shall be suitable for the media and pressure measured
 - Current Transformers:
 - Current transformers shall be designed to be installed or removed without dismantling the primary bus or cables. The transformer shall be of a split core design.
 - The core and windings shall be completely encased in a UL approved thermoplastic rated 94VA. No metal parts shall be exposed other than the terminals.
 - Current transformers shall meet the following specifications:
 - Frequency Limits: 50 to 400 Hz.
 - Insulation: 0.6 KV Class, 10 KV BIL.
 - Accuracy: $\pm 1\%$ at 5.0 to 25.0 VA accuracy class with U.P.F. burden.
 - Provide a disconnect switch for each current transformer.
 - Current Sensing Switches
 - Current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. Current sensing switches shall consist of a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept overcurrent up to twice its trip into range.
- ♦ FLOW MEASURING APPARATUS
- Duct Air Flow Measuring Stations

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- General:
 - Duct air flow measuring station shall be a multiple probe, aluminum constructed device located in a configuration and size equal to that of the duct it is installed. Sensors shall be provided along the approaching airflow to measure airflow by thermal dispersion technology.
 - The airflow traverse probe shall not induce a measurable pressure drop, nor amplify the sound level within the duct by its presence in the airstream.
 - The number of probes, sensors on each probe or the use of an air-straightener shall be based upon the technology utilized to comply with the ASHRAE Standards for duct traversing accuracy.
 - Stations utilizing thermal dispersion technology shall utilize hermetically sealed thermistors for each sensor and shall be factory calibrated to NIST traceable standards. Stations utilizing velocity pressure shall be AMCA certified.
 - Duct air flow measuring stations shall be accurate to $\pm 2.0\%$ of the measured airflow range down to 1000 feet per minute.
- ◆ ELECTRICAL CONTROL POWER AND LOW VOLTAGE WIRING
 - Provide interlock wiring between supply and return fans, electrical wiring for relays (including power feed) for temperature and pressure indication. Provide interlock wiring between refrigeration machines, pumps and condensing equipment as required for the specified sequence of operation and the refrigeration system integral controller(s). Do not provide interlock wiring if a dedicated digital output has been specified for the equipment or the sequence of operation requires independent start/stop.
 - Provide power wiring, conduit and connections for low temperature thermostats, high temperature thermostats, alarms, flow switches, actuating devices for temperature, humidity, pressure and flow indication, point resets and user disconnect switches for electric heating appliances controlled by this Section.
 - Provide all other wiring required for the complete operation of the specified systems.
 - FMS Network Communication Requirements
 - Wired network communication shall be via channels consisting of a 24 AWG twisted pair installed in a 3/4" EMT.
 - In all communication conduits, provide one spare twisted pair to be installed, tagged and labeled at each end.
 - Telephone lines, where required as a remote communication source, shall utilize voice band, non-switched, private line channels consistent with Bell Systems Technical Reference Pub. 41001 and shall be four-wire unconditioned 3002 channels. The modems shall have 25 pin EIA connectors and RS-232C interface.
 - Communication conduits shall not be installed closer than six feet from high power transformers or run parallel within six feet of electrical high power cables. Care shall be taken to route the cable as far from interference generating devices as possible.
 - All shields shall be ground (earth ground) at one point only, to eliminate ground loops.
 - There shall be no power wiring, in excess of 30 VAC rms, run in conduit with communications wiring. In cases where signal wiring is run in conduit with communication wiring, all communication wiring and signal wiring shall be run using separate twisted shielded pairs (24awg) with the shields grounded in accordance with the manufacturer's wiring practice.

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- Power & Communication Wiring Transient Protection
 - The control manufacturer's shall submit catalog data sheets providing evidence that all FMS products offered by the manufacturer are tested and comply with the standard for Transient Surge withstand capabilities for electrical devices ANSI C62.41, IEEE-587-1980, Categories A and B. Such testing shall have included power and communication trunk wiring. Compliance with IEEE-587 shall imply conformance with IEEE-472 transient standards based on the stated position of ANSI and IEEE regarding applicability of the rated standards.
 - Communications trunk wiring shall be protected with a transient surge protection device providing the minimal protection required.
 - The communications circuitry, input/output circuitry, and CU's, shall provide protection against a 1000 volt, 3 amp transient signal, directly applied to the communication or input/output terminations. The manufacturer's catalog data sheet shall provide evidence of conformance with this requirement. Systems not complying with this requirement shall provide equivalent protection external to the ATCS controller. Protection shall be provided for the individual communications and input/output terminations for each ATCS controller. Submittal documentation shall clearly define how this requirement will be met and how the external protection will not affect the performance of the controllers.
- Input/Output Control Wiring
 - Control wiring shall be sized to accommodate the voltage drop associated with the distance between the control device and the controller. Minimum size shall be as specified herein.
 - Control wiring not installed in conduit shall be UL rated for plenum installation.
 - RTD wiring shall be three-wire or four-wire twisted, shielded, minimum number 22 gauge.
 - Other analog inputs shall be a minimum of number 22 gauge, twisted, shielded.
 - Binary control function wiring shall be a minimum of number 18 gauge.
 - Analog output control functions shall be a minimum of number 22 gauge, twisted, shielded.
 - Binary input wiring shall be a minimum of number 22 gauge.
 - Thermistors shall be equipped with the manufacturer's calibrated lead wiring.
 - 120V control wiring shall be #14 THHN in 3/4" conduit. Provide 4 or 20% fill extra wire in each conduit.
- Splices
 - Splices in shielded cables shall consist of terminations and the use of shielded cable couplers that maintain the integrity of the shielding. Terminations shall be in accessible locations. Cables shall be harnessed with cable ties as specified herein.
- Conduit and Fittings
 - Conduit for Control Wiring, Control Cable and Transmission Cable: Electrical metallic tubing (EMT) with compression fittings, cold rolled steel, zinc coated or zinc-coated rigid steel with threaded connections.
 - Outlet Boxes (Dry Location): Sheradized or galvanized drawn steel suited to each application, in general, four inches square or octagon with suitable raised cover.
 - Outlet Boxes (Exposed to Weather): Threaded hub cast aluminum or iron boxes with gasket device plate.

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- Pull and Junction Boxes: Size according to number, size, and position of entering raceway as required by National Electrical Codes. Enclosure type shall be suited to location.
- Relays
 - Relays other than those associated with digital output cards shall be general purpose, enclosed plug-in type with 8-pin octal plug and protected by a heat and shock resistant duct cover. Number of contacts and operational function shall be as required.
 - Solid State Relays (SSR): Input/output isolation shall be greater than 10^9 ohms with a breakdown voltage of 1500V root mean square or greater at 60 Hz. The contact life shall be 10×10^6 operations or greater. The ambient temperature range of SSRs shall be -20 to +140F. Input impedance shall not be less than 500 ohms. Relays shall be rated for the application. Operating and release time shall be for 100 milliseconds or less. Transient suppression shall be provided as an integral part of the relay.
 - Contactors: Contactors shall be of the single coil, electrically operated, mechanically held type. Positive locking shall be obtained without the use of hooks, latches, or semi permanent magnets. Contactor shall be double-break, silver-to-silver type protected by arcing contacts. The number of contacts and rating shall be selected for the application. Operating and release times shall be 100 milliseconds or less. Contactors shall be equipped with coil transient suppression devices.

PART 2 - PRODUCTS AND MATERIALS

- ◆ GENERAL PRODUCT DESCRIPTION
- ◆ NETWORKING/COMMUNICATIONS

- Inherent in the system's design shall be the ability to expand or modify the network
- Local Network
 - Personal Computer/Panel Support: The Personal Computer or Digital Panel shall directly oversee a local network such that communications may be executed directly to and between standalone controllers. The Personal Computer version and Digital Panel version shall be referred to as the "Digital Panel(s)" throughout this document.
 - Data Access: All operator devices in network, shall have the ability to access all point status and application report data on the network. Access to system data shall not be restricted by the hardware configuration of the facility management system.
 - Global Data Sharing: Global Data Sharing or Global point broadcasting shall allow point data to be shared between standalone controllers, when it would be inefficient or impractical to locate multiple sensors.
 - General Network Design: Network design shall include the following provisions:
 - Data transfer rates for alarm reporting and quick point status from multiple standalone controllers. The minimum baud rate shall be 56000 baud.
 - Support of any combination of standalone controller's. A minimum of 100 standalone controller's shall be supported on a single local network. The bus shall be addressable for up to 255 standalone controllers.
 - Detection of single or multiple failures of standalone controller's or the network media.
 - Error detection, correction, and re-transmission to guarantee data integrity.
 - Commonly available, multiple-sourced, networking components shall be used.

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◆ DIGITAL PANELS

- General: Digital Panels shall be microprocessor-based, multi-tasking, multi-user, digital control processors.
- Memory: Non-volatile memory shall be incorporated for all critical controller configuration data. Each Digital Panel shall have sufficient memory to support its own operating system and data bases including:
 - Control processes
 - Energy Management Applications
 - Alarm Management
 - Trend Data
 - Maintenance Support Applications
 - Operator I/O
 - Manual Override Monitoring
- Expandability: The system shall be modular in nature, and shall permit easy expansion through the addition of field controllers, sensors, and actuators.
- Serial Communication Ports: Digital Panels shall provide at least two RS-232C serial data communication ports for simultaneous operation of multiple operator I/O devices, such as laptop computers, Personal Computers, and Video Display terminals.
- Hardware Override Monitoring: Digital Panels shall monitor the status of all overrides, and include this information in logs and summaries to inform the operator that automatic control has been inhibited.
- Integrated On-Line Diagnostics: Each Digital Panel shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all subsidiary equipment. Digital Panels shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each Digital Panel.
- Surge and Transient Protection: Isolation shall be provided at all network terminations, as well as all field point terminations, to suppress induced voltage transients consistent with IEEE Standard 587-1980. Isolation levels shall be sufficiently high as to allow all signal wiring to be run in the same conduit as high voltage wiring where acceptable by electrical code.
- Powerfail Restart: In the event of the loss of normal power, there shall be an orderly shutdown of the Digital Panel to prevent the loss of data base or operating system software. Upon restoration of normal power, the Digital Panel shall automatically resume full operation without manual intervention.
- Battery backup: Battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.

◆ SYSTEM SOFTWARE FEATURES

- General:
 - All necessary software to form a complete operating system, as described in this specification, shall be provided.
 - The software programs specified in this section shall be provided as an integral part of the Digital Panel, and shall not be dependent upon any higher level computer for execution.

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- Control Software Description:
 - Equipment Cycling Protection: Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.
 - Heavy Equipment Delays: The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.
- Energy Management Applications: Digital Panels shall have the ability to perform any or all of the following energy management routines:
 - Time of Day Scheduling
 - Calendar Based Scheduling
 - Holiday Scheduling
 - Optimal Start
 - Optimal Stop
 - Demand Limiting
 - Load Rolling
 - Heating/Cooling Interlock
- Programs: All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow user customization. Programs shall be applied to building equipment described in the "Execution" portion of this specification.
- Programming Capability: Digital Panels shall be able to execute configured processes defined by the user to automatically perform calculations and control routines.
 - Process Inputs and Variables: It shall be possible to use any of the following in a configured process:
 - Any system-measured point data or status
 - Any calculated data
 - Any results from other processes
 - Boolean logic operators (and, or)
 - Process Triggers: Configured processes may be triggered based on any combination of the following:
 - Time of day
 - Calendar Date
 - Other processes
 - Events (e.g., point alarms)
- Alarm Management: Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. Each Digital Panel shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall the Digital Panel's ability to report alarms be affected by either operator activity at the local I/O device, or communications with other standalone controllers on the network.
 - Point Change Report Description: All alarm or point change reports shall include the points' English language description, and the time and date of occurrence.
 - Prioritizing: The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator

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response to critical alarms. A minimum of three priority levels shall be provided. Users shall have the ability to manually inhibit alarm reporting for each point. The user shall also be able to define conditions under which point changes need to be acknowledged by an operator, and/or logged for analysis at a later date.

- Report Routing: Alarm reports and messages shall be directed to an operator device.
- Alarm Messages: In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 60-character alarm message to more fully describe the alarm condition or direct operator response. Each Digital Panel shall be capable of storing a library of at least 100 Alarm Messages. Each message may be assignable to any number of points in the panel.
- Auto-Dial Alarm Management: In Dial-up applications, only critical alarms shall initiate a call to a remote operator device. In all other cases, call activity shall be minimized by time-stamping and saving reports until a manual request is received, or until the buffer space is full. The alarm buffer must store a minimum of 50 alarms.
- Trends - Trends shall conform to the BACnet Trend Log Object specification. Each trend shall be set to historically maintain the trend information for 90 days. The system shall be able to trend and display graphically any analog, digital or calculated points. A trend log's properties shall be editable using the Navigation Tree and Graphic Pane.
 - Controls contractor shall submit the points intended for trending under the project via PROCORE.

PART 3 - EXECUTION

- ◆ startup and demonstration
 - Control system shall be set up and checked by competent technicians skilled in the setting and adjustment of the controls equipment used in this project. This technician is to be experienced in the type of HVAC systems associated with this project.
 - At the completion of the startup, this contractor shall demonstrate the sequence of operations for each system to the Owner or his representative.
 - At the completion of the start-up, the contractor shall demonstrate the pressure independent control valves meet the scheduled values as defined in the construction documents.
- ◆ TRAINING
 - General: At a time mutually agreed upon between the OWNER and Contractor, provide the services of a factory trained and authorized representative to train OWNER's designated personnel for a minimum of eight hours on the operation and maintenance of the equipment provided under this section.
 - The Controls Contractor shall provide 2 training courses.
 - Content: Training shall include but not be limited to:
 - Overview of the system and/or equipment as it relates to the facility as a whole.
 - Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.
 - Review data included in the operation and maintenance manuals.
 - Schedule: Schedule training with OWNER with at least 7 days' advance notice.

END OF SECTION