# DIVISION 23 – HEATING, VENTILATING, AND AIR-CONDITIONING

## 23 00 00 HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)

### 23 09 00 Instrumentation and Control for HVAC

**23 09 13 Instrumentation and Control Devices for HVAC**

**23 09 13.13 Actuators and Operators**

1. General Requirements
   1. Damper and valve actuators shall be electronic, as specified in the System Description section.
   2. The manufacturer shall be ISO 9001 certified.

##### Electronic Damper Actuators

* 1. Spring Return Actuators:
     1. Manufactured, brand labeled or distributed by Johnson Controls, Inc. or approved equivalent.
     2. Regulatory Agency Listing: cULus ,CSA C22.2 No. 24-93, and CE marked
     3. Direct-Coupled Design: Requires no crankarm or linkage for mounting to a shaft.
     4. Coupling: toothed V-bolt clamp and nuts with toothed cradle.
     5. Reversible Mounting: Provides either clockwise or counterclockwise operation.
     6. Power Failure Operation: Mechanical spring return system drives load to the home position. Other forms of internal energy storage for power failure operation are not acceptable.
     7. Motor Technology: i. Modulating Types: Microprocessor-controlled Brushless DC motor ii. On/Off Types: DC brush motor.
     8. Overload Protection: Electronic stall detection protects from overload at all angles of rotation without the use of end switches.
     9. Enclosure Ratings: i. NEMA type 2 / IP54 mounted in any orientation.
     10. Double-Insulated construction: Eliminate the need for electrical ground wires.
     11. Wiring: Integral cables with colored and numbered conductors.
     12. Sized for torque required to seal damper at load conditions
     13. Parallel Operation: Actuators shall be available that are capable of being mechanically or electrically paralleled.
     14. Proportional actuators shall be user configurable without the use of external computer software or programming tools. Calibration, input signal range selection, and control logic reversal shall be selectable with an external mode selection switch.
     15. Operating Temperature Range: i. 70 lb·in. Torque and Below: -40°F to 140°F ii. 71 lb·in. Torque and above: -40°F to 131°F
     16. Power Requirements:

i. Modulating Types:

* + - * + 27 lb·in. Torque and Below: 5VA maximum
        + 70 lb·in. to 19 lb·in.Torque: 8VA maximum
        + 89 lb·in. to 71 lb·in.Torque: 10VA maximum
        + 90 lb·in. to 177 lb·in.Torque: 16VA maximum
      1. 2-Position Types:
         * 27 lb·in. Torque and Below: 5VA maximum
         * 70 lb·in. to 19 lb·in.Torque: 7VA maximum
         * 71 lb·in. to 177 lb·in.Torque: 25VA maximum
  1. Non-Spring Return Actuators:
     1. Manufactured, brand labeled or distributed by Johnson Controls, Inc. or approved equivalent.
     2. Regulatory Agency: UL Listed ,CSA Certified, and CE marked
     3. Direct-Coupled Design: Requires no crankarm or linkage for mounting to a shaft.
     4. Coupling:
        1. Above 80 lb.·in.: toothed V-bolt clamp and nuts with toothed cradled
        2. 80 lb.·in.and below: single cup-point set screw and toothed cradle.
     5. Overload Protection: Electronic stall detection or magnetic slip clutch protects from overload at all angles of rotation without the use of end switches.
     6. Minimum Enclosure Ratings:
        1. Types with covered wiring terminals: NEMA type 2 / IP42 mounted in any orientation.
        2. Types without covered wiring terminals: NEMA type 1 / IP30 or IP40.
        3. Types with integrated cables: NEMA 2 / IP42 mounted in any orientation.
     7. Sized for torque required to seal damper at load conditions
     8. Parallel Operation: Actuators shall be available that are capable of being mechanically or electrically paralleled.
     9. Proportional actuators shall be user configurable without the use of external computer software or programming tools.
     10. Operating Temperature Range: -4°F to 122°F except for VAV and similar indoor applications in which case 32°F to 122°F is acceptable.
     11. Power Requirements: 24 V with models available for both 24 VAC and 24 VDC operation, maximum
         1. Above 80 lb.·in.: 7.5 VA at 24 VAC
         2. 80 lb.·in.and below: 3.5 VA at 24VAC
     12. The manufacturer shall provide 5-year limited warranty from the date of sale covering defects in material or workmanship.

**23 09 13.23 Sensors and Transmitters**

#### General Requirements

##### Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements.

#### Temperature Sensors

##### General Requirements:

###### Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.

###### The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD.

###### The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:

| Point Type | Accuracy |
| --- | --- |
| Chilled Water | + .5°F. |
| Room Temp | + .5°F. |
| Duct Temperature | + .5°F. |
| All Others | + .75°F. |

##### Room Temperature Sensors

###### Room sensors shall be constructed for either surface or wall box mounting.

###### Room sensors shall have the following options when specified:

###### Setpoint warmer/cooler dial or reset slide switch providing a +3 degree (adjustable) range.

###### Individual heating/cooling setpoint slide switches.

###### A momentary override request push button for activation of after-hours operation.

###### Analog thermometer.

##### Room Temperature Sensors with Integral Display

###### Room sensors shall be constructed for either surface or wall box mounting.

###### Room sensors shall have an integral LCD display and four button keypad with the following capabilities:

###### Display room air temperatures.

###### Display and adjust room comfort setpoint.

###### Display and adjust fan operation status.

###### Timed override request push button with LED status for activation of after-hours operation.

###### Display controller mode.

###### Password selectable adjustment of setpoint and override modes.

##### Thermo wells

###### Thermowell manufacturer shall have models available in stainless steel, brass body, and copper bulb.

###### When thermo wells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and sensor.

###### Thermo wells shall be pressure rated and constructed in accordance with the system working pressure.

###### Thermo wells and sensors shall be mounted in a direct mount (no adapter) offering faster installation or 1/2” NFT saddle and allow easy access to the sensor for repair or replacement.

###### Thermo wells constructed of 316 stainless steel shall comply with Canadian Registration Number (CRN) pressure vessel rating.

##### Outside Air Sensors

###### Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.

###### Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.

###### Temperature transmitters shall be of NEMA 3R (IP54) or NEMA 4 (IP65) construction and rated for ambient temperatures.

###### The outdoor sensor can be easily mounted on a roof, pole or side of a building utilizing its already assembled mounting bracket.

###### Outside Relative Humidity sensors 0-100% full range of accurate measurement. Operating temperature -4 to 140F (-20 to 60C).

###### Outside temperature sensors operating temperature range is -40 to 140F, +/- .55F (+/- .3C).

##### Duct Mount Sensors

###### Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.

###### Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.

###### For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

##### Averaging Sensors

###### For ductwork greater in any dimension that 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.

###### For plenum applications, such as mixed air temperature measurements, a continuous averaging sensor or a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment.

###### Capillary supports at the sides of the duct shall be provided to support the sensing string.

##### Acceptable Manufacturers: Johnson Controls, Minco.

**Note**: Include others, as appropriate.

#### Humidity Sensors

##### The sensor shall be a solid-state type, relative humidity sensor of the Thin Film Capacitance or Bulk Polymer Design. The sensor element shall resist service contamination.

##### The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 4-20 mA, 0-100% linear proportional output.

##### The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. 3% between 20% and 80% RH @ 77 Deg F unless specified elsewhere.

##### Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R (IP54) or NEMA 4 (IP65) enclosure with sealtite fittings.

##### A single point humidity calibrator shall be provided, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.

##### Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.

##### Acceptable Manufacturers: Johnson Controls and Vaisala.

#### CO2 Sensors

##### Where shown on the drawings, C02 sensors shall have either of the following features:

###### 0-10VDC output, 0-2000PPM Range

###### Communicate on the Network Sensor Bus

##### The C02 sensors shall have the ability to monitor and output the following variables as required by the systems sequence of operations:

###### Zone carbon-dioxide

##### The C02 Sensors shall be available with

###### CO2 reponse time (0-63%) of 1 minute

###### Less than 0.083% of full scale/F˚ temperature dependence of CO2 output

###### Long term CO2 stability ±5% of full scale for 5 years

###### CO2 measurement accuracy of ±(40ppm + 2.0% of reading)

###### CO2 non-linearity of less than 1.0% of full scale

##### The C02 Sensors may include the following items :

###### Relay output module

###### Liquid Crystal Display module

###### Analog temperature module with linear 0-10VDC output for 32-122F

#### Differential Pressure Transmitters

##### General Air Pressure Transmitter Requirements:

###### Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.

###### Pressure transmitters shall transmit a 0 to 5 VDC output signal.

###### Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device.

###### A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible.

##### Building Differential Air Pressure Applications (-1” to +1” w.c.)

###### The differential pressure transmitter shall be of industrial quality and transmit a linear, 0 to 5 vdc output in response to variation of differential pressure or air pressure sensing points.

###### The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:

###### -1.00 to +1.00 w.c. input differential pressure ranges. (Select range appropriate for system application)

###### 0 to 5 vdc output.

###### Maintain accuracy up to 20 to 1 ratio turndown.

###### Reference Accuracy: +0.2% of full span.

###### Acceptable Manufacturers: Johnson Controls

##### Low Differential Air Pressure Applications (0” to 5” w.c.)

###### The differential pressure transmitter shall be of industrial quality and transmit a linear, 0 to 5 vdc output in response to variation of differential pressure or air pressure sensing points.

###### The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:

###### (0.00 - 1.00” to 5.00”) w.c. input differential pressure ranges. (Select range appropriate for system application.)

###### 0-5 VDC output.

###### Maintain accuracy up to 20 to 1 ratio turndown.

###### Reference Accuracy: +0.25%, or 0.5% of full span.

###### Acceptable Manufacturers: Johnson Controls and Ruskin.

###### Status and Safety Switches

##### General Requirements

###### Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.

##### Current Sensing Switches

###### The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, 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 over-current up to twice its trip point range.

###### Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.

###### Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.

###### Acceptable manufacturers: Johnson Controls

##### Air Filter Status Switches

###### Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.

###### A complete installation kit shall be provided, including: static pressure tops, tubing, fittings, and air filters.

###### Provide appropriate scale range and differential adjustment for intended service.

###### Acceptable manufacturers: Johnson Controls, Cleveland Controls

##### Air Flow Switches

###### Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.

###### Acceptable manufacturers: Johnson Controls, Cleveland Controls

##### Air Pressure Safety Switches

###### Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120VAC.

###### Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.

###### Acceptable manufacturers: Johnson Controls, Cleveland Controls

##### Water Flow Switches

###### Water flow switches shall be equal to the Johnson Controls P74.

##### Low Temperature Limit Switches

###### The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.

###### The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.

###### For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.

###### The low temperature limit switch shall be equal to Johnson Controls A70.

###### Control Relays

##### Control Pilot Relays

###### Control pilot relays shall be of a modular plug-in design with retaining springs or clips.

###### Mounting Bases shall be snap-mount.

###### DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.

###### Contacts shall be rated for 10 amps at 120VAC.

###### Relays shall have an integral indicator light and check button.

###### Acceptable manufacturers: Johnson Controls, Functional Devices

##### Lighting Control Relays

###### Lighting control relays shall be latching with integral status contacts.

###### Contacts shall be rated for 20 amps at 277 VAC.

###### The coil shall be a low-voltage coil that when de-energized is in the normally closed position so the lights fail ON.

###### Thermostats

##### Electric room thermostats of the heavy-duty type shall be provided for unit heaters, cabinet unit heaters, and ventilation fans, where required. All these items shall be provided with concealed adjustment. Finish of covers for all room-type instruments shall match and, unless otherwise indicated or specified, covers shall be manufacturer’s standard finish.

**23 09 13.33 Control Valves**

1. Ball Valves, 1/2 through 2 in.:
2. Ball Valves shall have forged brass bodies.
3. Valves shall have available either Chrome Plated Brass Balls or 300 Series Stainless Steel Balls in all sizes.
4. Valves shall have available either Nickel Plated Brass Stems or 300 Series Stainless Steel Stems with a blow-out proof stem design in all sizes.
5. Valves shall have Graphite reinforced Polytetrafluoroethylene (PTFE) seats with Ethylene Propylene Diene Monomer (EPDM) O-ring backing.
6. Stem seals shall be double EPDM O-rings.
7. Flow Characterization Disk shall be manufactured from Amodel AS-1145HS Polyphthalamide Resin and rated for 50 psid maximum differential pressure and shall be inserted against the casting of the valve.
8. All ball valves with internal pipe thread end connections shall be rated to 580 psi maximum static pressure at 203°F (95°C) fluid temperature.
9. All ball valves with sweat end connections or press end connection shall be rated to 300 psig maximum static pressure at 203°F (95°C) fluid temperature
10. All valves shall be rated for service with hot water, chilled water and 50% glycol solutions.
11. Ball Valves with stainless steel balls and stems shall be rated for use with 15 psig saturated steam.
12. Flow Characteristics shall be equal percentage on the control port. Bypass port on three-way valves shall have linear flow characteristics.
13. Valves shall have a maximum leakage specification of 0.01% of maximum flow for the control port, ANSI/FCI 70-2, Class 4 and 1% of maximum flow, bypass port.
14. Valves shall be maintenance free
15. Valves shall be provided with a 5 year warranty.
16. Valves shall be rated for 200 psid closeoff pressure.
17. Valve actuators shall be UL-recognized or CSA-certified.

###### Valves shall be Johnson Controls VG1000 Series ball valves or approved equal.

1. Globe Valves, Brass, 1/2 through 2 in.
2. Valves shall have bodies manufactured from a RoHS compliant brass.
3. Valves shall meet the pressure and temperature requirements of ANSI B16.15, Class 250
4. Valve stems shall be a 300 Series Stainless Steel.
5. Valves with brass plug and seat shall have stem seals with Self-Adjusting Ethylene Propylene Rubber (EPR) Ring Pack U-Cups
6. Valves with Stainless Steel plug and seat shall valve stem seals with Spring Loaded Polytetrafluoroethylene (PTFE) and Elastomer V-Rings
7. Valves with brass trim shall have a maximum leakage specification of 0.01% of maximum flow per ANSI/FCI 70-2, Class 4 and valves with stainless steel trim shall have a maximum leakage of 0.05% of maximum flow
8. Flow Characteristics shall be equal percentage for two-way valves and linear for three-way valves.
9. Valves shall be serviceable without being removed from the pipe.
10. Valves shall be provided with a 3 year warranty.
11. Valve electric actuators shall be UL-recognized or CSA-certified.
12. Valves shall be Johnson Controls VG7000 Series globe valves or approved equal.
13. Electric Zone Valves, 1/2 through 1-1/4 in.
14. Valves shall have bodies manufactured from Forged Brass.
15. Valves stems shall be brass (Hard Chrome Plated)
16. Valve Actuator shall be UL, cUL listed or CSA certified.
17. Valves shall be rated for service with hot water, chilled water and 50% glycol solutions.
18. Two Position valves shall have models available rated for use with 15 psig saturated steam.
19. Valve Actuator shall be replaceable without removing valve from the pipe.
20. Modulating Valves flow characteristics shall be equal percentage
21. Valves shall be provided with a 2 year warranty.
22. Valve actuators shall be UL-recognized or CSA-certified.
23. Valves shall be Johnson Controls J Series electric zone valves or approved equal.

**23 09 13.43 Control Dampers**

##### The BMS Contractor shall furnish all automatic dampers. All automatic dampers shall be sized for the application by the BMS Contractor or as specifically indicated on the Drawings.

##### All rectangular dampers used for throttling airflow shall be of the opposed blade type arranged for normally open or normally closed operation, as required. The damper is to be sized so that, when wide open, the pressure drop is a sufficient amount of its close-off pressure drop to shift the characteristic curve to near linear.

##### All rectangular dampers used for two-position, open/close control shall be parallel blade type arranged for normally open or closed operation, as required.

##### Rectangular damper frames and blades shall be constructed of either galvanized steel or aluminum. Maximum blade length in any section shall be 60”. Damper blades shall be 16-gauge minimum and shall not exceed eight (8) inches in width. Damper frames shall be 16-gauge minimum hat channel type with corner bracing. All damper bearings shall be made of reinforced nylon, stainless steel or oil-impregnated bronze. Dampers shall be tight closing, low leakage type, with synthetic elastomer seals on the blade edges and flexible stainless steel side seals. Dampers of 48”x48” size shall not leak in excess of 8.0 cfm per square foot when closed against 4” w.g. static pressure when tested in accordance with AMCA Std. 500.

##### Airfoil blade dampers of double skin construction with linkage out of the air stream shall be used whenever the damper face velocity exceeds 1500 FPM or system pressure exceeds 2.5” w.g., but no more than 4000 FPM or 6” w.g.

##### Acceptable manufacturers are Johnson Controls VD-1250, or VD1630, Ruskin CD50 or CD60, and Vent Products 5650.

##### One piece rolled blade dampers with exposed or concealed linkage may be used with face velocities of 1500 FPM or below.

##### Acceptable manufacturers are: Johnson Controls VD-1620, Ruskin CD36, and Vent Products 5800.

##### Multiple section dampers may be jack-shafted to allow mounting of piston pneumatic actuators and direct connect electronic actuators. Each end of the jackshaft shall receive at least one actuator to reduce jackshaft twist.

##### Round dampers shall be one piece and constructed with 20ga galvanized steel and sealed with polyurethane foam tape. Acceptable manufactures are: Johnson Controls, Ruskin

**23 09 23 Direct-Digital Control System for HVAC**

## Part 1 – General

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### Related Documents

#### All work of this Division shall be coordinated and provided by the single Building Management System (BMS) Contractor or Mechanical Contractor.

#### The work of this Division shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference the Division 15 Sections for details.

#### The work of this Division shall be as required by the Specifications, Point Schedules and Drawings.

#### If the BMS or Mechanical Contractor believes there are conflicts or missing information in the project documents, the Contractor shall promptly request clarification and instruction from the design team.

### Definitions

#### Analog: A continuously variable system or value not having discrete levels. Typically exists within a defined range of limiting values.

#### Binary: A two-state system where an “ON” condition is represented by one discrete signal level and an “OFF” condition is represented by a second discrete signal level.

#### Building Management System (BMS): The total integrated system of fully operational and functional elements, including equipment, software, programming, and associated materials, to be provided by this Division BMS Contractor or Mechanical Contractor and to be interfaced to the associated work of other related trades.

#### BMS Contractor: The single Contractor to provide the work of this Division. This Contractor shall be the primary manufacturer, installer, commissioner and ongoing service provider for the BMS work.Mechanical Contractor: The single contractor that can provide a bundle solution of HVAC equipment and controls for the work of this division. This contractor shall be the primary

#### Control Sequence: A BMS pre-programmed arrangement of software algorithms, logical computation, target values and limits as required to attain the defined operational control objectives.

#### Direct Digital Control: The digital algorithms and pre-defined arrangements included in the BMS software to provide direct closed-loop control for the designated equipment and controlled variables. Inclusive of Proportional, Derivative and Integral control algorithms together with target values, limits, logical functions, arithmetic functions, constant values, timing considerations and the like.

#### BMS Network: The total digital on-line real-time interconnected configuration of BMS digital processing units, workstations, panels, sub-panels, controllers, devices and associated elements individually known as network nodes. May exist as one or more fully interfaced and integrated sub-networks, LAN, WAN or the like.

#### Node: A digitally programmable entity existing on the BMS network.

#### BMS Integration: The complete functional and operational interconnection and interfacing of all BMS work elements and nodes in compliance with all applicable codes, standards and ordinances so as to provide a single coherent BMS as required by this Division.

#### Provide: The term “Provide” and its derivatives when used in this Division shall mean to furnish, install in place, connect, calibrate, test, commission, warrant, document and supply the associated required services ready for operation.

#### PC: Personal Computer from a recognized major manufacturer

#### Furnish: The term “Furnish” and its derivatives when used in this Division shall mean supply at the BMS Contractor’s cost to the designated third party trade contractor for installation. BMS Contractor shall connect furnished items to the BMS, calibrate, test, commission, warrant and document.

#### Wiring: The term “Wiring” and its derivatives when used in this Division shall mean provide the BMS wiring and terminations.

#### Install: The term “Install” and its derivatives when used in this Division shall mean receive at the jobsite and mount.

#### Protocol: The term “protocol” and its derivatives when used in this Division shall mean a defined set of rules and standards governing the on-line exchange of data between BMS network nodes.

#### Software: The term “software” and its derivatives when used in this Division shall mean all of programmed digital processor software, preprogrammed firmware and project specific digital process programming and database entries and definitions as generally understood in the BMS industry for real-time, on-line, integrated BMS configurations.

#### The use of words in the singular in these Division documents shall not be considered as limiting when other indications in these documents denote that more than one such item is being referenced.

#### Headings, paragraph numbers, titles, shading, bolding, underscores, clouds and other symbolic interpretation aids included in the Division documents are for general information only and are to assist in the reading and interpretation of these Documents.

#### The following abbreviations and acronyms may be used in describing the work of this Division:

ADC - Analog to Digital Converter

AHJ - Authority Having Jurisdiction

AI - Analog Input

AN - Application Node

ANSI - American National Standards Institute

AO - Analog Output

ASCII - American Standard Code for Information Interchange

ASHRAE American Society of Heating, Refrigeration and Air Conditioning Engineers

AWG - American Wire Gauge

BTL - BACnet Testing Laboratories

CPU - Central Processing Unit

CRT - Cathode Ray Tube

DAC - Digital to Analog Converter

DDC - Direct Digital Control

DI - Digital Input

DO - Digital Output

EEPROM - Electronically Erasable Programmable Read Only

Memory

EMI - Electromagnetic Interference

FAS - Fire Alarm Detection and Annunciation System

GUI - Graphical User Interface

HOA - Hand-Off-Auto

ID - Identification

IEEE - Institute of Electrical and Electronics Engineers

I/O - Input/Output

IT - Information Technology

LAN - Local Area Network

LCD - Liquid Crystal Display

LED - Light Emitting Diode

MCC - Motor Control Center

NC - Normally Closed

NIC - Not In Contract

NO - Normally Open

OWS - Operator Workstation

OAT - Outdoor Air Temperature

PC - Personal Computer

RAM - Random Access Memory

RF - Radio Frequency

RFI - Radio Frequency Interference

RH - Relative Humidity

ROM - Read Only Memory

RTD - Resistance Temperature Device

SPDT - Single Pole Double Throw

SPST - Single Pole Single Throw

XVGA - Extended Video Graphics Adapter

TBA - To Be Advised

TCP/IP - Transmission Control Protocol/Internet

Protocol

TTD - Thermistor Temperature Device

UPS - Uninterruptible Power Supply

VAC - Volts, Alternating Current

VAV - Variable Air Volume

VDC - Volts, Direct Current

WAN - Wide Area Network

### BMS Description

#### The Building Management System (BMS) shall be a complete system designed for use with the enterprise IT systems. This functionality shall extend into the equipment rooms. Devices residing on the automation network located in equipment rooms and similar shall be fully IT compatible devices that mount and communicate directly on the IT infrastructure in the facility. Contractor shall be responsible for coordination with the owner’s IT staff to ensure that the BMS will perform in the owner’s environment without disruption to any of the other activities taking place on that LAN.

#### Any and all components of the BMS that are connected via field bus or IP network, including the network controllers, field controllers, application specific controllers, server and user interface software, system and controller programming tools and software applications shall be designed, engineered, and tested to work together as a complete building management system, and shall be manufactured by the same BMS manufacturer. Systems that use or require network controllers, field controllers, application specific controllers, server and user interface software, programming tools and software from more than one BMS manufacturer shall not be accepted.

#### All points of user interface shall be on standard PCs, laptops, phones and/or other mobile devices that do not require the purchase of any special software from the BMS manufacturer for use as an interface. The primary point of interface on these devices will be a standard Web Browser.

#### The work of the single BMS Contractor shall be as defined individually and collectively in all Sections of this Division specification together with the associated Point Sheets and Drawings and the associated interfacing work as referenced in the related documents.

#### The BMS work shall consist of the provision of all labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, cleaning, cutting and patching, warranties, services, and items, even though these may not be specifically mentioned in these Division documents which are required for the complete, fully functional and commissioned BMS.

#### Provide a complete, neat and workmanlike installation. Use only manufacturer employees who are skilled, experienced, trained, and familiar with the specific equipment, software, standards and configurations to be provided for this Project.

#### Manage and coordinate the BMS work in a timely manner in consideration of the Project schedules. Coordinate with the associated work of other trades so as to not impede or delay the work of associated trades.

#### The BMS as provided shall incorporate, at minimum, the following integrated features, functions and services:

###### Operator information, alarm management and control functions.

###### Enterprise-level information and control access.

###### Information management including monitoring, transmission, archiving, retrieval, and reporting functions.

###### Diagnostic monitoring and reporting of BMS functions.

###### Offsite monitoring and management access.

###### Energy management

###### Standard applications for terminal HVAC systems.

###### Indoor Air Quality monitoring and control

**Note:** Item h maybe removed if job does not specify IAQ control

### Quality Assurance

#### General

##### The Building Management System Contractor must be certified by and trained by the manufacture who’s Building Management System they are engineering, programming, installation and servicing. Independent controls contractors who are authorized by the BMS manufacturer must provide a letter written and signed by a company officer of the specific BMS manufacturer. This document must be dated within the 30 days prior to bid submittal and must state that they are currently a “direct authorized representative” in good standing for the BMS manufacturer for the building management system products described and listed in this specification, that they have “direct purchasing access” to all of the BMS manufacturer’s controllers, components and technical support, and that they will continue to be an Authorized representative with this access for the duration of the installation and warranty phases of project.

##### The Building Management System architecture shall consist of the products of a manufacturer regularly engaged in the production of Building Management Systems, and shall be the manufacturer’s latest standard of design at the time of bid.

#### Workplace Safety and Hazardous Materials

##### Provide a safety program in compliance with the Contract Documents.

##### The BMS Contractor shall have a corporately certified comprehensive Safety Certification Manual and a designated Safety Supervisor for the Project.

##### The Contractor and its employees and sub trades shall comply with federal, state and local safety regulations.

##### The Contractor shall ensure that all subcontractors and employees have written safety programs in place that covers their scope of work, and that their employees receive the training required by the OSHA rules that have jurisdiction for at least each topic listed in the Safety Certification Manual.

##### Hazards created by the Contractor or its subcontractors shall be eliminated before any further work proceeds.

##### Hazards observed but not created by the Contractor or its subcontractors shall be reported to either the General Contractor or the Owner within the same day. The Contractor shall be required to avoid the hazard area until the hazard has been eliminated.

##### The Contractor shall sign and date a safety certification form prior to any work being performed, stating that the Contractors’ company is in full compliance with the Project safety requirements.

##### The Contractor’s safety program shall include written policy and arrangements for the handling, storage and management of all hazardous materials to be used in the work in compliance with the requirements of the AHJ at the Project site.

##### The Contractor’s employees and subcontractor’s staff shall have received training as applicable in the use of hazardous materials and shall govern their actions accordingly.

#### Quality Management Program

##### Designate a competent and experienced employee to provide BMS Project Management. The designated Project Manager shall be empowered to make technical, scheduling and related decisions on behalf of the BMS Contractor. At minimum, the Project Manager shall:

###### Manage the scheduling of the work to ensure that adequate materials, labor and other resources are available as needed.

###### Manage the financial aspects of the BMS Contract.

###### Coordinate as necessary with other trades.

###### Be responsible for the work and actions of the BMS workforce on site.

### References

#### All work shall conform to the following Codes and Standards, as applicable:

**Note:** Edit those that apply to this job

##### National Fire Protection Association (NFPA) Standards.

##### National Electric Code (NEC) and applicable local Electric Code.

##### Underwriters Laboratories (UL) listing and labels.

##### UL 864 UUKL Smoke Control

##### UL 268 Smoke Detectors.

##### UL 916 Energy Management

##### NFPA 70 - National Electrical Code.

##### NFPA 90A - Standard For The Installation Of Air Conditioning And Ventilating Systems.

##### NFPA 92A and 92B Smoke Purge/Control Equipment.

##### Factory Mutual (FM).

##### American National Standards Institute (ANSI).

##### National Electric Manufacturer’s Association (NEMA).

##### American Society of Mechanical Engineers (ASME).

##### American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)

##### Air Movement and Control Association (AMCA).

##### Institute of Electrical and Electronic Engineers (IEEE).

##### American Standard Code for Information Interchange (ASCII).

##### Electronics Industries Association (EIA).

##### Occupational Safety and Health Administration (OSHA).

##### American Society for Testing and Materials (ASTM).

##### Federal Communications Commission (FCC) including Part 15, Radio Frequency Devices.

##### Americans Disability Act (ADA)

##### ANSI/EIA 909.1-A-1999 (LonWorks)

##### ANSI/ASHRAE Standard 195-2008 (BACnet)

#### In the case of conflicts or discrepancies, the more stringent regulation shall apply.

#### All work shall meet the approval of the Authorities Having Jurisdiction at the project site.

### Work By Others

**Note:** Include responsibility matrix as required for project coordination and common practice of the specifier.

#### The demarcation of work and responsibilities between the BMS Contractor and other related trades shall be as outlined in the BMS RESPONSIBILITY MATRIX

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **BMS RESPONSIBILITY MATRIX** |  |  |  |  |
| **WORK** | **FURNISH** | **INSTALL** | **Low Volt. WIRING/TUBE** | **LINE POWER** |
| **BMS low voltage and communication wiring \*1 (see note 1 below)** | **BMS** | **BMS** | **BMS** | **N/A** |
| **VAV box controller (note 2 below)** | **BMS** | **23 \*2** | **BMS** | **26** |
| **BMS conduits and raceway** | **BMS** | **BMS** | **BMS** | **BMS** |
| **Automatic dampers** | **BMS** | **23** | **N/A** | **N/A** |
| **Manual valves** | **23** | **23** | **N/A** | **N/A** |
| **Automatic valves** | **BMS** | **23** | **BMS** | **N/A** |
| **VAV boxes** | **23** | **23** | **N/A** | **N/A** |
| **Pipe insertion devices and taps including thermowells, flow and pressure stations.** | **BMS** | **23** | **BMS** | **BMS** |
| **BMS Current Switches.** | **BMS** | **BMS** | **BMS** | **N/A** |
| **BMS Control Relays** | **BMS** | **BMS** | **BMS** | **N/A** |
| **Power distribution system monitoring interfaces** | **26** | **26** | **BMS** | **26** |
| **Control air compressors** | **BMS** | **BMS** | **N/A** | **26** |
| **Concrete and/or inertia equipment pads and seismic bracing** | **23** | **23** | **N/A** | **N/A** |
| **BMS interface with Chiller controls** | **BMS** | **BMS** | **BMS** | **BMS** |
| **Chiller controls interface with BMS** | **23** | **23** | **BMS** | **26** |
| **Electric baseboard heating controls (note 3)** | **23** | **26 \*3** | **N/A \*3** | **26** |
| **BMS interface with Classroom unit controls** | **BMS** | **BMS** | **BMS** | **26** |
| **Classroom unit controls interface with BMS** | **23** | **23** | **BMS** | **26** |
| **ADD OTHER THIRD PARTY EQUIPMENT HERE** | **N/A** | **N/A** | **N/A** | **N/A** |
| **All BMS Nodes, equipment, housings, enclosures and panels.** | **BMS** | **BMS** | **BMS** | **BMS** |
| **Smoke Detectors (see note 4 below)** | **26** | **26** | **26/BMS \*4** | **26** |
| **Fire/Smoke Dampers (see note 5 below)** | **23** | **23** | **BMS \*5** | **26** |
| **Fire Dampers** | **23** | **23** | **N/A** | **N/A** |
| **Chiller Flow Switches** | **23** | **23** | **BMS** | **N/A** |
| **Boiler wiring** | **23** | **23** | **23** | **23** |
| **Water treatment system** | **23** | **23** | **23** | **26** |
| **VFDs** | **23** | **26** | **BMS** | **26** |
| **Refrigerant monitors** | **BMS** | **BMS** | **BMS** | **26** |
| **Computer Room A/C Unit field-mounted controls** | **23** | **23** | **BMS** | **26** |
| **Fire Alarm shutdown relay interlock wiring** | **26** | **26** | **26** | **26** |
| **Fire Alarm smoke control relay interlock wiring** | **26** | **26** | **BMS** | **26** |
| **Fireman’s Smoke Control Override Panel** | **26** | **26** | **26** | **26** |
| **Fan Coil Unit controls** | **BMS** | **BMS** | **BMS** | **26** |
| **Cabinet/Unit Heater controls (note 6 below)** | **BMS/23 \*6** | **26/BMS \*6** | **BMS** | **26** |
| **Packaged RTU space mounted controls** | **23** | **BMS** | **BMS** | **26** |
| **Packaged RTU factory-mounted controls** | **23** | **23** | **BMS** | **26** |
| **Packaged RTU field-mounted controls** | **BMS** | **BMS** | **BMS** | **26** |
| **Cooling Tower Vibration Switches** | **23** | **23** | **26** | **26** |
| **Cooling Tower Level Control Devices** | **23** | **23** | **26** | **26** |
| **Cooling Tower makeup water control devices** | **23** | **23** | **26** | **26** |
| **Pool Dehumidification Unit Controls** | **23** | **23** | **BMS** | **26** |
| **Starters, HOA switches** | **26** | **26** | **N/A** | **26** |
| **Control damper actuators** | **BMS** | **BMS** | **BMS** | **26** |
|  |  |  |  |  |

Footnotes:

\*1: BMS low voltage and communications wiring: BMS Ethernet communications cable and IP infrastructure furnish and install by BMS Contractor or Division 26 Electrical Contractor as per options in Paragraph 2, A6 above

\*2: VAV box controller factory install would normally be by Division 23 Mechanical who furnishes the VAV boxes; could be by BMS for field installation where applicable

\*3: Electric Baseboard Heating Controls – for line voltage stand-alone controls: furnished by Division 23 Mechanical Contractor who furnishes the baseboard units; line voltage controls installed and connected by Division 26 Electrical Contractor. Alternate: controls to be furnished and installed by BMS Contractors for projects requiring Baseboard Heating controls to be integrated into BMS. Refer to Section 230993 SEQUENCE OF OPERATIONS

\*4: Smoke Detector also wired to shut down AHU/HVAC by BMS Contractor; Division 26 for projects NYC

\*5: Fire/Smoke Dampers: BMS Contractor to provide and ensure OPEN/CLOSE control of Fire/Smoke dampers is coordinated between BMS HVAC systems sequences, controls and overrides, and the Fire Alarm system control status priorities and overrides

### \*6: Cabinet/Unit Heater Controls – for line voltage stand-alone controls: furnished by Division 23 Mechanical Contractor who furnishes the Cabinet/Unit Heaters; line voltage stand-alone controls installed and connected by Division 26 Electrical Contractor. Alternate: controls to be furnished and installed by BMS Contractors for projects requiring Cabinet/Unit Heater controls to be integrated into BMS. Refer to Section 230993 SEQUENCE OF OPERATIONS

### Submittals

#### Shop Drawings, Product Data, and Samples

##### The BMS contractor shall submit a list of all shop drawings with submittals dates within 30 days of contract award.

##### Submittals shall be in defined packages. Each package shall be complete and shall only reference itself and previously submitted packages. The packages shall be as approved by the Architect and Engineer for Contract compliance.

##### Allow 15 working days for the review of each package by the Architect and Engineer in the scheduling of the total BMS work.

##### Equipment and systems requiring approval of local authorities must comply with such regulations and be approved. Filing shall be at the expense of the BMS Contractor where filing is necessary. Provide a copy of all related correspondence and permits to the Owner.

##### Prepare an index of all submittals and shop drawings for the installation. Index shall include a shop drawing identification number, Contract Documents reference and item description.

##### The BMS Contractor shall correct any errors or omissions noted in the first review.

##### At a minimum, submit the following:

###### BMS network architecture diagrams including all nodes and interconnections.

###### Systems schematics, sequences, and flow diagrams.

###### Points schedule for each point in the BMS, including: Point Type, Object Name, Expanded ID, Display Units, Controller type, and Address.

###### Samples of Graphic Display screen types and associated menus.

###### Detailed Bill of Material list for each system or application, identifying quantities, part numbers, descriptions, and optional features.

###### Control Damper Schedule including a separate line for each damper provided under this section and a column for each of the damper attributes, including: Code Number, Fail Position, Damper Type, Damper Operator, Duct Size, Damper Size, Mounting, and Actuator Type.

* + - * Room Schedule including a separate line for each VAV box and/or terminal unit indicating location and address

###### Control Valve Schedules including a separate line for each valve provided under this section and a column for each of the valve attributes: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close off Pressure, Capacity, Valve CV, Design Pressure, and Actuator Type.

###### Details of all BMS interfaces and connections to the work of other trades.

###### Product data sheets or marked catalog pages including part number, photo and description for all products including software.

### Record Documentation

#### Operation and Maintenance Manuals

##### Three (3) copies of the Operation and Maintenance Manuals shall be provided to the Owner's Representative upon completion of the project. The entire Operation and Maintenance Manual shall be furnished on Compact Disc media, and include the following for the BMS provided:

###### Table of contents.

###### As-built system record drawings. Computer Aided Drawings (CAD) record drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.

###### Manufacturer’s product data sheets or catalog pages for all products including software.

###### System Operator’s manuals.

###### Archive copy of all site-specific databases and sequences.

###### BMS network diagrams.

###### Interfaces to all third-party products and work by other trades.

##### The Operation and Maintenance Manual CD shall be self-contained, and include all necessary software required to access the product data sheets. A logically organized table of contents shall provide dynamic links to view and print all product data sheets. Viewer software shall provide the ability to display, zoom, and search all documents.

**Note:** Item (b) is optional, edit as required

#### On-Line documentation: After completion of all tests and adjustments the contractor shall provide a copy of all as-built information and product data to be installed on a customer designated computer workstation or server

### Warranty

#### Standard Material and Labor Warranty:

##### Provide a one-year labor and material warranty on the BMS.

##### If within twelve (12) months from the date of acceptance of product, upon written notice from the owner, it is found to be defective in operation, workmanship or materials, it shall be replaced, repaired or adjusted at the option of the BMS Contractor at the cost of the BMS Contractor.

##### Maintain an adequate supply of materials within 100 miles of the Project site such that replacement of key parts and labor support, including programming. Warranty work shall be done during BMS Contractor’s normal business hours

## Part 2 – Products

### General Description

#### The Building Management System (BMS) shall provide the owner with a simple user experience with configurable controls. The system must consist of Johnson Control Smart Equipment Technology and must be plug and play with the Verasys™ system.

#### The Building Management System shall consist of the following:

##### Smart Building Hub(s)

##### Verasys Controller(s)

##### Input/Output Module(s)

##### Network Sensor(s)

#### The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.

#### System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.

##### The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

##### The System shall maintain all settings through a system reboot.

#### System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.

### BMS Architecture

#### Automation Network

##### The automation network shall be based on a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard “off the shelf” products available through normal PC vendor channels.

##### The Smart Building Hub shall reside on the automation network.

##### The Smart Building Hub shall create a standard Wi-Fi hotspot that can be used as a local connection for a laptop, phone, tablet or any other device that uses Wi-Fi and has a standard web browser.

#### Control Network

##### Smart Building Hub shall provide supervisory control over the control network and shall support the BACnet Standard MS/TP Protocol SSPC-135, Clause 9.

##### Control networks shall provide either “Peer-to-Peer,” Master-Slave, or Supervised Token Passing communications, and shall operate at the communication speed of 34800 baud.

##### DDC Controllers that support the Johnson Control Smart Equipment Technology shall reside on the control network.

##### Control network communication protocol shall be BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135.

##### Control network communication protocol shall use equipment profiles for connectivity of HVAC application that can provide the Smart Building Hub with equipment information on user experience, BACnet objects mapping, Trends, Alarms, Scheduling all as plug and play

##### No additional software or tools are needed to setup a control network hub, all configuration shall be supported through the Wi-Fi connection to the Smart Building Hub

### Smart Building Hub User Interface

#### Browser Based User Interface

##### The system interface shall be just a standard browser (Internet Explorer, Google Chrome or Apple Safari). The system is accessible when using these browsers by a phone, laptop or tablet. No other software is need.

##### The connection to the system can be either thru the local hot spot built into the Smart Building Hub or when the Smart Building Hub Ethernet connection can be made thru the customer network Ethernet backbone. When a browser connection is made the follow security measures must take place or have options to add.

###### Communication switched to secure port 443 (https).

###### The ability to add certificates that are signed by a public authority.

###### Access to an audit log to be able to diagnose who has been granted access and the activities performed when logged in.

###### The ability to set the user access to three different levels.

###### Tenant Level – Access to only the device list and the home pages of each device. The Tenant may also manage their own password.

###### Tech Level – Access to all HVAC system functions. The Tech level can view Smart Building Hub settings but cannot adjust them. Tech level is also not allowed to add users.

###### Admin Level – Access to all functions

###### Wifi SSID and Passphrase shall be adjustable by a user with Admin Level Access.

###### Email alarm notifications shall have the option for TLS encryption.

#### Smart Building Hub

##### Plug and Play

###### When a Smart Equipment Controller is connected to the system bus and the device address is not conflicting with other devices the device will appear automatically in the device list.

###### All controller trends, alarms, schedules, and view definitions will be predefined within the controller and when a user selects a controller these items will appear for the user to interact with in the interface.

###### View Definition – The view definition is organization of the controllers objects, it is not adjustable. However the user can adjust objects and parameters for the system.

###### Trends – Each controller will have a predetermined list of objects that are designated for trending. The amount of objects and the duration of the trends may vary.

###### Schedules – Each controller will hold its own schedule so if communication is lost the controller will function in a standalone manor.

###### All controller software operating parameters shall be displayed for the operator to view/modify from the user interface. These include: setpoints, alarm limits, time delays, controller setup, run-times, point statistics, schedules, and so forth.

##### Alarms Notification

###### Alarms shall be routed directly from the controllers to the Smart Building Hub so they may be emailed or text to the end user. The following features of alarm notification must be included:

* + - * + Log date and time of alarm occurrence.
        + Provide the ability to direct alarms to an e-mail address or text to a phone via email.
        + Each controller must keep track of what is currently in alarm and a history of past alarms.

###### The BMS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions.

### Verasys System Controllers

#### SE-SPU Unit Control Boards (UCB’s)

##### The SE-SPU Unit Control Boards come standard in packaged units that are manufactured by Johnson Controls. Packaged Unit Brands that use SE-SPU Unit Control Boards are as follows:

###### York

###### Johnson Controls

###### Coleman

###### Tempmaster

###### Luxaire

###### Champion

###### Fraiser-Johnson

###### A communication card for the SE-SPU is required so it can support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.

* + - * + The SE-SPU is BACnet Testing Labs (BTL) certified and carry the BTL Label.
        + The SE-SPU is tested and certified as a BACnet Application Specific Controller (B-AAC).

##### The SE-SPU controllers is factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately.  Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.

##### The SE-SPU controller includes an integral real-time clock and support time-based tasks which enables these field controllers to monitor and control:

###### Schedules

###### Alarms

###### Trends

##### The SE-SPU controller can continue time-based monitoring when offline for extended periods of time from a network.

##### The SE-SPU can operate as a stand-alone controller in applications that do not require a networked supervisory device or for network applications where it is preferred to have the scheduling, alarming, and/or trending performed locally in the field controllers.

##### The SE-SPU shall include the options to control the economizer and provide fault diagnostics that are in compliance with California Title 24.

###### Economizer Controller must be a certified economizer controller by the California Energy Commission

###### Economizer Faults must alarm thru the Smart Building Hub with that option that the alarms can be emailed

##### The SE-SPU shall have the option to expand the refrigeration diagnostics to include fault detection. Each circuit will monitor supply and suction temperature and pressure. The controller will take these inputs and diagnose issues with this refrigeration circuits. The following issues will be reported thru the Smart Building Hub:

###### Low/High Charge

###### Poor Evaporator Heat Transfer

###### Poor Condenser Heat Transfer

###### Refrigerant Flow Restriction

###### Low Compressor Pumping Efficiency

###### Non-condensable gas in system

###### Efficiency Index (EI)

###### Capacity Index (CI)

Supper heat and subcooling trends and calculations

Real time gauge of efficiency and capacity

##### The SE-SPU shall have inputs to support control via one of two methods:

###### Inputs to control the unit via a thermostat

###### Inputs for a local network sensor so the SE-SPU controller perform all control functions

##### The SE-SPU shall have the ability to connect on the system or zone bus of a Verasys System and the view definition will be the same in either location.

##### The SE-SPU has the ability to support these additional control features:

###### Demand Ventilation Control

###### Morning Warmup

#### Verasys Equipment Controller (VEC100)

##### The Verasys Equipment Controller (VEC100) shall be a fully configurable, digital controller that communicates via BACnet MS/TP protocol. The controller will control packaged units for variable air volume or change over bypass systems when the unit is not a unit manufactured by Johnson Controls. In order to use this controller on another manufactures unit the unit must have been provided with the following:

###### A conventional thermostat interface for controller connection.

###### Can control up to 2 stages of heat.

###### Can control up to 4 stages of cooling.

###### The unit must not be a heat pump or if it is a heat pump is must have the ability to control with a standard (non-heat pump) thermostat.

###### If the unit is VAV is must accept a 0-10v input for speed control.

##### The VEC100 shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.

##### The VEC100 controllers is factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately.  Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.

##### The VEC100 controller includes an integral real-time clock and support time-based tasks which enables these field controllers to monitor and control:

###### Schedules

###### Alarms

###### Trends

##### The VEC100 controller can continue time-based monitoring when offline for extended periods of time from a network.

##### The VEC100 has the option to control the economizer on the packaged unit if it is available.

##### The VEC100 has the ability to support these additional control features:

###### Demand Ventilation Control

###### Morning Warmup

#### Verasys Zone Coordinator (VZC100)

##### The Verasys Zone Controller (VZC100) shall be a fully configurable, digital controller that communicates via BACnet MS/TP protocol. The controller will talk directly to the Smart Building Hub and will coordinate the system logic for a variable air volume and change over bypass system. The system logic it may coordinate is as follows:

###### Scheduling of Unit and Zones

###### System Enable

###### Global Shutdown and Load Shedding

###### Balance Mode and Control Mode

###### Temporary Occupancy Requests

###### Demand ventilation control when CO2 sensor is connected to a zone.

###### Change Over Bypass – Voting Logic and system switchover from heat to cool

###### Change Over Bypass – Construction Mode

###### Variable Air Volume – Supply Temperature Reset Strategies

###### Variable Air Volume – Duct Static Pressure Reset Strategies

###### Variable Air Volume – Unoccupied Heating or Cooling Commands

###### Variable Air Volume – Economizer Minimum Position Reset based on VFD Speed

##### The VZC100 shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.

##### The controller will have a second BACnet MSTP bus (Zone Bus) that will be MSTP trunk for the equipment that makes up the Variable Air Volume or Change over Bypass system. The following controllers are supported to connect to the zone bus:

###### SE-SPU or VEC100 Unit Controller. One unit controller per zone coordinator.

###### BYP200 Bypass Damper Controller. One change over bypass controller per system. Not supported for Variable Air Volume systems.

###### ZEC310 Zone Damper Controllers for change over bypass systems. Not supported for Variable Air Volume systems.

###### ZEC410 VAV Controllers for either change over bypass or VAV systems.

###### Note you can have up to 32 ZECxxx zone controllers per zone coordinator. All zone controllers must be physically ducted to the one unit that is connect to the zone coordinator.

##### The VZC100 controller includes an integral real-time clock and support time-based tasks which enables these field controllers to monitor and control:

###### Schedules

###### Alarms

###### Trends

##### The VZC100 controller can continue time-based monitoring when offline for extended periods of time from a network.

#### BYP200 Bypass Damper Controller (BYP200)

##### The Bypass Damper Controller (BYP200) shall be a fully configurable, digital controller that communicates via BACnet MS/TP protocol. The controller will communicate only to the Verasys Zone coordinator on the zone coordinators zone bus. The controller will maintain the pressure in the duct for a change over bypass system. The controller will have the following features:

###### A built-in actuator that will drive the first bypass damper

###### An output that can drive more bypass dampers

###### An input for a duct pressure sensor that outputs a 0 to 5 vdc output and has a range of 0 to 5 in wc.

###### A manual release button to test the connection of the actuator to the damper.

##### The BYP200 shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.

##### The BYP200 controller is factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately.  Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.

##### The BYP200 Controller shall have internal electrical isolation for AC power, DC inputs, and MS/TP communications. An externally mounted isolation transformer shall not be acceptable.

##### The BYP200 Controller shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB or the controller is designed and suitable for use in other environmental air space (plenums) in accordance with Section 300.252(C) of the National Electrical Code.

##### The integral damper actuator shall be a fast response stepper motor capable of stroking 90 degrees in 60 seconds for quick damper positioning to speed commissioning and troubleshooting tasks.

#### ZEC410 VAV Controllers (ZEC410)

##### The ZEC410 VAV controller shall provide networked direct digital control of variable air volume terminal units. It shall address just single duct applications.

##### The ZEC410 VAV controller shall communicate over the FC Bus using BACnet Standard protocol SSPC-135, Clause 9.

##### The ZEC410 VAV controller shall have internal electrical isolation for AC power, DC inputs, and MS/TP communications. An externally mounted isolation transformer shall not be acceptable.

##### The ZEC410 VAV controller shall be a configurable digital controller with integral differential pressure transducer and damper actuator. All components shall be connected and mounted as a single assembly that can be removed as one piece.

##### The ZEC410 VAV controller shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB or the controller is designed and suitable for use in other environmental air space (plenums) in accordance with Section 300.252(C) of the National Electrical Code.

##### The integral damper actuator shall be a fast response stepper motor capable of stroking 90 degrees in 60 seconds for quick damper positioning to speed commissioning and troubleshooting tasks.

##### The controller shall determine airflow by a state-of-the-art digital non-flow pressure sensor to provide 14-bit resolution with bidirectional flow operation that supports automatic correction for polarity on high- and low-pressure DP tube connections; this pressure sensor eliminates high- and low-pressure connection mistakes.

##### Each controller shall have the ability to automatically calibrate the flow sensor to eliminate pressure transducer offset error due to ambient temperature / humidity effects.

##### The controller shall utilize a proportional plus integration (PI) algorithm for the space temperature control loops.

##### Each controller shall continuously, adaptively tune the control algorithms to improve control and controller reliability through reduced actuator duty cycle. In addition, this tuning reduces commissioning costs, and eliminates the maintenance costs of manually re-tuning loops to compensate for seasonal or other load changes.

##### The controller will be fully configurable and available in 3 models that support the following configurations:

|  |  |  |  |
| --- | --- | --- | --- |
| Model | Fan Configurations Supported | Box Heat Supported | Supplemental Heat Supported |
| ZEC410-1 | None, Parallel and Series | 3 On/Off Stages | 1 On/Off Stage |
| ZEC410-2 | None, Parallel and Series | 1 incremental | 1 incremental |
| ZEC410-3 | None, Parallel and Series | 1 Proportional (SCR Support) | 1 incremental |

##### Each model will plug and play with Johnson Controls network temperature sensors. When a network sensor is connected to the sensor actuator bus the ZEC410 will recognize it and use it in the controller logic. Up to 5 network maybe connected and the temperature will control to the average to the sensors connected.

##### Each model will plug and play with Johnson Controls network CO2 sensors. When a network CO2 sensor is connected to the sensor actuator bus the ZEC410 will recognize it and use it in the controller logic. Up to 5 network maybe connected and the highest CO2 will be used for demand ventilation control.

##### The controller shall interface with balancer tools that allow automatic recalculation of box flow pickup gain (“K” factor), and the ability to directly command the airflow control loop to the box minimum and maximum airflow setpoints.

##### Inputs:

###### An optional connection to monitor discharge air temperature is provided.

###### A dry contact for a motion sensor is provided to put the box in standby when the sensor is not sensing motion.

###### For noise immunity, the inputs shall be internally isolated from power, communications, and output circuits.

##### Outputs

###### Analog outputs shall provide the following control outputs:

* + - * + 0-10 VDC

###### Binary outputs shall provide a SPST Triac output rated for 500mA at 24 VAC.

###### For noise immunity, the outputs shall be internally isolated from power, communications, and other output circuits.

##### Sensor Support

###### The ZEC410 VAV controller shall communicate over the Sensor-Actuator Bus (SA Bus) with a Network Sensor.

###### The ZEC410 VAV controller shall support an LCD display room sensor.

#### ZEC310 Change over Bypass Zone Controllers (ZEC310)

##### The ZEC310 zone controller shall provide networked direct digital control of change over bypass zone dampers.

##### The ZEC310 zone controller shall communicate over the FC Bus using BACnet Standard protocol SSPC-135, Clause 9.

##### The ZEC310 zone controller shall have internal electrical isolation for AC power, DC inputs, and MS/TP communications. An externally mounted isolation transformer shall not be acceptable.

##### The ZEC310 zone controller shall be a configurable digital controller and damper actuator. All components shall be connected and mounted as a single assembly that can be removed as one piece.

##### The ZEC310 zone controller shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB or the controller is designed and suitable for use in other environmental air space (plenums) in accordance with Section 300.252(C) of the National Electrical Code.

##### The integral damper actuator shall be a fast response stepper motor capable of stroking 90 degrees in 60 seconds for quick damper positioning to speed commissioning and troubleshooting tasks.

##### The controller shall utilize a proportional plus integration (PI) algorithm for the space temperature control loops.

##### Each controller shall continuously, adaptively tune the control algorithms to improve control and controller reliability through reduced actuator duty cycle. In addition, this tuning reduces commissioning costs, and eliminates the maintenance costs of manually re-tuning loops to compensate for seasonal or other load changes.

##### The controller will be fully configurable. The sensor actuator bus will plug and play with Johnson Controls network temperature sensors. When a network sensor is connected to the sensor actuator bus the ZEC310 will recognize it and use it in the controller logic. Up to 5 network maybe connected and the temperature will control to the average to the sensors connected.

##### Each model will plug and play with Johnson Controls network CO2 sensors. When a network CO2 sensor is connected to the sensor actuator bus the ZEC310 will recognize it and use it in the controller logic. Up to 5 network maybe connected and the highest CO2 will be used for demand ventilation control.

##### The controller shall support a single stage of supplemental heat to be added on to the controller.

##### The controller will also support a 0-10V output to drive additional zone dampers.

##### Inputs:

###### A dry contact for a motion sensor is provided to put the box in standby when the sensor is not sensing motion.

###### For noise immunity, the inputs shall be internally isolated from power, communications, and output circuits.

##### Outputs

###### Analog outputs shall provide the following control outputs:

* + - * + 0-10 VDC

###### Binary outputs shall provide a SPST Triac output rated for 500mA at 24 VAC.

###### For noise immunity, the outputs shall be internally isolated from power, communications, and other output circuits.

##### Sensor Support

###### The ZEC310 zone controller shall communicate over the Sensor-Actuator Bus (SA Bus) with a Network Sensor.

###### The ZEC310 zone controller shall support an LCD display room sensor.

#### Input/Output Module (IOM100)

##### The Input/Output Module (IOM) provides additional inputs and outputs for simple interlock control.

##### The IOM shall communicate directly on the system bus.

##### The IOM shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.

##### The IOM shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.

##### The IOM shall have a two analog inputs, two binary inputs and four binary outputs for a total of eight points.

##### The IOM can connect to these predefined analog inputs:

###### 0–100% Relative Humidity (RH) (0–10 VDC)

###### 0–2,000 ppm Carbon Dioxide (CO2) (0–10 VDC)

###### 0–250 FC Light Sensor (0–10 VDC)

###### 0–1,000 ppm Refrigerant (0–5 VDC)

###### ±0.1 W.C. Building Pressure (0–5 VDC)

###### ±0.25 W.C. Building Pressure (0–5 VDC)

###### 0–0.25 W. C. Building Pressure (0–5 VDC)

###### Any Temperature Sensor with a 1000 Ohm Nickel Element

#### On/Off or Incremental Fan Coil Unit Network Thermostat (TEC 361X Series)

##### The network thermostat shall be capable of controlling two- or four-pipe fan coils, cabinet unit heaters, a pressure dependent Variable Air Volume System, zoning type systems employing reheat including local hydronic reheat valves, or other similar equipment.

##### The Networked Thermostat shall communicate over the FC Bus using BACnet Standard protocol SSPC-135, Clause 9 or Johnson Controls N2 protocol.

###### Communications shall be selectable locally at thermostat through the display

##### The TEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.

###### The TEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).

###### A BACnet Protocol Implementation Conformance Statement shall be provided for the TEC.

###### The Conformance Statement shall be submitted 10 days prior to bidding.

##### The network thermostat shall include a 4.2 inch LED backlit touch screen with the following configurable icons.

###### Home screen configurable icons include

* + - * + On/Off icon
        + Fan override icon
        + Zone temperature icon
        + Hold temperature icon
        + Zone humidity (on applicable models) icon
        + Occupancy status (on applicable models) icon
        + Temperature setpoint icon
        + Alarm icon
        + Unit status icon
        + Date/Time icon
        + Fan override icon

###### Home screen non-configurable icon includes

* + - * + Menu icon

##### The network thermostat shall provide the flexibility to support any one of the following inputs:

###### Integral indoor air temperature sensor

###### Analog input for remote air temperature sensing that supports the following sensor types

* + - * + Nickel
        + Platinum
        + A99B PENN
        + 2.25k ohm NTC
        + 10k ohm NTC
        + 10k ohm NTC Type 3

###### Universal input that supports the following configurations

* + - * + Analog sensor
        + Cooling when switch is closed
        + Heating when switch is closed

###### Remote indoor air temperature sensor

###### Two configurable binary inputs with the following configurations

* + - * + Disabled
        + Occupancy
        + Override
        + Remote PIR
        + Dirty filter
        + Service
        + Fan Lock
        + Open door
        + Open window

##### The network thermostat shall provide the flexibility to support any one of the following fan outputs:

###### Three speed fan control

###### Proportional speed fan control configurable from 0 to 10V

##### The network thermostat shall provide the flexibility to support any one of the following valve outputs:

###### Two on/off

###### Two floating

##### The network thermostat shall provide 4 digit passcode security

##### The network thermostat shall provide the flexibility to adjust the following control parameters:

###### Adjustable maximum setpoint offset from 0 to 20˚F

###### Adjustable fan on delay from 0 to 120 seconds

###### Adjustable fan off delay from 0 to 120 seconds

###### Adjustable minimum cooling on time from 0 to 360 seconds

###### Adjustable minimum cooling off time from 0 to 360 seconds

###### Adjustable minimum heating on time from 0 to 360 seconds

###### Adjustable minimum heating off time from 0 to 360 seconds

###### Adjustable minimum reheat on time from 0 to 360 seconds

###### Adjustable minimum reheat off time from 0 to 360 seconds

###### Adjustable stroke time from 5 to 300 seconds

###### Adjustable supply fan minimum command from 0 to 100%

###### Adjustable supply fan Medium command from 0 to 100%

###### Adjustable supply fan high command from 0 to 100%

###### Adjustable reheat minimum damper position from 0 to 100%

##### Where required by application and indicated on plans or room schedules provide the network thermostat with an integral Passive Infra-Red (PIR) occupancy sensor models.

##### Where required by application and indicated on plans or room schedules provide the network thermostat with an integral relative humidity sensor model.

##### The network thermostat shall employ nonvolatile electrically erasable programmable read-only memory (EEPROM) for all adjustable parameters.

##### The network thermostat shall have a temperature accuracy of ±0.9F°/±0.5C° at 70.0°F/21.0°C typical calibrated

##### The network thermostat shall have a humidity accuracy of ±5% RH from 20 to 80% RH at 50 to 90°F (10 to 32°C)

##### The network thermostat includes an integral real-time clock and support time-based tasks which enables this thermostat to monitor and view the following thru the Smart Building Hub:

###### Schedules

###### Alarms

###### Trends

##### The network thermostat can continue time-based monitoring when offline for extended periods of time from a network.

* + - * + Disabled
        + Occupancy
        + Override
        + Remote PIR
        + Dirty filter
        + Service
        + Fan Lock
        + Open door
        + Open window

##### The network thermostat shall provide the flexibility to support any one of the following fan outputs:

###### Three speed fan control

###### Proportional speed fan control configurable from 0 to 10V

##### The network thermostat shall provide the flexibility to support any one of the following valve outputs:

###### Two on/off

###### Two floating

##### The network thermostat shall provide 4 digit passcode security

##### The network thermostat shall provide the flexibility to adjust the following control parameters:

###### Adjustable maximum setpoint offset from 0 to 20˚F

* + - 1. Adjustable fan on delay from 0 to 120 seconds
      2. Adjustable fan off delay from 0 to 120 seconds
      3. Adjustable minimum cooling on time from 0 to 360 seconds
      4. Adjustable minimum cooling off time from 0 to 360 seconds
      5. Adjustable minimum heating on time from 0 to 360 seconds
      6. Adjustable minimum heating off time from 0 to 360 seconds
      7. Adjustable minimum reheat on time from 0 to 360 seconds
      8. Adjustable minimum reheat off time from 0 to 360 seconds
      9. Adjustable stroke time from 5 to 300 seconds
      10. Adjustable supply fan minimum command from 0 to 100%
      11. Adjustable supply fan Medium command from 0 to 100%
      12. Adjustable supply fan high command from 0 to 100%
      13. Adjustable reheat minimum damper position from 0 to 100%

##### Where required by application and indicated on plans or room schedules provide the network thermostat with an integral Passive Infra-Red (PIR) occupancy sensor models.

##### Where required by application and indicated on plans or room schedules provide the network thermostat with an integral relative humidity sensor model.

##### The network thermostat shall employ nonvolatile electrically erasable programmable read-only memory (EEPROM) for all adjustable parameters.

* + 1. The network thermostat shall have a temperature accuracy of ±0.9F°/±0.5C° at 70.0°F/21.0°C typical calibrated
    2. The network thermostat shall have a humidity accuracy of ±5% RH from 20 to 80% RH at 50 to 90°F (10 to 32°C)

##### The network thermostat includes an integral real-time clock and support time-based tasks which enables this thermostat to monitor and view the following thru the Smart Building Hub:

###### Schedules

###### Alarms

###### Trends

##### The network thermostat can continue time-based monitoring when offline for extended periods of time from a network.

#### Proportional Fan Coil Unit Network Thermostat (TEC 362X Series)

##### The network thermostat shall be capable of controlling two- or four-pipe fan coils, cabinet unit heaters, a pressure dependent Variable Air Volume System, zoning type systems employing reheat including local hydronic reheat valves, or other similar equipment.

##### The Networked Thermostat shall communicate over the FC Bus using BACnet Standard protocol SSPC-135, Clause 9 or Johnson Controls N2 protocol.

###### Communications shall be selectable locally at thermostat through the display

###### The TEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.

###### The TEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).

###### A BACnet Protocol Implementation Conformance Statement shall be provided for the TEC.

* + - * + The Conformance Statement shall be submitted 10 days prior to bidding.

##### The network thermostat shall include a 4.2 inch LED backlit touch screen with the following configurable icons.

* + - 1. Home screen configurable icons include
         * On/Off icon
         * Fan override icon
         * Zone temperature icon
         * Hold temperature icon
         * Zone humidity (on applicable models) icon
         * Occupancy status (on applicable models) icon
         * Temperature setpoint icon
         * Alarm icon
         * Unit status icon
         * Date/Time icon
         * Fan override icon
      2. Home screen non-configurable icon includes
         * Menu icon

##### The network thermostat shall provide the flexibility to support any one of the following inputs:

* + - 1. Integral indoor air temperature sensor
      2. Analog input for remote air temperature sensing that supports the following sensor types
         * Nickel
         * Platinum
         * A99B PENN
         * 2.25k ohm NTC
         * 10k ohm NTC
         * 10k ohm NTC Type 3
      3. Universal input that supports the following configurations
         * Analog sensor
         * Cooling when switch is closed
         * Heating when switch is closed

###### Remote indoor air temperature sensor

###### Two configurable binary inputs with the following configurations

* + - * + Disabled
        + Occupancy
        + Override
        + Remote PIR
        + Dirty filter
        + Service
        + Fan Lock
        + Open door
        + Open window

##### The network thermostat shall provide the flexibility to support any one of the following fan outputs:

###### Three speed fan control

###### Proportional speed fan control configurable from 0 to 10V

##### The network thermostat shall provide the flexibility to support any one of the following valve outputs:

###### Two proportional configurable from 0 to 10V

##### The network thermostat shall provide 4 digit passcode security

##### The network thermostat shall provide the flexibility to adjust the following control parameters:

###### Adjustable maximum setpoint offset from 0 to 20˚F

* + - 1. Adjustable fan on delay from 0 to 120 seconds
      2. Adjustable fan off delay from 0 to 120 seconds
      3. Adjustable minimum reheat on time from 0 to 360 seconds
      4. Adjustable minimum reheat off time from 0 to 360 seconds
      5. Adjustable supply fan minimum command from 0 to 100%
      6. Adjustable supply fan Medium command from 0 to 100%
      7. Adjustable supply fan high command from 0 to 100%
      8. Adjustable reheat minimum damper position from 0 to 100%
      9. Adjustable proportional valve opened voltage from 0 to 10 VDC
      10. Adjustable proportional valve closed voltage from 0 to 10 VDC

##### Where required by application and indicated on plans or room schedules provide the network thermostat with an integral Passive Infra-Red (PIR) occupancy sensor models.

##### Where required by application and indicated on plans or room schedules provide the network thermostat with an integral relative humidity sensor models.

##### The network thermostat shall employ nonvolatile electrically erasable programmable read-only memory (EEPROM) for all adjustable parameters.

##### The network thermostat shall have a temperature accuracy of ±0.9F°/±0.5C° at 70.0°F/21.0°C typical calibrated

##### The network thermostat shall have a humidity accuracy of ±5% RH from 20 to 80% RH at 50 to 90°F (10 to 32°C)

##### The network thermostat includes an integral real-time clock and support time-based tasks which enables this thermostat to monitor and view the following thru the Smart Building Hub:

###### Schedules

###### Alarms

###### Trends

##### The network thermostat can continue time-based monitoring when offline for extended periods of time from a network.

#### Staged Equipment Network Thermostat (TEC 363X Series)

##### The network thermostat shall be capable of controlling the following types of split or packaged units:

###### Cooling only units

###### Cooling units with gas or electric heat

###### Heat pumps

###### Units with economizers

##### The Networked Thermostat shall communicate over the FC Bus using BACnet Standard protocol SSPC-135, Clause 9 or Johnson Controls N2 protocol.

##### Communications shall be selectable locally at thermostat through the display

###### The TEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.

###### The TEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).

###### A BACnet Protocol Implementation Conformance Statement shall be provided for the TEC.

* + - * + The Conformance Statement shall be submitted 10 days prior to bidding.

##### The network thermostat shall include a 4.2 inch LED backlit touch screen with the following configurable icons.

###### Home screen configurable icons include

* + - * + On/Off icon
        + Fan override icon
        + Zone temperature icon
        + Hold temperature icon
        + Zone humidity (on applicable models) icon
        + Occupancy status (on applicable models) icon
        + Temperature setpoint icon
        + Alarm icon
        + Unit status icon
        + Date/Time icon
        + Fan override icon

###### Home screen non-configurable icon includes

* + - * + Menu icon

##### The network thermostat shall provide the flexibility to support any one of the following inputs:

* + - 1. Integral indoor air temperature sensor
      2. Analog input for remote air temperature sensing that supports the following sensor types
         * Nickel
         * Platinum
         * A99B PENN
         * 2.25k ohm NTC
         * 10k ohm NTC
         * 10k ohm NTC Type 3

###### Remote indoor air temperature sensor

* + - 1. Analog input for outdoor air temperature sensor
      2. Analog input for remote temperature monitoring

###### Two configurable binary inputs with the following configurations

* + - * + Disabled
        + Occupancy
        + Override
        + Remote PIR
        + Dirty filter
        + Service
        + Fan Lock
        + Open door
        + Open window

##### The network thermostat shall provide the flexibility to support any one of the following outputs:

###### Up to two heating stages

###### Up to two cooling stages

##### The network thermostat shall provide 4 digit passcode security

##### The network thermostat shall provide the flexibility to adjust the following control parameters:

###### Adjustable compressor minimum on time from 0 to 360 seconds

###### Adjustable compressor minimum off time from 0 to 360 seconds

###### Adjustable maximum setpoint offset from 0 to 20˚F

* + - 1. Adjustable heating minimum on time from 0 to 360 seconds
      2. Adjustable heating minimum off time from 0 to 360 seconds
      3. Adjustable cooling lockout temperature from 0 to 100˚F
      4. Adjustable heating lockout temperature from 0 to 100˚F
      5. Adjustable supplemental minimum on time from 0 to 360 seconds
      6. Adjustable supplemental minimum off time from 0 to 360 seconds
      7. Adjustable economizer minimum position from 0 to 100%
      8. Adjustable economizer dry bulb setpoint from 0 to 100˚F
      9. Adjustable compressor low lockout temperature from -20 to 100˚F
      10. Adjustable compressor high lockout temperature from -20 to 100˚F

##### Where required by application and indicated on plans or room schedules provide the network thermostat with an integral Passive Infra-Red (PIR) occupancy sensor model.

##### The network thermostat shall employ nonvolatile electrically erasable programmable read-only memory (EEPROM) for all adjustable parameters.

##### The network thermostat shall have a temperature accuracy of ±0.9F°/±0.5C° at 70.0°F/21.0°C typical calibrated

##### The network thermostat includes an integral real-time clock and support time-based tasks which enables this thermostat to monitor and view the following thru the Smart Building Hub:

###### Schedules

###### Alarms

###### Trends

##### The network thermostat can continue time-based monitoring when offline for extended periods of time from a network.

#### Network Sensors (NS-XXX-700X)

##### The Network Sensors (NS) shall have the ability to monitor the following variables as required by the systems sequence of operations:

###### Zone Temperature

###### Zone Humidity

###### Zone Setpoint

###### Zone CO2

##### The NS shall transmit the information back to the controller on the Sensor-Actuator Bus (SA Bus) using BACnet Standard protocol SSPC-135, Clause 9.

##### The NS shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.

###### The NS shall be tested and certified as a BACnet Smart Sensors (B-SS).

###### A BACnet Protocol Implementation Conformance Statement shall be provided for the NS.

###### The Conformance Statement shall be submitted 10 days prior to bidding.

##### The Network Zone Temperature Sensors shall include the following items:

###### A backlit Liquid Crystal Display (LCD) to indicate the Temperature, Humidity and Setpoint

###### An LED to indicate the status of the Override feature

###### A button to toggle the temperature display between Fahrenheit and Celsius

###### A button to program the display for temperature or humidity

###### A button to initiate a timed override command

###### Available in either surface mount, wall mount, or flush mount

###### Available with either screw terminals or phone jack

##### The Network CO2 Zone Sensors shall include the following:

###### Available in either surface mount or wall mount

###### Available with screw terminals or phone jack

#### Handheld VAV Balancing Sensor (ATV7003)

###### The sensor shall be a light weight portable device of dimensions not more than 3.2 x 3.2 x 1.0 inches.

###### The sensor shall be capable of displaying data and setting balancing parameters for VAV control applications.

###### The sensor shall be powered through a connection to either the Sensor-Actuator (SA) or the Field Controller (FC) Bus.

###### The sensor shall be a menu driven device that shall modify itself automatically depending upon what type of application resides in the controller.

###### The sensor shall contain a dial and two buttons to navigate through the menu and to set balancing parameters.

###### The sensor shall provide an adjustable time-out parameter that will return the controller to normal operation if the balancing operation is aborted or abandoned.

###### The sensor shall include the following

* + - 1. 5 foot retractable cable
      2. Laminated user guide
      3. Nylon caring case

###### The sensor shall be Underwriters Laboratory UL 916 listed and CSA certified C22.2 N. 205, CFR47.

### Miscellaneous Devices

#### Local Control Panels

##### All control panels shall be factory constructed, incorporating the BMS manufacturer’s standard designs and layouts. All control panels shall be UL inspected and listed as an assembly and carry a UL 508 label listing compliance. Control panels shall be fully enclosed, with perforated sub-panel, hinged door, and slotted flush latch.

##### In general, the control panels shall consist of the DDC controller(s), display module as specified and indicated on the plans, and I/O devices—such as relays, transducers, and so forth—that are not required to be located external to the control panel due to function. Where specified the display module shall be flush mounted in the panel face unless otherwise noted.

##### Low and line voltage wiring shall be segregated. All provided terminal strips and wiring shall be UL listed, 300-volt service and provide adequate clearance for field wiring.

##### All wiring shall be neatly installed in plastic trays or tie-wrapped.

## Part 3 – Performance/Execution

### BMS Specific Requirements

#### Actuation / Control Type

##### Primary Equipment

###### Controls shall be provided by equipment manufacturer as specified herein.

###### All damper and valve actuation shall be electric.

##### Air Handling Equipment

###### All air handlers shall be controlled with a HVAC-DDC Controller

###### All damper and valve actuation shall be electric.

##### Terminal Equipment:

###### Terminal Units (VAV, UV, etc.) shall have electric damper and valve actuation.

###### All Terminal Units shall be controlled with HVAC-DDC Controller)

### Installation Practices

#### BMS Wiring

##### All conduit, wiring, accessories and wiring connections required for the installation of the Building Management System, as herein specified, shall be provided by the BMS Contractor unless specifically shown on the Electrical Drawings under Division 16 Electrical. All wiring shall comply with the requirements of applicable portions of Division 16 and all local and national electric codes, unless specified otherwise in this section.

##### All BMS wiring materials and installation methods shall comply with BMS manufacturer recommendations.

##### The sizing, type and provision of cable, conduit, cable trays, and raceways shall be the design responsibility of the BMS Contractor. If complications arise, however, due to the incorrect selection of cable, cable trays, raceways and/or conduit by the BMS Contractor, the Contractor shall be responsible for all costs incurred in replacing the selected components.

##### Class 2 Wiring

###### All Class 2 (24VAC or less) wiring shall be installed in conduit unless otherwise specified.

###### Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5’ from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements.

##### Class 2 signal wiring and 24VAC power can be run in the same conduit. Power wiring 120VAC and greater cannot share the same conduit with Class 2 signal wiring.

##### Provide for complete grounding of all applicable signal and communications cables, panels and equipment so as to ensure system integrity of operation. Ground cabling and conduit at the panel terminations. Avoid grounding loops.

#### BMS Line Voltage Power Source

##### 120-volt AC circuits used for the Building Management System shall be taken from panel boards and circuit breakers provided by Division 16.

##### Circuits used for the BMS shall be dedicated to the BMS and shall not be used for any other purposes.

##### DDC terminal unit controllers may use AC power from motor power circuits.

#### BMS Raceway

##### All wiring shall be installed in conduit or raceway except as noted elsewhere in this specification. Minimum control wiring conduit size 1/2”.

##### Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Architect.

##### All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the surface to which they are attached.

##### Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls. Flexible Metal Conduit shall be UL listed.

#### Penetrations

##### Provide fire stopping for all penetrations used by dedicated BMS conduits and raceways.

##### All openings in fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.

##### All wiring passing through penetrations, including walls shall be in conduit or enclosed raceway.

##### Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true, and square.

#### BMS Identification Standards

##### Node Identification. All nodes shall be identified by a permanent label fastened to the enclosure. Labels shall be suitable for the node location.

##### Cable types specified in Item A shall be color coded for easy identification and troubleshooting.

#### BMS Panel Installation

##### The BMS panels and cabinets shall be located as indicated at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer’s recommendations.

##### The BMS contractor shall be responsible for coordinating panel locations with other trades and electrical and mechanical contractors.

#### Input Devices

##### All Input devices shall be installed per the manufacturer recommendation

##### Locate components of the BMS in accessible local control panels wherever possible.

#### HVAC Input Devices – General

##### All Input devices shall be installed per the manufacturer recommendation

##### Locate components of the BMS in accessible local control panels wherever possible.

##### The mechanical contractor shall install all in-line devices such as temperature wells, pressure taps, airflow stations, etc.

##### Input Flow Measuring Devices shall be installed in strict compliance with ASME guidelines affecting non-standard approach conditions.

##### Outside Air Sensors

###### Sensors shall be mounted on the North wall to minimize solar radiant heat impact or located in a continuous intake flow adequate to monitor outside air conditions accurately.

###### Sensors shall be installed with a rain proof, perforated cover.

##### Building Differential Air Pressure Applications (-1” to +1” w.c.):

###### Transmitters exterior sensing tip shall be installed with a shielded static air probe to reduce pressure fluctuations caused by wind.

###### The interior tip shall be inconspicuous and located as shown on the drawings.

##### Duct Temperature Sensors:

###### Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement.

###### The sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate.

###### For ductwork greater in any dimension than 48 inches or where air temperature stratification exists such as a mixed air plenum, utilize an averaging sensor.

###### The sensor shall be mounted to suitable supports using factory approved element holders.

##### Space Sensors:

###### Shall be mounted per ADA requirements.

###### Provide lockable tamper-proof covers in public areas and/or where indicated on the plans.

#### HVAC Output Devices

#### All output devices shall be installed per the manufacturers recommendation. The mechanical contractor shall install all in-line devices such as control valves, dampers, airflow stations, pressure wells, etc.

#### Actuators: All control actuators shall be sized capable of closing against the maximum system shut-off pressure. The actuator shall modulate in a smooth fashion through the entire stroke. When any pneumatic actuator is sequenced with another device, pilot positioners shall be installed to allow for proper sequencing.

#### Control Dampers: Shall be opposed blade for modulating control of airflow. Parallel blade dampers shall be installed for two position applications.

#### Control Valves: Shall be sized for proper flow control with equal percentage valve plugs. The maximum pressure drop for water applications shall be 5 PSI. The maximum pressure drop for steam applications shall be 7 PSI.

### Training

#### The BMS contractor shall provide the following training services:

##### One day of on-site orientation by a system technician who is fully knowledgeable of the specific installation details of the project. This orientation shall, at a minimum, consist of a review of the project as-built drawings, the BMS software layout and naming conventions, and a walk through of the facility to identify panel and device locations.

### Commissioning

#### Fully commission all aspects of the Building Management System work.

#### Acceptance Check Sheet

##### Prepare a check sheet that includes all points for all functions of the BMS as indicated on the point list included in this specification.

##### Submit the check sheet to the Engineer for approval

##### The Engineer will use the check sheet as the basis for acceptance with the BMS Contractor.

#### Promptly rectify all listed deficiencies and submit to the Engineer that this has been done.

### 23 09 93 Sequence of Operation for HVAC Controls

### Sequence of Operation

**Note:** Insert applicable sequences here

### Point Lists

**Note:** Insert applicable points lists here