Fullerton College

HVAC Instrumentation and Controls Design Standards

Design Guide v2017-1

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PART 1 - GENERAL

I. Description

A. This section defines the Basic Materials and Methods used in the installation of an open protocol BACNET system using industry standard "HayStack" (http://project-haystack.org) tagging and documentation to provide the functions necessary for control of the mechanical systems (and/or lighting, etc.) on the project serving this building. Use of an alternate API is not acceptable. The information to Interface to the campus EMS system will be provided by Fullerton College. Please be advised that the requirements of this design guide shall be strictly enforced. Systems that do not meet the requirements of the standard shall not be accepted.

B. For all renovation projects, the controls contractor, after the completion of the physical installation, shall test and commission the installed controls for a period of two weeks in the stand-alone mode before connecting to the campus wide network. Submit detailed trend logs of the space temperatures along with the HVAC equipment performance covering the entire test period for the Engineers and the Fullerton College Facility Management's review. Use Network Traffic Monitoring tools to monitor and minimize system traffic before connecting to the network after approval has been obtained.

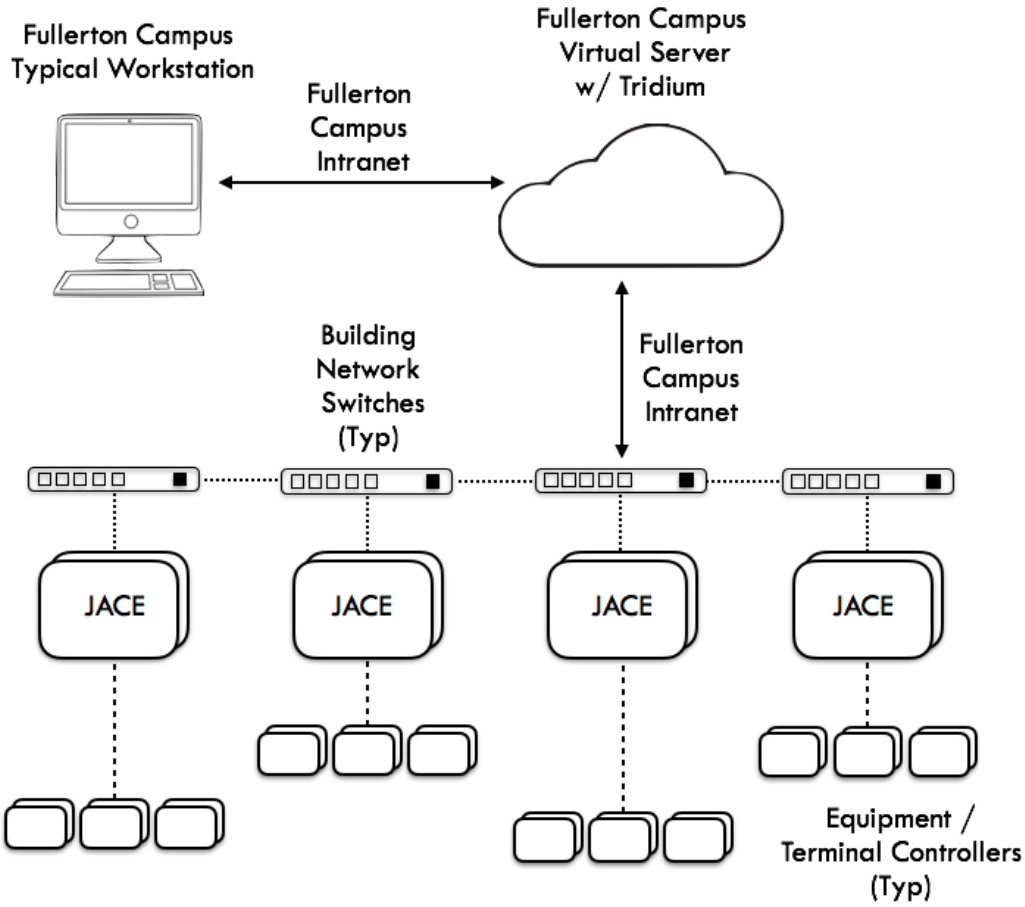
C. For all new construction projects, prior to the physical installation of any controls devices, the project controls contractor shall generate all graphics and simulate the controls sequences as generated by the controls contractor and approved by the project engineer. The owner shall have an opportunity to visit the simulation, hosted by the controls contractor to verify that the graphics are acceptable, and view the simulation live. Failure of 10% of the points shall be simulated, proving that the sequences are operating as intended, that all alarms are generated properly, and all security settings are in place.

D. The intent of this specification is to provide Fullerton College with a completely integrated building management solution based on a non-proprietary, open architecture. Fullerton College is interested in obtaining the services and expertise of a system integrator to design and install an open network of devices. Each building shall be capable of operating independent of the Campus Network. It is the `Contractor's responsibility to provide all items, labor and material, required to

complete the installation. This includes but is not limited to, system controllers, network hardware, computer hardware, operator interface software, graphics, input/output devices, sensors, actuators, control circuit transformers, engineering, documentation, and training, which is required to meet the performance as set forth in the following clauses. The contractor shall provide all wiring, piping, raceways, conduit, installation, supervision, and labor, including calibration, adjustments, checkouts, and commissioning necessary for a complete and fully operational system. All work shall be done in strict accordance with laws and ordinances that may be applicable.

E. Provide a Building Control System incorporating BACNet protocol, utilizing BTL Certified hardware Direct Digital Control, equipment monitoring and control consisting of microprocessor based control processors interfacing directly with sensors, actuators, and environmental delivery systems (i.e. HVAC units); electric controls and mechanical devices for all items indicated on drawings described herein including dampers, valves, panels, sensing devices; and a primary communications network to allow data exchange between microprocessor based devices.

F. The system will use a hierarchical architecture, where the terminal controllers, and equipment controllers connect to a building JACE “Above”. (See figure below).



G. All devices shall communicate with each other over a twisted pair of wires.

H. The control system shall be able to accommodate multiple user operation. Access to the control system data should be limited only by operator password. Multiple users shall have access to all valid system data.

I. The control system shall be designed such that mechanical equipment within the building will be able to operate under "stand-alone" control.

J. The documentation contained in this section and other contract documents pertaining to HVAC controls is schematic in nature. The Consultant / Contractor shall provide documents to provide hardware and software necessary to implement the functions shown or as implied in the design standard.

K. System configuration and monitoring shall be performed via a PC-type computer. Under no circumstances shall the PC be used as a control device for the network. It can be used for storage of data.

L. System shall utilize BACNet defined standard network and command protocol types for all system data including, but not limited to physical input and output values, input and output overrides, as well as general purpose input and output values used by the controller's control program. The utilization of explicit messaging or protocol converters shall not be acceptable unless approved in writing by Fullerton College's representative prior to bid.

M. Upon job completion, require the network integrator to provide all drawings, databases, resource files, configuration files, etc on CD to Fullerton College.

N. It is a requirement of all projects that the network integrator provide a legal copy of all software tools, configuration tools, management tools (including network traffic monitoring tools), and utilities used during system commissioning and installation. All tools shall be generally available in the market. No closed and/or unavailable tools will be permitted.

O. The BMS server shall host all graphic files for the control system. All graphics and navigation schemes for this project shall match those that are on the existing campus Tridium front end server

P. All JACE hardware products used on this project must be Made in the USA or come through the Tridium Richmond, VA shipping facility. JACE hardware products not meeting these requirements shall not be allowed.

II. Summary of Work

A. Provide BACNet (MS/TP) Protocol based HVAC Controls system downstream of the JACE that communicates on multiple channels to meet the functional specifications as indicated on the drawings and the dedicated product functional specifications and profiles specified in other Sections. BACNet over IP shall be used upstream of the JACE.

B. Provide routers and repeaters as required to combine different communication channels onto a central field bus or as required to segment groups of Intelligent Devices and/or Control Units.

C. The design shall provide sensors, Terminal Unit Controllers, Field Controllers, Equipment Controllers, and Network Controllers as herein specified, and as

needed to perform functions indicated in the input/output summaries and sequences of operation, and/or indicated on the HVAC drawings.

D. Provide wire, raceway systems, 120 volt and/or 24 DC and/or 24 AC power supplies and final connections to nodes provided by this contract and the following Control Units.

E. The Building Management System Contractor shall provide all controls, sequences of operation, and systems monitoring as required by the standards and by the drawings. Provide all required devices, sensors, hardware, software, wiring, controllers, etc. The Building Management System shall be configured to provide all controls, sequences of operation, and systems monitoring as required by these standards and by the drawings. Provide all required devices, sensors, hardware, software, wiring, controllers, etc.

F. The Campus Facility Management System shall be configured by Fullerton College to make available all controls, sequences of operation, and systems monitoring as required by these specifications and by the drawings. The contractor shall provide all required devices, sensors, hardware, software, wiring, controllers, etc.

G. Renovations projects (larger than 3,000-square feet) where existing pneumatic controls are in place, shall have new electric controls provided for that renovated space. Existing pneumatic tubing and devices shall be removed. If the building does not have a JACE, then one shall be provided by the renovation project, and all new controls shall be integrated into the new JACE. Renovation projects small than 3,000-square feet shall NOT be required to provide a JACE, unless required through the Fullerton College Project Manager, or unless specifically identified in the project scope.

H. New Construction projects larger than 40,000-square feet or more than 3-stories, shall have 1 JACE provided at every other floor.

III. Quality Assurances

A. General

1. The HVAC Control System shall be furnished, engineered, and installed by Licensed Trade Technicians. The contractor shall be a Certified Network Integrator (written certification by the hardware and software

manufacturer). The contractor shall employ technicians who have completed factory authorized training. The contractor shall employ technicians to provide instruction, routine maintenance, and emergency service within 24 hours upon receipt of request.

2. The system integrator must be regularly engaged in the service and installation of the controls based systems as specified herein, and must have been so for a minimum of three (3) years.

3. The system integrator must be an authorized representative in good standing of the specified manufacturer of the hardware and software components, and must have been so for a minimum of three (3) years.

4. The system integrator shall have an office that is staffed with designers trained in integrating interoperable systems and technicians fully capable of providing instruction and routine emergency maintenance service on all system components.

5. The system integrator shall have in house capabilities to provide control strategies for whole building control. This includes HVAC, lighting, access, and security applications.

6. The system integrator shall have a service facility, staffed with qualified service personnel, capable of providing instructions and routine emergency maintenance service within 24 hours for networked control systems.

7. The system integrator shall submit a list of no less than three (1) similar projects, which have BACNet with Haystack tagged building systems as specified herein installed by the system integrator These projects must be on-line and functional such that Fullerton College's Users/ Representative can observe the system in full operation.

8. The system integrator must be a certified Integrator, or submit resumes with the proposal indicating passing certificates for training. Such proof must include summary of coursework and indicate both written and laboratory requirements of alternate training.

B. Hardware and Software Component Manufacturer Qualifications

1. The manufacturer of the hardware and software components shall have an authorized representative capable of providing service and support as referenced above, and must have done so for a minimum of three (3) years.

2. The manufacturer of the hardware and software components shall have a technical support group accessible via a toll free number that is staffed with qualified personnel, capable of providing instruction and technical support service for networked control systems.

3. The manufacturer of the hardware and software components must have no less than three (3) similar projects, which have BACNet based building systems with Haystack integrated as specified herein installed by the authorized representative referenced above. These projects must be on-line and functional such that Fullerton College's representative can observe the system in full operation.

4. Acceptable manufacturers of the hardware and software components as specified herein are as follows:

   a) Johnson Controls, Inc (JCI)

C. SUBMITTALS

1. General: Submit the following per conditions of the contract and Division 23 Specification sections. In addition, provide the following:

   a) Product data on all components used to meet the requirements of the specifications such as enclosures, network transceivers, Resource files, configuration parameter options, mounting details, control panel layout details, with power supplies, etc.

   b) Software documentation regarding the proposed PC operating system, third party utilities and application programs, and the proposed application program for the Control Units.

   c) Logical and physical diagrams for each device with corresponding protocol upstream and downstream.

d) Submit functional temperature control diagrams, sequences of operation for each Mechanical system served by the HVAC Control System. Indicate and Tag each input/output served by each Control Unit or Intelligent Device. Haystack tagging shall be submitted along with the sequences.

e) Contractor shall submit for review all commissioning checklists

f) Submit 3 sets of submittals for review within 3 weeks of contract award.

2. Shop Drawings

a) The controls contractor shall submit AutoCAD or Visio generated schematic drawings for the entire control system for review and approval before work shall begin. Included in the submittal drawings shall be a one-page diagram depicting the complete system architecture complete with a communications riser. Drawings shall include point-to-point wiring diagrams and must show all temperature controls, start-stop arrangement for each piece of equipment, equipment interlocks, wiring terminal numbers and any special connection information required for properly controlling the mechanical equipment. The submittal shall include a bill of material reference list as well as equipment sequences of operation.

b) The submittals shall include manufacturer's catalog data describing each item of control equipment or component provided and installed for the project.

c) System Color Graphics using the AutoCAD or Visio generated schematic drawings. Dynamic points, menus icons, command able points, etc. should be clearly identified.

d) Color conventions proposed for all graphics.

3. Close-Out Documents

a) Contractor must submit final copies of the shop drawings outlined above. These final submittals shall reflect all field modifications and change orders required to complete the installation. Submit the

following quantities of record submittal drawings immediately following receipt of notification of substantial completion. Auto CAD drawings and REVIT models of all shop drawings on DVD ROM disks (Both native and .pdf formats).

b) Three complete sets of documents located in a three-ring notebook and organized by subject with divider tabs.

c) Two weeks of trend data proving that the system is operating to Fullerton College's expectations, before connection to the Campus wide network.

d) Two weeks of logging to verify that network traffic is not adversely affected by the new system, before connection to the dedicated campus wide EMS network.

D. OPERATION AND MAINTENANCE MANUALS

1. 3 sets of operation and maintenance manuals shall be required in accordance with requirements of Division 23 specifications.

2. Include the following documentation:

a) Network Management Software User Manual specific to each tool package provided.

b) Maintenance Instructions: Document all maintenance and repair/ replacement procedures. Provide ordering number for each system component, and source of supply. Provide a list of recommended spare parts needed to minimize downtime.

c) Documentation of network variables, network node configurations, priority interrupts, node binding, addressing structure, etc.

E. INSTRUCTION OF FULLERTON COLLEGE OPERATING PERSONNEL

1. All training shall be by [INSERT TRAINERS NAME] and shall utilize specified manuals, as-built documentation, and the on-line help utility. Training shall take place on campus and shall allow for (6) campus maintenance personnel.

2. Operator training shall include 2 initial 8-hour sessions. The initial operator training program shall be to establish a basic understanding of Windows based software, functions, commands, mouse, etc. The training shall encompass as a minimum:

   a) Troubleshooting of input devices, i.e., bad sensors.

   b) Sequence of operation review.

   c) Sign on - sign off.

   d) Selection of all displays and reports.

   e) Commanding of points, keyboard and mouse mode.

   f) Modifying English text

   g) Use of all dialogue boxes and menus.

   h) System initialization.

   i) GUI Software.

F. ACCEPTANCE PROCEDURE

1. Upon completion of the installation, Contractor shall start-up the system and perform all necessary calibration and testing to ensure proper operation of the project control systems.

2. Schedule a hardware demonstration and system acceptance test in the presence of the assigned Fullerton College representative. The acceptance testing is defined as demonstrating the sequence of operation as indicated in the drawings. The Contractor shall perform all tests, and provide to the project team all checklists before scheduling the acceptance test and hardware demonstration to insure the overall system is ready for inspection and observations.

3. When the system performance is deemed satisfactory in whole or in part by these observers, the system parts will be accepted for beneficial use and be deemed substantially complete as defined in Division 1.

G. WARRANTY

1. The HVAC Control System shall be free from defects in workmanship and material under normal use and service. If within eighteen (18) months from the date of substantial completion, the installed equipment is found to be defective in operation, workmanship or materials, the building systems contractor shall replace, repair or adjust the defect at no cost. Service shall be provided within 4 hours upon notice from Fullerton College's designated Representative.

2. The warranty shall extend to material that is supplied and installed by the Contractor. Material supplied but not installed by the Contractor shall be covered per the above to the extent of the product only. Installation labor shall be the responsibility of the trade contractor performing the installation.

3. All corrective software modifications made during warranty service periods shall be updated on all user documentation and on user and manufacturer archived software disks.

H. PRODUCT DELIVERY, STORAGE AND HANDLING

1. Do not install electronic hardware in the project until non-condensing environmental conditions have been established. Products installed in violation of this request may be requested to be replaced at no additional cost to the project.

2. Coordinate storage requirements for factory mounted terminal control units on air terminal devices, air handling units or other packaged control equipment. Do not store control units on site in non-conditioned areas for more than two weeks.

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

I. SPARE PARTS

1. Contractor to provide (1) additional controller of each type used for the specific project.

J. SPARE POINTS

1. Each project (renovation and new) shall include 10-percent additional points for future improvements.

PART II - MATERIALS

I. Instrumentation and Control Devices for HVAC

A. Actuators and Operators

1. General Requirements

a) Damper and valve actuators shall be electronic and as specified in the System Description section.

i. The manufacturer shall be ISO 9001 certified.

2. Electronic Damper Actuators

a) Spring Return Actuators:

i. Manufactured, brand labeled or distributed by Belimo or approved equivalent.

ii. Regulatory Agency Listing: cULus, CSA C22.2 No. 24-93, and CE marked

iii. Direct-Coupled Design: Requires no crank arm or linkage for mounting to a shaft.

iv. Coupling: toothed V-bolt clamp and nuts with toothed cradle.

v. Reversible Mounting: Provides either clockwise or counterclockwise operation.

vi. 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.

vii. Motor Technology:

- Modulating Types: Microprocessor-controlled Brushless DC motor
- On/Off Types: DC brush motor.

viii. Overload Protection: Electronic stall detection protects from overload at all angles of rotation without the use of end switches.

ix. Enclosure Ratings:

- NEMA type 2 / IP54 mounted in any orientation.

x. Double-Insulated construction: Eliminate the need for electrical ground wires.

xi. Wiring: Integral cables with colored and numbered conductors.

xii. Sized for torque required to seal damper at load conditions

xiii. Parallel Operation: Actuators shall be available that are capable of being mechanically or electrically paralleled.

xiv. 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.

xv. Operating Temperature Range:

- 70 lb·in. Torque and Below: -40°F to 140°F
- 71 lb· in. Torque and above: -40°F to 131°F

xvi. Power Requirements:

- Modulating Types:
  - i. 27 lb·in. Torque and Below: 5VA maximum

xvii. 70 lb·in. to 19 lb·in.Torque: 8VA maximum

  - i. 89 lb·in. to 71 lb·in.Torque: 10VA maximum
  - ii. 90 lb·in. to 177 lb·in.Torque: 16VA maximum
- 2-Position Types:
  - i. 27 lb·in. Torque and Below: 5VA maximum
  - ii. 70 lb·in. to 19 lb·in.Torque: 7VA maximum
  - iii. 71 lb·in. to 177 lb·in.Torque: 25VA maximum

b) Non-Spring Return Actuators:

i. Manufactured, brand labeled or distributed by Belimo or approved equivalent.

ii. Regulatory Agency: UL Listed ,CSA Certified, and CE marked

iii. Direct-Coupled Design: Requires no crankarm or linkage for mounting to a shaft.

iv. Coupling:

- Above 80 lb.˙ in.: toothed V-bolt clamp and nuts with toothed cradled
- 80 lb.˙ in. and below: single cup-point set screw and toothed cradle.

v. Overload Protection: Electronic stall detection or magnetic slip clutch protects from overload at all angles of rotation without the use of end switches.

vi. Minimum Enclosure Ratings:

- Types with covered wiring terminals: NEMA type 2 / IP42 mounted in any orientation.
- Types without covered wiring terminals: NEMA type 1 / IP30 or IP40.
- Types with integrated cables: NEMA 2 / IP42 mounted in any orientation.

vii. Sized for torque required to seal damper at load conditions

viii. Parallel Operation: Actuators shall be available that are capable of being mechanically or electrically paralleled.

ix. Proportional actuators shall be user configurable without the use of external computer software or programming tools.

x. 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.

xi. Power Requirements: 24 V with models available for both 24 VAC and 24 VDC operation, maximum

- Above 80 lb.˙ in.: 7.5 VA at 24 VAC
- 80 lb.˙ in. and below: 3.5 VA at 24VAC

xii. The manufacturer shall provide 5-year limited warranty from the date of sale covering defects in material or workmanship.

B. Sensors and Transmitters

1. General Requirements

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

2. Temperature Sensors

a) General Requirements:

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

ii. 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.

iii. 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.

b) Room Temperature Sensors

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

ii. 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.

c) Room Temperature Sensors with Integral Display

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

ii. Room sensors shall have an integral LCD display and either a setpoint adjustment dial or setpoint adjustment push buttons, and the following capabilities when specified:

- Display room air temperatures.
- Display and adjust room comfort setpoint.
- Display and adjust fan operation status via push button.
- Override request via Occupancy Override push button with LED status for activation of after-hours operation.
- Override request via setpoint adjustment dial or setpoint adjustment push buttons for activation of after-hours operation.
- Occupancy sensor
- F/C toggle pushbutton to toggle between F and C.
- RH%/Temperature toggle push button to temporarily display RH%

d) Thermowells

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

ii. When thermowells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and sensor.

iii. Thermowells shall be pressure rated and constructed in accordance with the system working pressure.

iv. Thermowells 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.

v. Thermowells constructed of 316 stainless steel shall comply with Canadian Registration Number (CRN) pressure vessel rating.

e) Outside Air Sensors

i. 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.

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

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

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

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

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

f) Duct Mount Sensors

i. 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.

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

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

g) Averaging Sensors

i. 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.

ii. 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.

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

h) Acceptable Manufacturers: Johnson Controls, Minco.

3. Humidity Sensors

a) 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.

b) 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.

c) 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.

d) 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.

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

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

g) Acceptable Manufacturers: Veris, Mamac.

4. CO2 Sensors

a) Where shown on the drawings, C02 sensors shall have the following features:

i. Jumper selectable: 0-20mA, 4-20mA & 0-10VDC output

ii. Liquid Crystal Display

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

i. Zone carbon-dioxide

c) The C02 shall transmit the information back to the controller via jumper selectable 0-20mA, 4-20mA & 0-10VDC output signals.

i. The C02 sensors shall provide a maximum output current of 25mA; Maximum output voltage of 12.5V.

ii. The C02 sensors shall be FCC compliant to CFR47 Part 15 subpart B Class A.

d) The C02 Sensors shall be available with

i. CO2 response time (0-63%) of 1 minute

ii. Less than 0.083% of full scale/F° temperature dependence of CO2 output

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

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

v. CO2 non-linearity of less than 1.0% of full scale

e) The C02 Sensors may include the following items:

i. Relay output module

ii. Liquid Crystal Display module

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

5. BTU Meters

a) Manufacturer – Onicon

b) Model – System 10

c) Device specifications

i. Each BTU measurement system shall be individually calibrated using application specific flow and temperature data and shall be provided with calibration certificates. The device shall have an accuracy of +/- 0.15 degF over the calibrated range of temperature. The flow accuracy shall be +/- 2-pct of the range.

6. Differential Pressure Transmitters

a) General Air and Water Pressure Transmitter Requirements:

i. All Differential Pressure Transmitters shall be remotely located into a lockable recessed control panel, accessible from the occupied space, with tubing extending from the device to the ductwork or piping being measured. Appropriate space and fittings shall be provided to remove and replace the device without damaging the cabinet.

ii. 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.

iii. Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.

iv. Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device, and shall be supplied with Tee fittings and shut-off valves in the high and low sensing pick-up lines to allow the balancing Contractor and Owner permanent, easy-to-use connection.

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

b) Low Differential Water Pressure Applications (0” - 20” w.c.)

i. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of flow meter differential pressure or water pressure sensing points.

ii. 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:

- .01-20" w.c. input differential pressure range.
- 4-20 mA output.
- Maintain accuracy up to 20 to 1 ratio turndown.
- Reference Accuracy: +0.2% of full span.

iii. Acceptable Manufacturers: Setra and Mamac.

c) Medium to High Differential Water Pressure Applications (Over 21" w.c.)

i. The differential pressure transmitter shall meet the low pressure transmitter specifications with the following exceptions:

- Differential pressure range 10" w.c. to 300 PSI.
- Reference Accuracy: +1% of full span (includes non-linearity, hysteresis, and repeatability).

ii. Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.

iii. Acceptable Manufacturers: Setra and Mamac.

d) Building Differential Air Pressure Applications (-1" to +1" w.c.)

i. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.

ii. 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)
- 4-20 mA output.
- Maintain accuracy up to 20 to 1 ratio turndown.
- Reference Accuracy: +0.2% of full span.

iii. Acceptable Manufacturers: Veris, Setra

e) Low Differential Air Pressure Applications (0" to 2.5" w.c.)

i. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.

ii. 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.)
- 4-20 mA, 0-5 VDC, 0-10 VDC, output.
- Maintain accuracy up to 20 to 1 ratio turndown.
- Reference Accuracy: +0.25%, or 0.5% of full span.

iii. Acceptable Manufacturers: Veris, Setra

f) Medium Differential Air Pressure Applications (5" to 21" w.c.)

i. The pressure transmitter shall be similar to the Low Air Pressure Transmitter, except that the performance specifications are not as severe. Differential pressure transmitters shall be provided that meet the following performance requirements:

- Zero & span: (c/o F.S./Deg. F): .04% including linearity, hysteresis and repeatability.
- Accuracy: 1% F.S. (best straight line) Static Pressure Effect: 0.5% F.S. (to 100 PSIG.
- Thermal Effects: <+.033 F.S./Deg. F. over 40°F. to 100°F. (calibrated at 70°F.).

ii. Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.

iii. Acceptable manufacturers: Veris, Setra.

7. Flow Monitoring

a) Air Flow Monitoring

i. Fan Inlet Air Flow Measuring Stations

- At the inlet of each fan and near the exit of the inlet sound trap, airflow sensors shall be provided that shall continuously monitor the fan air volumes or velocity pressure.
- Each sensor shall be surface mount type. Unit shall be capable of monitoring and reporting the airflow and temperature at each fan inlet location through two or four sensing circuits. If a static pressure manifold is used, it shall incorporate dual offset static tips on the opposing sides of the averaging manifold so as to be insensitive to flow-angle variations of as much as + 20° in the approaching air stream.
- Devices creating fan performance degradation, resulting in additional energy consumption, caused from pressure drop associated with probes or mounting apparatus in the center of the fan inlet are not allowed. The device shall not induce a significant pressure drop, nor shall the sound level within the duct be amplified by its singular or multiple presence in the air stream. Sensor circuit casings shall be constructed of U.L. 94 flame rated, high impact ABS and include a stainless steel thermistor cap that maintains the precise calibrated flow over the heated and ambient measurement points. Each sensor circuit shall consist of two ceramic base, glass encapsulated, thermistors for measuring ambient temperature and velocity. Circuit shall be designed for operation in a wide range of environments, including high humidity (non-condensing) and rapid thermal cycling.
- Acceptable manufacturers are: Ebtron, Air Monitor Corp.

ii. Single Probe Air Flow Measuring Sensor

- The single probe airflow-measuring sensor shall be duct mounted with an adjustable sensor insertion length of up to eight inches. The transmitter shall produce a 4-20 mA or 0-10 VDC signal linear to air velocity. The sensor shall be a thermal dispersion and utilize one temperature sensor and a heated thermistor. The sensor pair shall measure the air temperature and airflow velocity.

iii. Duct Air Flow Measuring Stations

- Furnish and install, at locations shown on plans or as in accordance with schedules, an equalized air measuring probe system piped to a high performance pressure transducer or an electronic type airflow temperature measuring station.
- Each device shall be designed and built to comply with, and provide results in accordance with, accepted practice as defined for system testing in the ASHRAE Handbook of fundamentals, as well as in the Industrial Ventilation Handbook.
- Assembly shall be AMCA tested and capable of measuring a range from 70 to 5,000 FPM (22 to 1524 MPM).
- Equalized air measuring assembly shall measure to ±3% average and consist of 6063T5 extruded aluminum step sensing blade(s) with anodized finish, plenum-rated polyethylene pressure tubing, brass barbed fittings, mounting hardware and a glass-on-silicone capacitance sensor pressure transducer capable of measuring up to five field-selectable pressure ranges up to 2.5 in. w.c.
- The transducer shall be accurate to ±0.5%, or 0.25% of full scale and be contained in a National Electrical Manufacturer's Association (NEMA) 4 (IP-65) enclosure. Transducer shall be factory mounted and piped to high and low pressure ports through fittings made of brass.
- All sensor tubing shall terminate in solid brass barbed fittings.
- Total and static pressure manifolds shall terminate with external ports for connection to control tubing. An identification label shall be placed on each unit casing, listing model number, size, area, and specified airflow capacity.
- Air straightener shall be provided for sizes over 17 square feet (1.6 sq meter).

- Airflow measuring station assemblies shall be fabricated of galvanized steel or aluminum casing of appropriate thickness for slip fits or with 90 Deg. connecting flanges in configuration and size equal to that of the duct into which it is mounted. Each station shall be complete with an air directionalizer and parallel cell profile suppressor (3/4" maximum cell) across the entering air stream and mechanically fastened to the casing in such a way to withstand velocities up to 5000 feet per minute. This air directionalizer and parallel cell honeycomb suppressor shall provide 98% free area, and eliminate turbulent and rotational flow from the air stream prior to the measuring point.
- Equalized air measuring probe assemblies shall be, in all respects, equivalent to Johnson Controls® AD-1250 or AD-1251 airflow measuring systems.
- Electronic air measuring station shall be capable of monitoring and reporting the airflow and temperature at each measuring location through one or more measuring probes containing multiple sensor points and a control transmitter that outputs a 4-20 mA linear signal.
- Probe(s) shall be constructed of an airfoil shaped aluminum extrusion containing the sensor circuit(s).
- Each sensor circuit shall consist of coated thermistors, for temperature and velocity, mounted to a Printed Circuit Board (PCB).
- Probe multiplexer circuit(s) shall include a microprocessor that collects data from each PCB and digitally communicates the average airflow and temperature of each probe to a microprocessor based control transmitter.
- Multiplexer board shall be encased to prevent moisture damage.
- Shielded CAT5e communications cable shall be Underwriters Laboratories Inc.® (UL) plenum-rated with RJ45 terminal connectors. Dust boot covers and gold-plated contacts shall link probes to electronic controller.
- Control transmitter shall be capable of processing independent sensing points and shall operate on a fused 24 VAC supply.

- Control transmitter shall feature a 16 x 2 character alphanumeric LCD screen, digital offset/gain adjustment, continuous performing sensor/transmitter diagnostics, and a visual alarm to detect malfunctions.
- All electronic components of the assembly shall be Restriction of Hazardous Substances (RoHS) Directive compliant.
- Equal to Johnson Controls AD-1252
- Installation Considerations
  - i. The maximum allowable pressure loss through the Flow and Static Pressure elements shall not exceed .04" w.c. at 1000 feet per minute, or .11" w.c. at 2000 feet per minute. Each unit shall measure the airflow rate within an accuracy of plus 3-5% as determined by AMCA.
  - ii. Where the stations are installed in insulated ducts, the airflow passage of the station shall be the same size as the inside airflow dimension of the duct. Station flanges shall be 1.5 inches to facilitate matching connecting ductwork.
  - iii. Where control dampers are shown as part of the airflow measuring station, parallel blade precision controlled volume dampers integral to the station and complete with actuator, and linkage shall be provided.
  - iv. Stations shall be installed in strict accordance with the manufacturer's published requirements, and in accordance with ASME Guidelines affecting non-standard approach conditions.
- All air measuring devices shall be tested according to AMCA Standard 610
- Acceptable manufacturers: Ebtron, Air Monitor Corp.

iv. Static Pressure Traverse Probe

- Duct static traverse probes shall be provided where required to monitor duct static pressure. The probe shall contain multiple static pressure sensors located along exterior surface of the cylindrical probe.
- Acceptable manufacturers: Cleveland Controls

v. Shielded Static Air Probe

- A shielded static pressure probe shall be provided at each end of the building. The probe shall have multiple sensing ports, an impulse suppression chamber, and airflow shielding. A suitable probe for indoor and outdoor locations shall be provided.

vi. Water Flow Monitoring

- Water flow meters shall be electromagnetic type with integral microprocessor-Based electronics. The meter shall have an accuracy of 0.25%.
- Acceptable manufacturers: Onicon

8. Power Monitoring Devices

a) Current Measurement (Amps)

i. Current measurement shall be by a combination current transformer and a current transducer. The current transformer shall be sized to reduce the full amperage of the monitored circuit to a maximum 5 Amp signal, which will be converted to a 4-20 mA DDC compatible signal for use by the Facility Management System.

ii. Current Transformer – A split core current transformer shall be provided to monitor motor amps.

- Operating frequency – 50 - 400 Hz.
- Insulation – 0.6 Kv class 10Kv BIL.
- UL recognized.
- Five amp secondary.
- Select current ration as appropriate for application.
- Acceptable manufacturers: Setra

iii. Current Transducer – A current to voltage or current to mA transducer shall be provided. The current transducer shall include:

- 6X input over amp rating for AC inrushes of up to 120 amps.
- Manufactured to UL 1244.
- Accuracy: +.5%, Ripple +1%.
- Minimum load resistance 30kOhm.
- Input 0-20 Amps.
- Output 4-20 mA.

- Transducer shall be powered by a 24VDC regulated power supply (24 VDC +5%).
- Acceptable manufacturers: Setra

9. Refrigerant Leak Detectors

a) The refrigerant leak detector shall be a standalone device and shall provide a SPDT output to directly energize the refrigeration room exhaust ventilation fans. The detector shall include a sensor or sensors connected to a control panel. Two relay contacts at the control panel shall provide trouble and alarm indication to the Facility Management System. The alarm relay contact shall also directly energize the exhaust fans.

b) The refrigerant leak detector shall sense the type of refrigerant used in the specified chillers. Multiple sensors shall be required to detect different refrigerants and/or provide proper sensing coverage for the area of the refrigeration room.

c) Acceptable manufacturers: MSA Instruments, Thermal Gas

10. Smoke Detectors

a) Ionization type air duct detectors shall be furnished as specified elsewhere in Division 16 for installation under Division 15. All wiring for air duct detectors shall be provided under Division 16, Fire Alarm System.

11. Status and Safety Switches

a) General Requirements

i. 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.

b) Current Sensing Switches

i. 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.

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

iii. 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.

iv. Acceptable manufacturers: Veris

c) Air Filter Status Switches

i. 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.

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

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

iv. Acceptable manufacturers: Johnson Controls, Cleveland Controls

d) Air Flow Switches

i. 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.

ii. Acceptable manufacturers: Johnson Controls, Cleveland Controls

e) Air Pressure Safety Switches

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

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

iii. Acceptable manufacturers: Johnson Controls, Cleveland Controls

f) Water Flow Switches

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

g) Low Temperature Limit Switches

i. 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.

ii. 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.

iii. 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.

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

12. Control Relays

a) Control Pilot Relays

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

ii. Mounting Bases shall be snap-mount.

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

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

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

vi. Acceptable manufacturer: Veris Full Feature, VMD-FxxA 2P2T

b) Lighting Control Relays

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

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

iii. The coil shall be a split low-voltage coil that moves the line voltage contact armature to the ON or OFF latched position.

iv. Lighting control relays shall be controlled by:

- Pulsed Tri-state Output – Preferred method.
- Pulsed Paired Binary Outputs.
- A Binary Input to the Facility Management System shall monitor integral status contacts on the lighting control relay. Relay status contacts shall be of the "dry-contact" type.

v. The relay shall be designed so that power outages do not result in a change-of-state, and so that multiple same state commands will simply maintain the commanded state. Example: Multiple OFF command pulses shall simply keep the contacts in the OFF position.

13. Electronic Signal Isolation Transducers

a) A signal isolation transducer shall be provided whenever an analog output signal from the BMS is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input signal from a remote system.

b) The signal isolation transducer shall provide ground plane isolation between systems.

c) Signals shall provide optical isolation between systems.

d) Acceptable manufacturers: Advanced Control Technologies

14. Electronic/Pneumatic Transducers

a) Electronic to Pneumatic transducers shall provide:

i. Output: 3-15 PSIG.

ii. Input: 4-20 mA or 0-10 VDC.

iii. Manual output adjustment.

iv. Pressure gauge.

v. External replaceable supply air filter.

vi. Acceptable manufacturers: Johnson Controls, Mamac

15. Thermostats

a) 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.

C. Control Valves

1. Ball Valves, 1/2 through 2 in.:

a) Ball Valves shall have forged brass bodies.

b) Valves shall have available 300 Series Stainless Steel Balls in all sizes.

c) Valves shall have available 300 Series Stainless Steel Stems with a blow-out proof stem design in all sizes.

d) Valves shall have Graphite reinforced Polytetrafluoroethylene (PTFE) seats with Ethylene Propylene Diene Monomer (EPDM) O-ring backing.

e) Stem seals shall be double EPDM O-rings.

f) 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.

g) 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.

h) 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

i) All valves shall be rated for service with hot water, chilled water and 50% glycol solutions.

j) Ball Valves with stainless steel balls and stems shall be rated for use with 15 psig saturated steam.

k) Flow Characteristics shall be equal percentage on the control port. Bypass port on three-way valves shall have linear flow characteristics.

l) 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.

m) Valves shall be maintenance free

n) Valves shall be provided with a 5 year warranty.

o) Valves shall be rated for 200 psid closeoff pressure.

p) Valve actuators shall be UL-recognized or CSA-certified.

q) Valves shall be Belimo

2. Ball Valves, 2-1/2 through 4 in. Flanged:

a) Ball Valves shall have forged brass bodies with ASME Class 150 ductile iron flanges.

b) Valves shall have 300 Series Stainless Steel Balls.

c) Valves shall have 300 Series Stainless Steel Stems with a blow-out proof stem design.

d) Valves shall have Graphite reinforced Polytetrafluoroethylene (PTFE) seats with Ethylene Propylene Diene Monomer (EPDM) O-ring backing.

e) Stem seals shall be double EPDM O-rings.

f) Flow Characterization Disk shall be manufactured from Amodel AS-1145HS Polyphthalamide Resin and rated for 50 psid maximum differential pressure.

g) Flow Characteristics shall be equal percentage on the control port. Bypass port on three-way valves shall have linear flow characteristics.

h) 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.

i) All valves shall be rated for service with hot water, chilled water, 50% glycol solutions and rated for use with 25 psig saturated steam.

j) Two-Way Valves shall be rated for 100 psid closeoff pressure and Three-Way Valves shall be rated for 50 psid closeoff pressure.

k) Valves shall be maintenance free.

l) Valves shall be provided with a 5 year warranty.

m) Valve actuators shall be UL-recognized or CSA-certified.

n) Valves shall be Belimo ball valves.

3. Butterfly Valves, 2 through 20 in. resilient seat ASME Class 125/150 Flanged:

a) Butterfly Valves shall have cast iron bodies meetings ASTM A126 Class B requirements and meet ASME class 125/150 flange requirements and shall be fully lugged.

b) Butterfly Valves seat shall be Ethylene Propylene Diene Monomer (EPDM).

c) Butterfly Valve disk shall be Ductile Iron with Nylon 11 coating.

d) Butterfly Valve stems shall be Stainless Steel.

e) Flow Characteristics shall be equal percentage up to 70° of disk rotation.

f) All valves shall be rated for service with hot water, chilled water and 50% glycol solutions.

g) Valves shall be maintenance free.

h) Valve shall be provided with a 3 year warranty.

i) Valve electric actuators shall be UL-recognized or CSA-certified.

j) Valves shall be Belimo butterfly valves.

4. Butterfly Valves, High Performance 2-1/2 through 16 in.

a) Butterfly Valves shall have bodies manufactured from Carbon Steel, ASTM A216 GR WCB/A516 GR 70 and shall be fully lugged per ASME Class 150 or ASME Class 300.

b) Butterfly Valves seat assembly shall be RPTFE (reinforced polytetrafluoroethylene) and the seat retainer shall be Carbon Steel, ASTM A516 GR 70

c) Butterfly Valve disk shall be Stainless Steel, ASTM A 351 GR CF8M

d) Butterfly Valve stems shall be 17-4 PH Stainless Steel, ASTM A564-Type 630

e) Butterfly Valve Stem Seals shall be One Carbon Fiber Ring and Three TFE Rings

f) Flow Characteristics shall be equal percentage up to 70° of disk rotation.

g) All valves shall be rated for service with hot water, chilled water, 50% glycol solutions and 50 psig saturated steam in modulating service or 150 psig saturated steam in two position service.

h) Butterfly Valves shall meet the performance requirements of ASME Class 150 or Class 300.

i) Valves shall be maintenance free.

j) Valves shall be provided with a 3 year warranty.

k) Valve electric actuators shall be UL-recognized or CSA-certified.

l) Valves shall be Belimo butterfly valves.

5. Globe Valves, Brass, 1/2 through 2 in.

a) Valves shall have bodies manufactured from a RoHS compliant brass.

b) Valves shall meet the pressure and temperature requirements of ANSI B16.15, Class 250

c) Valve stems shall be a 300 Series Stainless Steel.

d) Valves with brass plug and seat shall have stem seals with Self-Adjusting Ethylene Propylene Rubber (EPR) Ring Pack U-Cups

e) Valves with Stainless Steel plug and seat shall valve stem seals with Spring Loaded Polytetrafluoroethylene (PTFE) and Elastomer V-Rings

f) 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

g) Flow Characteristics shall be equal percentage for two-way valves and linear for three-way valves.

h) Valves shall be serviceable without being removed from the pipe.

i) Valves shall be provided with a 3 year warranty.

j) Valve electric actuators shall be UL-recognized or CSA-certified.

k) Valves shall be Belimo globe valves.

6. Globe Valves, Cast Iron, 2-1/2 through 6 in.

a) Valves shall have bodies manufactured from cast iron.

b) Valves shall meet the pressure and temperature requirements of ANSI B16.1, Class 125

c) Valve stems shall be a 316 Series Stainless Steel.

d) Valves shall have stem seals with Ethylene Propylene Terpolymer (EPT) Ring Pack U-Cups

e) Valves shall have a maximum leakage specification of 0.1% of maximum flow per ANSI/FCI 70-2, Class 3

f) Flow Characteristics shall be equal modified linear.

g) Valves shall be serviceable without being removed from the pipe.

h) Valves shall be provided with a 3 year warranty.

i) Valve electric actuators shall be UL-recognized or CSA-certified.

j) Valves shall be Belimo globe valves.

7. Electric Zone Valves, 1/2 through 1-1/4 in.

a) Valves shall have bodies manufactured from Forged Brass.

b) Valves stems shall be brass (Hard Chrome Plated)

c) Valve Actuator shall be UL, cUL listed or CSA certified.

d) Valves shall be rated for service with hot water, chilled water and 50% glycol solutions.

e) Two Position valves shall have models available rated for use with 15 psig saturated steam.

f) Valve Actuator shall be replaceable without removing valve from the pipe.

g) Modulating Valves flow characteristics shall be equal percentage

h) Valves shall be provided with a 2 year warranty.

i) Valve actuators shall be UL-recognized or CSA-certified.

j) Valves shall be Belimo electric zone valves.

8. Pressure Independent Valves, 1/2 through 2 in.

a) Valves bodies shall be manufactured from forged brass and shall be nickel plated

b) Valves shall have a stem and ball manufactured from chrome plated brass

c) Valve seat shall be fiberglass reinforced with Teflon®

d) Characterizing disk shall be brass for 1/2 and 3/4 in. valves, and Tefzel® for sizes 1 through 2 in. valves

e) Valves shall pressure ratings of 600 psi for 1/2, 3/4 and 1 in. size valves, and pressure rating of 400 psi for 1-1/4, 1-1/2 and 2 in. size valves

f) Closeoff Pressure rating shall be 200 psid

g) Valves shall have a maximum leakage specification of 0.01% of maximum flow per ANSI/FCI 70-2, Class 4 with a 50 psid differential pressure applied.

h) Valves shall be maintenance free.

i) Valves shall be provided with a 5 year warranty.

j) Valve actuators shall be UL-recognized or CSA-certified.

k) Valves shall be Belimo pressure independent valves.

D. Control Dampers

1. 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.

2. All 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.

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

4. 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.

5. 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.

   a) Acceptable manufacturers are Johnson Controls VD-1250, VD1630, or VD-1330, Ruskin CD50 or CD60, and Vent Products 5650.

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

   a) Acceptable manufacturers are: Johnson Controls VD-1620, VD-1320, Ruskin CD36, and Vent Products 5800.

7. 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.

E. DDC System Controllers

1. Advanced Application Field Equipment Controller (FAC 261X)

   a) The JCI PCG Series Controllers shall be a fully user-programmable, digital controller that communicates via BACnet MS/TP protocol.

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

- The FAC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
- The FAC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
- A BACnet Protocol Implementation Conformance Statement shall be provided for the FAC.
- The Conformance Statement shall be submitted 10 days prior to bidding.

b) The FAC shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.

c) Controllers shall be 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 FAC shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.

d) The FAC shall include an integral real-time clock and support time-based tasks which enables these field controllers to monitor and control:

i. Schedules

ii. Calendars

iii. Alarms

iv. Trends

e) The FAC can continue time-based monitoring when offline for extended periods of time from a Metasys system network.

f) The FAC 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.

g) The FAC shall include troubleshooting LED indicators to identify the following conditions:

i. Power On

ii. Power Off

iii. Download or Startup in progress, not ready for normal operation

iv. No Faults

v. Device Fault

vi. Field Controller Bus - Normal Data Transmission

vii. Field Controller Bus - No Data Transmission

viii. Field Controller Bus - No Communication

ix. Sensor-Actuator Bus - Normal Data Transmission

x. Sensor-Actuator Bus - No Data Transmission

xi. Sensor-Actuator Bus - No Communication

h) The FAC shall accommodate the direct wiring of analog and binary I/O field points.

i) The FAC shall support the following types of inputs and outputs:

i. Universal Inputs - shall be configured to monitor any of the following:

- Analog Input, Voltage Mode
- Analog Input, Current Mode
- Analog Input, Resistive Mode
- Binary Input, Dry Contact Maintained Mode
- Binary Input, Pulse Counter Mode

ii. Binary Inputs - shall be configured to monitor either of the following:

- Dry Contact Maintained Mode
- Pulse Counter Mode

iii. Analog Outputs - shall be configured to output either of the following

- Analog Output, Voltage Mode
- Analog Output, Current Mode

iv. Binary Outputs - shall output the following:

- Line-voltage relay outputs
- 24 VAC Triac

v. Configurable Outputs - shall be capable of the following:

- Analog Output, Voltage Mode
- Binary Output Mode

j) The FAC shall have the ability to reside on a Field Controller Bus (FC Bus).

i. The FC Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.

ii. The FC Bus shall support a minimum of 100 IOMs and FACs in any combination.

iii. The FC Bus shall operate at a maximum distance of 15,000 Ft. between the FAC and the furthest connected device.

k) The FAC shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).

i. The SA Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard Protocol SSPC-135, Clause 9.

ii. The SA Bus shall support a minimum of 10 devices per trunk.

iii. The SA Bus shall operate at a maximum distance of 1,200 Ft. between the FAC and the furthest connected device.

l) The FAC shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the FC Bus or the SA Bus.

m) The FAC shall support, but not be limited to, the following applications:

i. Chilled water/central plant optimization applications including but not limited to:

- Selection and sequencing of up to eight chillers of different sizes
- Selection and sequencing of up to eight (each) primary and secondary chilled water pumps of varying pumping capacities
- Selection and sequencing of up to eight condenser water pumps
- Selection and sequencing of cooling towers and bypass valve, including single speed, multi-speed, and vernier control
- Selection and sequencing of up to four heat exchangers, of different capacities
- A proven and documented central cooling plant optimization program that incorporates custom equipment efficiency profiles, without rewriting software code, in order to meet the building load using the least amount of energy as calculated.

- The use of advanced control algorithms that apply equipment specific parameters, including operational limits and efficiency profiles, in order to determine equipment start and runtime preferences
- Identification of the most efficient equipment combination and automatic control of state and speed of all necessary equipment to balance runtime, optimize timing and sequencing and ensure the efficiency and stability of the central cooling plant
- Control definition for the chiller plant in a single FAC, FEC, or NCE, as supported by available memory and point Input/Output (I/O), or capable of being split across multiple FACs, FECs, or NCEs

ii. Heating central plant applications

iii. Built-up air handling units for special applications

iv. Terminal & package units

v. Special programs as required for systems control

n) The FAC shall support a Local Controller Display (DIS-1710) either as an integral part of the FAC or as a remote device communicating over the SA Bus.

i. The Display shall use a BACnet Standard SSPC-135, clause 9 Master-Slave/Token-Passing protocol.

ii. The Display shall allow the user to view monitored points without logging into the system.

iii. The Display shall allow the user to view and change setpoints, modes of operation, and parameters.

iv. The Display shall provide password protection with user adjustable password timeout.

v. The Display shall be menu driven with separate paths for:

vi. Input/Output

vii. Parameter/Setpoint

viii. Overrides

ix. The Display shall use easy-to-read English text messages.

x. The Display shall allow the user to select the points to be shown and in what order.

xi. The Display shall support a back lit Liquid Crystal Display (LCD) with adjustable contrast and brightens and automatic backlight brightening during user interaction.

xii. The display shall be a minimum of 4 lines and a minimum of 20 characters per line

xiii. The Display shall have a keypad with no more than 6 keys.

xiv. The Display shall be panel mountable.

2. Field Equipment Controller (FEC X611)

a) The Field Equipment Controller (FEC) shall be a fully user-programmable, digital controller that communicates via BACnet MS/TP protocol.

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

- The FEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
- The FEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
- A BACnet Protocol Implementation Conformance Statement shall be provided for the FEC.
- The Conformance Statement shall be submitted 10 days prior to bidding.

b) The FEC shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.

c) Controllers shall be 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 FEC shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.

d) The FEC shall include troubleshooting LED indicators to identify the following conditions:

i. Power On

ii. Power Off

iii. Download or Startup in progress, not ready for normal operation

iv. No Faults

v. Device Fault

vi. Field Controller Bus - Normal Data Transmission

vii. Field Controller Bus - No Data Transmission

viii. Field Controller Bus - No Communication

ix. Sensor-Actuator Bus - Normal Data Transmission

x. Sensor-Actuator Bus - No Data Transmission

xi. Sensor-Actuator Bus - No Communication

e) The FEC shall accommodate the direct wiring of analog and binary I/O field points.

f) The FEC shall support the following types of inputs and outputs:

i. Universal Inputs - shall be configured to monitor any of the following:

- Analog Input, Voltage Mode
- Analog Input, Current Mode
- Analog Input, Resistive Mode
- Binary Input, Dry Contact Maintained Mode
- Binary Input, Pulse Counter Mode

ii. Binary Inputs - shall be configured to monitor either of the following:

- Dry Contact Maintained Mode
- Pulse Counter Mode

iii. Analog Outputs - shall be configured to output either of the following

- Analog Output, Voltage Mode
- Analog Output, current Mode

iv. Binary Outputs - shall output the following:

- 24 VAC Triac

v. Configurable Outputs - shall be capable of the following:

- Analog Output, Voltage Mode
- Binary Output Mode

g) The FEC shall have the ability to reside on a Field Controller Bus (FC Bus).

i. The FC Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.

ii. The FC Bus shall support a minimum of 100 IOMs and FECs in any combination.

iii. The FC Bus shall operate at a maximum distance of 15,000 Ft. between the FEC and the furthest connected device.

h) The FEC shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).

i. The SA Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard Protocol SSPC-135, Clause 9.

ii. The SA Bus shall support a minimum of 10 devices per trunk.

iii. The SA Bus shall operate at a maximum distance of 1,200 Ft. between the FEC and the furthest connected device.

i) The FEC shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the FC Bus or the SA Bus.

j) The FEC shall support, but not be limited to, the following applications:

i. Chilled water/central plant optimization applications including but not limited to:

- Selection and sequencing of up to eight chillers of different sizes
- Selection and sequencing of up to eight (each) primary and secondary chilled water pumps of varying pumping capacities
- Selection and sequencing of up to eight condenser water pumps
- Selection and sequencing of cooling towers and bypass valve, including single speed, multi-speed, and vernier control
- Selection and sequencing of up to four heat exchangers, of different capacities
- A proven and documented central cooling plant optimization program that incorporates custom equipment efficiency profiles, without rewriting software code, in order to meet the building load using the least amount of energy as calculated.

- The use of advanced control algorithms that apply equipment specific parameters, including operational limits and efficiency profiles, in order to determine equipment start and runtime preferences
- Identification of the most efficient equipment combination and automatic control of state and speed of all necessary equipment to balance runtime, optimize timing and sequencing and ensure the efficiency and stability of the central cooling plant
- Control definition for the chiller plant in a single FEC, FAC, or NCE, as supported by available memory and point Input/Output (I/O), or capable of being split across multiple FECs, FACs, or NCEs

ii. Heating central plant applications

iii. Built-up air handling units for special applications

iv. Terminal & package units

v. Special programs as required for systems control

k) The FEC shall support a Local Controller Display (DIS-1710) either as an integral part of the FEC or as a remote device communicating over the SA Bus.

i. The Display shall use a BACnet Standard SSPC-135, clause 9 Master-Slave/Token-Passing protocol.

ii. The Display shall allow the user to view monitored points without logging into the system.

iii. The Display shall allow the user to view and change setpoints, modes of operation, and parameters.

iv. The Display shall provide password protection with user adjustable password timeout.

v. The Display shall be menu driven with separate paths for:

- Input/Output
- Parameter/Setpoint
- Overrides

vi. The Display shall use easy-to-read English text messages.

vii. The Display shall allow the user to select the points to be shown and in what order.

viii. The Display shall support a back lit Liquid Crystal Display (LCD) with adjustable contrast and brightens and automatic backlight brightening during user interaction.

ix. The display shall be a minimum of 4 lines and a minimum of 20 characters per line

x. The Display shall have a keypad with no more than 6 keys.

xi. The Display shall be panel mountable.

F. Field Devices

1. Input/Output Module (IOM X711)

a) The Input/Output Module (IOM) provides additional inputs and outputs for use in the FEC.

b) The IOM shall communicate with the FEC over the FC Bus or the SA Bus.

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

i. The IOM shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.

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

iii. A BACnet Protocol Implementation Conformance Statement shall be provided for the FEC.

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

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

e) The IOM shall have a minimum of 4 points to a maximum of 17 points.

f) The IOM shall support the following types of inputs and outputs:

i. Universal Inputs - shall be configured to monitor any of the following:

- Analog Input, Voltage Mode
- Analog Input, Current Mode
- Analog Input, Resistive Mode
- Binary Input, Dry Contact Maintained Mode

- Binary Input, Pulse Counter Mode

ii. Binary Inputs - shall be configured to monitor either of the following:

- Dry Contact Maintained Mode
- Pulse Counter Mode

iii. Analog Outputs - shall be configured to output either of the following

- Analog Output, Voltage Mode
- Analog Output, current Mode

iv. Binary Outputs - shall output the following:

- 24 VAC Triac

v. Configurable Outputs - shall be capable of the following:

- Analog Output, Voltage Mode
- Binary Output Mode

g) The IOM shall include troubleshooting LED indicators to identify the following conditions:

i. Power On

ii. Power Off

iii. Download or Startup in progress, not ready for normal operation

iv. No Faults

v. Device Fault

vi. Normal Data Transmission

vii. No Data Transmission

viii. No Communication

2. Standalone Thermostat (TEC 331X Series)

a) The standalone 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.

b) The standalone thermostat shall include a 4.2 inch LED backlit touch screen with the following configurable icons.

i. 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

ii. Home screen non-configurable icon includes

- Menu icon

c) The standalone thermostat shall provide the flexibility to support any one of the following inputs:

i. Integral indoor air temperature sensor

ii. 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

iii. Universal input that supports the following configurations

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

iv. Remote indoor air temperature sensor

v. Two configurable binary inputs with the following configurations

- Disabled
- Occupancy
- Override
- Remote PIR
- Dirty filter
- Service
- Fan Lock

- Open door
- Open window

d) The standalone thermostat shall provide the flexibility to support any one of the following fan outputs:

i. Three speed fan control

ii. Proportional speed fan control configurable from 0 to 10V

e) The standalone thermostat shall provide the flexibility to support any one of the following valve outputs:

i. Two on/off

ii. Two floating

f) The standalone thermostat shall provide 4 digit passcode security

g) The standalone thermostat shall provide the flexibility to adjust the following control parameters:

i. Adjustable maximum setpoint offset from 0 to 20˚F

ii. Adjustable fan on delay from 0 to 120 seconds

iii. Adjustable fan off delay from 0 to 120 seconds

iv. Adjustable minimum cooling on time from 0 to 360 seconds

v. Adjustable minimum cooling off time from 0 to 360 seconds

vi. Adjustable minimum heating on time from 0 to 360 seconds

vii. Adjustable minimum heating off time from 0 to 360 seconds

viii. Adjustable minimum reheat on time from 0 to 360 seconds

ix. Adjustable minimum reheat off time from 0 to 360 seconds

x. Adjustable stroke time from 5 to 300 seconds

xi. Adjustable supply fan minimum command from 0 to 100%

xii. Adjustable supply fan Medium command from 0 to 100%

xiii. Adjustable supply fan high command from 0 to 100%

xiv. Adjustable reheat minimum damper position from 0 to 100%

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

i. Occupancy sensor motion detection models shall sense to a minimum of 94 angular degrees up to a distance of 15 ft (4.6m) based on a clear line of site

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

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

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

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

3. Standalone Thermostat (TEC 332X Series)

a) The standalone 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.

b) The standalone thermostat shall include a 4.2 inch LED backlit touch screen with the following configurable icons.

i. 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

ii. Home screen non-configurable icon includes

- Menu icon

c) The standalone thermostat shall provide the flexibility to support any one of the following inputs:

i. Integral indoor air temperature sensor

ii. 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

iii. Universal input that supports the following configurations

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

iv. Remote indoor air temperature sensor

v. Two configurable binary inputs with the following configurations

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

d) The standalone thermostat shall provide the flexibility to support any one of the following fan outputs:

i. Three speed fan control

ii. Proportional speed fan control configurable from 0 to 10V

e) The standalone thermostat shall provide the flexibility to support any one of the following valve outputs:

i. Two proportional configurable from 0 to 10V

f) The standalone thermostat shall provide 4 digit passcode security

g) The standalone thermostat shall provide the flexibility to adjust the following control parameters:

i. Adjustable maximum setpoint offset from 0 to 20˚F

ii. Adjustable fan on delay from 0 to 120 seconds

iii. Adjustable fan off delay from 0 to 120 seconds

iv. Adjustable minimum reheat on time from 0 to 360 seconds

v. Adjustable minimum reheat off time from 0 to 360 seconds

vi. Adjustable supply fan minimum command from 0 to 100%

vii. Adjustable supply fan Medium command from 0 to 100%

viii. Adjustable supply fan high command from 0 to 100%

ix. Adjustable reheat minimum damper position from 0 to 100%

x. Adjustable proportional valve opened voltage from 0 to 10 VDC

xi. Adjustable proportional valve closed voltage from 0 to 10 VDC

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

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

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

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

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

4. Standalone Thermostat (TEC 333X Series)

a) The standalone thermostat shall be capable of controlling the following types of split or packaged units:

- Cooling only units
- Cooling only units with gas or electric heat
- Heat pumps
- Units with economizers

b) The standalone thermostat shall include a 4.2 inch LED backlit touch screen with the following configurable icons.

i. 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

ii. Home screen non-configurable icon includes

- Menu icon

c) The standalone thermostat shall provide the flexibility to support any one of the following inputs:

i. Integral indoor air temperature sensor

ii. 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

iii. Remote indoor air temperature sensor

iv. Analog input for outdoor air temperature sensor

v. Analog input for remote temperature monitoring

vi. Two configurable binary inputs with the following configurations

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

d) The standalone thermostat shall provide the flexibility to support the following outputs:

i. Up to two heating stages

ii. Up to two cooling stages

e) The standalone thermostat shall provide 4 digit passcode security

f) The standalone thermostat shall provide the flexibility to adjust the following control parameters:

i. Adjustable compressor minimum on time from 0 to 360 seconds

ii. Adjustable compressor minimum off time from 0 to 360 seconds

iii. Adjustable maximum setpoint offset from 0 to 20˚F

iv. Adjustable heating minimum on time from 0 to 360 seconds

v. Adjustable heating minimum off time from 0 to 360 seconds

vi. Adjustable cooling lockout temperature from 0 to 100˚F

vii. Adjustable heating lockout temperature from 0 to 100˚F

viii. Adjustable supplemental minimum on time from 0 to 360 seconds

ix. Adjustable supplemental minimum off time from 0 to 360 seconds

x. Adjustable economizer minimum position from 0 to 100%

xi. Adjustable economizer dry bulb setpoint from 0 to 100˚F

xii. Adjustable compressor low lockout temperature from -20 to 100˚F

xiii. Adjustable compressor high lockout temperature from -20 to 100˚F

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

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

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

5. Network Thermostat (TEC 361X Series)

a) 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.

b) The Networked Thermostat shall communicate over the FC Bus using BACnet Standard protocol SSPC-135, Clause 9.

i. Communications shall be selectable locally at thermostat through the display

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

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

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

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

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

i. 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

ii. Home screen non-configurable icon includes

- Menu icon

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

i. Integral indoor air temperature sensor

ii. 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

iii. Universal input that supports the following configurations

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

iv. Remote indoor air temperature sensor

v. Two configurable binary inputs with the following configurations

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

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

i. Three speed fan control

ii. Proportional speed fan control configurable from 0 to 10V

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

i. Two on/off

ii. Two floating

h) The network thermostat shall provide 4 digit passcode security

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

i. Adjustable maximum setpoint offset from 0 to 20°F

ii. Adjustable fan on delay from 0 to 120 seconds

iii. Adjustable fan off delay from 0 to 120 seconds

iv. Adjustable minimum cooling on time from 0 to 360 seconds

v. Adjustable minimum cooling off time from 0 to 360 seconds

vi. Adjustable minimum heating on time from 0 to 360 seconds

vii. Adjustable minimum heating off time from 0 to 360 seconds

viii. Adjustable minimum reheat on time from 0 to 360 seconds

ix. Adjustable minimum reheat off time from 0 to 360 seconds

x. Adjustable stroke time from 5 to 300 seconds

xi. Adjustable supply fan minimum command from 0 to 100%

xii. Adjustable supply fan Medium command from 0 to 100%

xiii. Adjustable supply fan high command from 0 to 100%

xiv. Adjustable reheat minimum damper position from 0 to 100%

j) 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.

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

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

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

n) 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)

o) The network thermostat shall provide user equipment visibility from a mobile device through the Mobil Access Portal (MAP) release 4.0 or later.

6. Network Thermostat (TEC 362X Series)

a) 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.

b) The Networked Thermostat shall communicate over the FC Bus using BACnet Standard protocol SSPC-135, Clause 9.

i. Communications shall be selectable locally at thermostat through the display

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

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

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

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

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

i. 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

ii. Home screen non-configurable icon includes

- Menu icon

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

i. Integral indoor air temperature sensor

ii. 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

iii. Universal input that supports the following configurations

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

iv. Remote indoor air temperature sensor

v. Two configurable binary inputs with the following configurations

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

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

i. Three speed fan control

ii. Proportional speed fan control configurable from 0 to 10V

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

i. Two proportional configurable from 0 to 10V

h) The network thermostat shall provide 4 digit passcode security

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

i. Adjustable maximum setpoint offset from 0 to 20˚F

ii. Adjustable fan on delay from 0 to 120 seconds

iii. Adjustable fan off delay from 0 to 120 seconds

iv. Adjustable minimum reheat on time from 0 to 360 seconds

v. Adjustable minimum reheat off time from 0 to 360 seconds

vi. Adjustable supply fan minimum command from 0 to 100%

vii. Adjustable supply fan Medium command from 0 to 100%

viii. Adjustable supply fan high command from 0 to 100%

ix. Adjustable reheat minimum damper position from 0 to 100%

x. Adjustable proportional valve opened voltage from 0 to 10 VDC

xi. Adjustable proportional valve closed voltage from 0 to 10 VDC

j) 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.

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

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

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

n) 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)

o) The network thermostat shall provide user equipment visibility from a mobile device through the Mobil Access Portal (MAP) release 4.0 or later.

7. Network Thermostat (TEC 363X Series)

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

i. Cooling only units

ii. Cooling units with gas or electric heat

iii. Heat pumps

iv. Units with economizers

b) The Networked Thermostat shall communicate over the FC Bus using BACnet Standard protocol SSPC-135, Clause 9.

i. Communications shall be selectable locally at thermostat through the display

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

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

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

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

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

i. 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

ii. Home screen non-configurable icon includes

- Menu icon

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

i. Integral indoor air temperature sensor

ii. 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

iii. Remote indoor air temperature sensor

iv. Analog input for outdoor air temperature sensor

v. Analog input for remote temperature monitoring

vi. Two configurable binary inputs with the following configurations

- Disabled
- Occupancy
- Override
- Remote PIR
- Dirty filter
- Service

- Fan Lock
- Open door
- Open window

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

i. Up to two heating stages

ii. Up to two cooling stages

g) The network thermostat shall provide 4 digit passcode security

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

i. Adjustable compressor minimum on time from 0 to 360 seconds

ii. Adjustable compressor minimum off time from 0 to 360 seconds

iii. Adjustable maximum setpoint offset from 0 to 20˚F

iv. Adjustable heating minimum on time from 0 to 360 seconds

v. Adjustable heating minimum off time from 0 to 360 seconds

vi. Adjustable cooling lockout temperature from 0 to 100˚F

vii. Adjustable heating lockout temperature from 0 to 100˚F

viii. Adjustable supplemental minimum on time from 0 to 360 seconds

ix. Adjustable supplemental minimum off time from 0 to 360 seconds

x. Adjustable economizer minimum position from 0 to 100%

xi. Adjustable economizer dry bulb setpoint from 0 to 100˚F

xii. Adjustable compressor low lockout temperature from -20 to 100˚F

xiii. Adjustable compressor high lockout temperature from -20 to 100˚F

i) 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.

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

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

l) The network thermostat shall provide user equipment visibility from a mobile device through the Mobil Access Portal (MAP) release 4.0 or later.

8. VAV Modular Assembly (VMA 16XX)

a) The VAV Modular Assembly shall provide both standalone and networked direct digital control of pressure-independent, variable air volume terminal units. It shall address both single and dual duct applications.

b) The VMA shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.

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

ii. A BACnet Protocol Implementation Conformance Statement shall be provided for the VMA.

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

c) The VAV Modular Assembly shall communicate over the Field Controller Bus (FC Bus) using BACnet Standard protocol SSPC-135, Clause 9.

d) The VAV Modular Assembly shall have internal electrical isolation for AC power, DC inputs, and MS/TP communications. An externally mounted isolation transformer shall not be acceptable.

e) The VAV Modular Assembly 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. Additional models are available as follows:

i. A configurable digital controller with integral differential pressure transducer but without a damper actuator – this controller is well suited for controlling large VAV boxes that require more than 4 N•m of torque

ii. A configurable digital controller with an integral damper actuator but without a differential pressure transducer – this controller is well suited for commercial zoning applications or for pressure-dependent VAV box applications where no DPT is required

iii. A configurable digital controller with an integral damper actuator and ball valve linkage but without a differential pressure transducer – this controller is for use on the Johnson Controls VG-1000 1/2 - 1 inch valves and needs to be used primarily as a replacement for the VMA assembly of the VG-1000 Series Smart Valve product. The smart valve product line is ideal for chilled beam applications.

f) The VAV Modular Assembly 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.

g) 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.

h) 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.

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

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

k) 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.

l) The controller shall provide the ability to download and upload VMA configuration files, both locally and via the communications network. Controllers shall be able to be loaded individually or as a group using a zone schedule generated spreadsheet of controller parameters.

m) Control setpoint changes initiated over the network shall be written to VMA non-volatile memory to prevent loss of setpoint changes and to provide consistent operation in the event of communication failure.

n) The controller firmware shall be flash-upgradeable remotely via the communications bus to minimize costs of feature enhancements.

o) The controller shall provide fail-soft operation if the airflow signal becomes unreliable, by automatically reverting to a pressure-dependent control mode.

p) 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.

q) Controller shall have on-board diagnostics. These diagnostics shall consist of control loop performance measurements executing at each control loop's sample interval, which may be used to continuously monitor and document system performance. The VMA shall calculate exponentially weighted moving averages (EWMA) for each of the following. These metrics shall be available to the end user for efficient management of the VAV terminals.

   i. Absolute temperature loop error

   ii. Signed temperature loop error

   iii. Absolute airflow loop error

   iv. Signed airflow loop error

   v. Average damper actuator duty cycle

r) The controller shall detect system error conditions to assist in managing the VAV zones. The error conditions shall consist of:

   i. Unreliable space temperature sensor

   ii. Unreliable differential pressure sensor

   iii. Starved box

   iv. Actuator stall

   v. Insufficient cooling

   vi. Insufficient heating

s) The controller shall provide a flow test function to view damper position vs. flow in a graphical format. The information would alert the user to check damper position. The VMA would also provide a method to calculate actuator duty cycle as an indicator of damper actuator runtime.

t) The controller shall provide a compliant interface for ASHRAE Standard 62-1989 (indoor air quality), and shall be capable of resetting the box minimum airflow based on the percent of outdoor air in the primary air stream.

u) The controller shall comply with ASHRAE Standard 90.1 (energy efficiency) by preventing simultaneous heating and cooling, and where the control strategy requires reset of airflow while in reheat, by modulating the box reheat device fully open prior to increasing the airflow in the heating sequence.

v) Inputs:

i. Analog inputs with user defined ranges shall monitor the following analog signals, without the addition of equipment outside the terminal controller cabinet:

- 0-10 VDC Sensors
- 1000ohm RTDs
- NTC Thermistors

ii. Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input "bouncing."

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

iv. Provide side loop application for humidity control.

w) Outputs

i. Analog outputs shall provide the following control outputs:

- 0-10 VDC

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

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

x) Application Configuration

i. The VAV Modular Assembly shall be configured with a software tool that provides a simple Question/Answer format for developing applications and downloading.

y) Sensor Support

i. The VAV Modular Assembly shall communicate over the Sensor-Actuator Bus (SA Bus) with a Network Sensor.

ii. The VMA shall support an LCD display room sensor.

iii. The VMA shall also support standard room sensors as defined by analog input requirements.

iv. The VMA shall support humidity sensors defined by the AI side loop.

9. Network Sensors (NS-XXX-700X)

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

i. Zone Temperature

ii. Zone Humidity

iii. Zone Setpoint

iv. Discharge Air Temperature

v. Zone CO2

b) 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.

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

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

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

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

d) The Network Zone Temperature Sensors shall include the following items:

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

ii. An LED to indicate the status of the Override feature

iii. A button to toggle the temperature display between Fahrenheit and Celsius

iv. A button to program the display for temperature or humidity

v. A button to initiate a timed override command

vi. Available in either surface mount, wall mount, or flush mount

vii. Available with either screw terminals or phone jack

e) The Network Discharge Air Sensors shall include the following:

i. 4 inch or 8 inch duct insertion probe

ii. 10 foot pigtail lead

iii. Dip Switches for programmable address selection

iv. Ability to provide an averaging temperature from multiple locations

v. Ability to provide a selectable temperature from multiple locations

f) The Network CO2 Zone Sensors shall include the following:

i. Available in either surface mount or wall mount

ii. Available with screw terminals or phone jack

10. Many-To-One Wireless Room Temperature Sensor System (WRS-XTX-0000)

a) The Many-To-One System Receiver (WRS Receiver) shall receive wireless Radio Frequency (RF) signals containing temperature data from multiple Wireless Room Temperature Sensors (WRS Sensors).

i. The WRS Receiver shall use direct sequence spread spectrum RF technology.

ii. The WRS Receiver shall operate on the 2.4 GHZ ISM Band.

iii. The WRS Receiver shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.

iv. The WRS Receiver shall be FCC compliant to CFR Part 15 subpart B Class A.

v. The WRS Receiver shall operate as a bidirectional transceiver with the sensors to confirm and synchronize data transmission.

vi. The WRS Receiver shall be capable of communication with WRS Sensors up to a distance of 200 Feet.

vii. The WRS Receiver shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.

viii. The WRS Receiver shall have LED indicators to provide information regarding the following conditions:

- Power On/Off
- Ethernet – Receiver Activity/No Activity
- Wireless Normal Mode – Transmission from sensors/No Transmission
- Wireless Rapid Transmit Mode – No transmission/ weak signal/Adequate signal/Excellent signal
- Ethernet Connection – No connection/10Mbps connection/100Mbps connection
- Network Activity – No Network Activity/Half-Duplex Communication/Full-Duplex Communication

b) The WRS Sensors shall sense and report room temperatures to the WRS Receiver.

i. The WRS Sensors shall use direct sequence spread spectrum RF technology.

ii. The WRS Sensors shall operate on the 2.4 GHZ ISM Band.

iii. The WRS Sensors shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.

iv. The WRS sensors shall be FCC compliant to CFR Part 15 subpart B Class A.

v. The WRS sensors shall be available with

- Warmer/Cooler Set Point Adjustment
- No Set Point Adjustment
- Set Point Adjustment Scale – 55 to 85° F.

vi. The WRS sensors shall be assembled in NEMA 1 plastic housings.

11. ZFR1800 Series Wireless Field Bus System

a) The ZFR1800 Series System shall employ ZigBee technology to create a wireless mesh network to provide wireless connectivity for Metasys BACnet devices at multiple system levels. This includes communications from FEC and VMA field controllers to sensors and from engines to these field controllers. Wireless devices shall co-exist on the same network with hardwired devices. Hardwired controllers shall be capable of retrofit to wireless devices with no special software.

b) The ZFR1810 Wireless Field Bus Coordinator shall provide a wireless interface between supported field controllers and an NCE25 supervisory controller via the BACnet MS/TP field bus. Each wireless mesh network shall be provided with a ZFR1810 Coordinator for initiation and formation of the network

i. The ZFR Coordinator shall use direct sequence spread spectrum RF technology.

ii. The ZFR Coordinator shall operate on the 2.4 GHZ ISM Band.

iii. The ZFR Coordinator shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.

iv. The ZFR Coordinator shall be FCC compliant to CFR Part 15 subpart B Class A.

v. The ZFR Coordinator shall operate as a bidirectional transceiver with the sensors and routers to confirm and synchronize data transmission.

vi. The ZFR Coordinator shall be capable of communication with sensors and routers up to a maximum distance of 250 Feet (line of sight).

vii. The ZFR Coordinator shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.

viii. The ZFR Coordinator shall have LED indicators to provide diagnostic information required for efficient operation and commissioning.

c) The ZFR1811 Wireless Field Bus Router shall be used with any model Field Equipment Controller (FEC) or VMA1600 series VAV Modular Assembly to provide a wireless interface to supervisory engines, via the ZFR1810 Coordinator, and associated WRZ Wireless Mesh Room Temperature Sensors. The ZFR1811 is an alternative mechanical packaging design to the ZFR1812.

i. The ZFR1811 Router shall use direct sequence spread spectrum RF technology.

ii. The ZFR1811 Router shall operate on the 2.4 GHZ ISM Band.

iii. The ZFR1811 Router shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.

iv. The ZFR1811 Router shall be FCC compliant to CFR Part 15 subpart B Class A.

v. The ZFR1811 Router shall operate as a bidirectional transceiver with other mesh network devices to ensure network integrity.

vi. The ZFR1811 Router shall be capable of communication with other mesh network devices at a maximum distance of 250 feet (line of sight).

vii. The ZFR1811 Router shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.

viii. The ZFR1811 Router shall provide LED indication for use in commissioning and troubleshooting that can be disabled.

ix. The ZFR1811 router shall support the ability to be used alternatively as a wireless repeater should the network design require it.

d) The ZFR1812 Wireless Field Bus Router shall be used with any model Field Equipment Controller (FEC) or VMA1600 series VAV Modular Assembly to provide a wireless interface to supervisory engines, via the ZFR1810 Coordinator, and associated WRZ Wireless Mesh Room Temperature Sensors. The ZFR1812 is an alternative mechanical packaging design to the ZFR1811 and provides flexible mounting options where needed.

i. The ZFR1812 Router shall use direct sequence spread spectrum RF technology.

ii. The ZFR1812 Router shall operate on the 2.4 GHZ ISM Band.

iii. The ZFR1812 Router shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.

iv. The ZFR1812 Router shall be FCC compliant to CFR Part 15 subpart B Class A.

v. The ZFR1812 Router shall operate as a bidirectional transceiver with other mesh network devices to ensure network integrity.

vi. The ZFR1812 Router shall be capable of communication with other mesh network devices at a maximum distance of 250 feet (line of sight).

vii. The ZFR1812 Router shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.

viii. The ZFR1812 Router shall provide LED indication for use in commissioning and troubleshooting that can be disabled.

ix. The ZFR1812 Router shall be available in either surface mount, wall mount, or ceiling mount.

x. The ZFR1812 router shall support the ability to be used alternatively as a wireless repeater should the network design require it.

12. One-to-One Wireless Room Temperature Sensor System (WRZ)

a) The One-To-One Wireless Receiver (WRS Receiver) shall receive wireless Radio Frequency (RF) signals containing temperature data from multiple Wireless Room Temperature Sensors (WRZ Sensors) and communicate this information to either FEC or VMA controllers via the Sensor/Actuator (SA) Bus.

i. The WRZ Receiver shall use direct sequence spread spectrum RF technology.

ii. The WRZ Receiver shall operate on the 2.4 GHZ ISM Band.

iii. The WRZ Receiver shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.

iv. The WRZ Receiver shall be FCC compliant to CFR Part 15 subpart B Class A.

v. The WRZ Receiver shall operate as a bidirectional transceiver with the sensors to confirm and synchronize data transmission.

vi. The WRZ Receiver shall be capable of communication with from one to five WRZ Sensors up to a distance of 200 Feet.

vii. The WRZ Receiver shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.

viii. The WRZ Receiver shall have LED indicators to provide information regarding the following conditions:

- Power
- SA Bus – Receiver Activity/No Activity
- Wireless RF – Transmission from sensors/No Transmission
- Wireless Rapid Transmit Mode – No transmission/ weak signal/Adequate signal/Excellent signal

b) The WRZ Sensors shall sense and report room temperatures to the WRZ Receiver.

i. The WRZ Sensors shall use direct sequence spread spectrum RF technology.

ii. The WRZ Sensors shall operate on the 2.4 GHZ ISM Band.

iii. The WRZ Sensors shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.

iv. The WRZ sensors shall be FCC compliant to CFR Part 15 subpart B Class A.

v. The WRZ sensors shall be available with

- Warmer/Cooler Set Point Adjustment
- No Set Point Adjustment
- Set Point Adjustment Scale – *55* to 85° F.

vi. The WRZ sensors shall be assembled in NEMA 1 plastic housings.

13. Room Pressure Monitor (**LB-RPM1611-0**)

a) Description - A room pressure monitor system shall be furnished and installed to measure and display the measured room pressurization independent of supply and exhaust flow volumes. The system shall ensure that the air pressure of the space is negative with respect to the corridor to comply with the recommendations put forth in the ANSI/ASHRAE Standard 170-2008, Ventilation of Health Care Facilities, the Facilities Guidelines Institute Guidelines for Design and Construction of Hospitals and Outpatient Facilities and the Guidelines for Environmental Infection Monitor in Health-Care Facilities - Recommendations of CDC and the Healthcare Infection Monitor Practices Advisory Committee (HICPAC).

b) Warranty - The room pressure monitor system shall have a limited three-year warranty for all parts. The warranty shall commence on the date of shipment from the manufacturer.

System Performance Requirements

c) The room pressure monitor system shall be completely independent for each individual patient room. The room pressure monitor system shall not depend on measurements from other patient room monitor systems.

d) The room pressure monitor system shall measure the pressure differential between the patient room and reference space. The room pressure sensor shall have a resolution of 5% of the measured value and shall detect any change in the room pressure within 0.1 second, with a minimum reading of 0.00001 inches H2O.

e) The room pressure monitor system shall accept one pressure sensor input. The primary sensor shall measure the pressure differential between the patient room and corridor.

f) Each monitor shall have a full color touch screen interface with a minimum touchscreen size of 4.3 inches. Screen shall be capable of displaying multiple colors at one time. The monitor shall be capable of displaying room mode, alarm status, user-configurable room label and all measurements connected on a single screen without scrolling. Displays that change the backlighting color or external LEDs to indicate alarm status are not acceptable. Monitors that use keypads are not acceptable.

g) Local audible and visual alarms and relay contacts shall be enabled whenever either measured room pressure differential falls below its user configurable low alarm set point or rises above its user configurable high alarm set point, after a configurable delay. The pressure sensor shall have individual alarm set points for high and low alarms. A mute function shall temporarily silence the audible alarm for a user configured delay. Manual or automatic reset of the alarms shall be configurable.

h) The room pressure monitor system shall accept 7 inputs configurable as:

i. Input 1:Room 1 Pressure Sensor

ii. Input 2:Not Used

iii. Input 3:Supply Flow

iv. Input 4:Door switch or Occupancy Switch

v. Input 5:Keyswitch

vi. Input 6:Door switch or Occupancy Switch

vii. Input 7:Exhaust Flow

i) The room pressure monitor will use the flow station to calculate the Air Changes per Hour ventilation rate for the patient room. Local audible and visual alarms shall be enabled whenever the measured air volume falls below its configurable low alarm set point, after a configurable delay. Supply and exhaust flows shall have individual alarm set points. The audible alarm shall have a mute function to temporarily silence the alarm for a user-configured delay. Manual or automatic reset of the alarms shall be configurable.

j) The room pressure monitor system shall have Positive Mode, Negative Mode and No Isolation Mode. Users can change room mode either with an input from a keyswitch or through the touchscreen without accessing the full menu system. The keyswitch or touchscreen shall change the room mode from Positive Mode or Negative Mode to No Isolation Mode (and back), allowing the room to be used for standard patient care. In No Isolation Mode, the room pressure monitor will disable all alarms.

k) Calibration of room pressure differential and air flow shall be done electronically through the use of the integral keypad. Calibration shall consist of adjusting the sensor zero point and sensor span to match a reference measurement. Password protection of the calibration items shall limit unauthorized access. Neither remote calibration nor calibrating through the use of potentiometers is acceptable.

l) The room pressure monitor shall have the ability to communicate with a building automation system (BMS) via Modbus, BACnet® MS/TP (preferred) communication protocols. Communication shall be native to the monitor device and not require an external interface or gateway.

Materials

m) The room pressure monitor system shall measure the room pressure differential. The system must accept up to 3 room pressure measurements. Systems that exclusively monitor the supply and exhaust flow volumes to maintain a volumetric offset are not allowed.

n) The room pressure monitor system shall mount to a standard depth electrical box. The monitor shall not extend more than 0.625 inches from the wall.

o) The room pressure monitor system shall accept 2 flow measurements. The flow measurements shall be 0 to 10V signals. The flow measurements will be linear with respect to velocity pressure, linear with respect to velocity or venturi valve feedback.

i. Optional: The flow measurements may be airflow proving switches that open or close to indicate the presence of flow.

p) The room pressure monitor shall have a digital display of all configuration parameters. Configuration shall be done through the touchscreen display on the monitor. Password protection shall limit unauthorized access to configuration parameters. An analog output of room pressure differential shall be user configurable to either 0 to 10V or 4 to 20 mA. The room pressure monitor shall have an RS 485 communications port, supporting the Modbus or BACnet MS/TP for seamless integration to the building automation system. Systems relying on an external gateway for communications are not acceptable.

q) The room pressure sensor shall be bi-directional with an accuracy of 10% of reading. The sensor shall be capable of being mounted in the corridor (reference space) or the patient room (monitor led space). The room pressure sensor shall use two in-line ceramic coated RTDs to measure the pressure differential. The room pressure sensor shall be temperature compensated over a range of 55degF to 95degF. Sensors employing a thermistor-based sensor or that cannot differentiate between positive and negative pressures are not allowed. Field-calibration of the sensor shall be performed through the touchscreen on the room pressure monitor.

i. Systems utilizing pressure transducers to measure room pressure differential must use copper or stainless steel tubing to eliminate kinking. Systems utilizing pressure transducers must provide accuracy statements including non-linearity, hysteresis, non-repeatability, zero offset, span offset, and temperature compensation errors. Systems utilizing pressure transducers must include 10 years of recalibrations using a calibration kit that meets or exceeds Accuracy: ±0.04% FS, precision 0.0002 in H2O,calibration stability of 0.2% Reading/Yr. Calibration kit must have valid NIST-traceable calibration certificate. Calibrations that consist of re-zeroing the sensor without adjusting the sensor span are not acceptable.

r) The room pressure monitor system shall be capable of interfacing with a remote monitor at the nurses' station. The nurses' station monitor shall display alarm status, room mode and room name for up to 8 rooms with room pressure monitor or monitor systems. The nurses' station monitor shall be able to change the room mode or mute alarms for any displayed room. The room monitor shall not communicate to connected room pressure monitors or monitors over the bas wiring to limit network traffic and provide fail-safe operation.

Installation

s) The Automatic Temperature Measures (ATC) contractor shall install the room pressure sensor and monitor in each patient room, as recommended by the manufacturer's installation instructions.

t) The ATC contractor shall connect all measure wiring as required.

Equipment Start-Up, Calibration, and Training

u) The manufacturer or a factory-authorized representative shall perform system start up. Start-up shall include calibration of the monitors. Calibration shall be performed only after substantial completion of the building. Ceilings and doors shall be installed and the HVAC systems (exhaust and supply fans) shall be properly air-balanced. The balancing contractor shall be responsible for final verification and reporting of all air flows.

v) The manufacturer or a factory-authorized representative shall provide ___ hours of training for building personnel.

14. Room Pressure Monitor (**LB-RPM1621-0**)

a) Description - A room pressure monitor system shall be furnished and installed to measure and display the measured room pressurization independent of supply and exhaust flow volumes. The system shall ensure that the air pressure of the space is negative with respect to the corridor to comply with the recommendations put forth in the ANSI/ASHRAE Standard 170-2008, Ventilation of Health Care Facilities, the Facilities Guidelines Institute Guidelines for Design and Construction of Hospitals and Outpatient Facilities and the Guidelines for Environmental Infection Monitor in Health-Care Facilities - Recommendations of CDC and the Healthcare Infection Monitor Practices Advisory Committee (HICPAC).

b) Warranty - The room pressure monitor system shall have a limited three-year warranty for all parts. The warranty shall commence on the date of shipment from the manufacturer.

System Performance Requirements

c) The room pressure monitor system shall be completely independent for each individual patient room. The room pressure monitor system shall not depend on measurements from other patient room monitor systems.

d) The room pressure monitor system shall measure the pressure differential between the patient room and reference space. The room pressure sensor shall have a resolution of 5% of the measured value and shall detect any change in the room pressure within 0.1 second, with a minimum reading of 0.00001 inches H2O.

e) The room pressure monitor system shall accept three pressure sensor inputs. The primary sensor shall measure the pressure differential between the patient room and corridor. The second sensor shall measure the pressure differential between a second patient room and the corridor. The third sensor shall measure the pressure differential between the anteroom and corridor.

f) Each monitor shall have a full color touch screen interface with a minimum touchscreen size of 4.3 inches. Screen shall be capable of displaying multiple colors at one time. The monitor shall be capable of displaying room mode, alarm status, and user-configurable room labels for three rooms on a single screen without scrolling. Displays that change the backlighting color or external LEDs to indicate alarm status are not acceptable. Monitors that use keypads are not acceptable.

g) Local audible and visual alarms and relay contacts shall be enabled whenever either measured room pressure differential falls below its user configurable low alarm set point or rises above its user configurable high alarm set point, after a configurable delay. The primary, second and third pressure sensors shall have individual alarm set points for high and low alarms. A mute function shall temporarily silence the audible alarm for a user configured delay. Manual or automatic reset of the alarms shall be configurable.

h) The room pressure monitor system shall accept 7 inputs configurable as:

i. Input 1:Room 1 Pressure Sensor

ii. Input 2:Room 2 Pressure Sensor

iii. Input 3:Room 1 Supply Flow or Room 3 Pressure Sensor

iv. Input 4:Room 1 Door switch or Occupancy Switch

v. Input 5:Room 1 Keyswitch or Relative Humidity Sensor

vi. Input 6:Room 1 Temperature or Room 2 Door switch or Occupancy Switch

vii. Input 7:Room 1 Exhaust Flow or Room 2 Keyswitch

i) The room pressure monitor will use the flow station to calculate the Air Changes per Hour ventilation rate for the patient room. Local audible and visual alarms shall be enabled whenever the measured air volume falls below its configurable low alarm set point, after a configurable delay. Supply and exhaust flows shall have individual alarm set points. The audible alarm shall have a mute function to temporarily silence the alarm for a user-configured delay. Manual or automatic reset of the alarms shall be configurable.

j) The room pressure monitor system shall have Positive Mode, Negative Mode and No Isolation Mode for each room monitored. Users can change room mode either with an input from a keyswitch or through the touchscreen without accessing the full menu system. The keyswitch or touchscreen shall change the room mode from Positive Mode or Negative Mode to No Isolation Mode (and back), allowing the room to be used for standard patient care. In No Isolation Mode, the room pressure monitor will disable all alarms.

k) Calibration of room pressure differential and air flow shall be done electronically through the use of the integral keypad. Calibration shall consist of adjusting the sensor zero point and sensor span to match a reference measurement. Password protection of the calibration items shall limit unauthorized access. Neither remote calibration nor calibrating through the use of potentiometers is acceptable.

l) The room pressure monitor shall have the ability to communicate with a building automation system (BMS) via Modbus, BACnet® MS/TP (preferred) communication protocol. Communication shall be native to the monitor device and not require an external interface or gateway.

Materials

m) The room pressure monitor system shall measure the room pressure differential. The system must accept up to 3 room pressure measurements. Systems that exclusively monitor the supply and exhaust flow volumes to maintain a volumetric offset are not allowed.

n) The room pressure monitor system shall mount to a standard depth electrical box. The monitor shall not extend more than 0.625 inches from the wall.

o) The room pressure monitor system shall accept 2 flow measurements. The flow measurements shall be 0 to 10V signals. The flow measurements will be linear with respect to velocity pressure, linear with respect to velocity or venturi valve feedback. Optional: The flow measurements may be airflow proving switches that open or close to indicate the presence of flow.

p) The room pressure monitor shall have a digital display of all configuration parameters. Configuration shall be done through the touchscreen display on the monitor. Password protection shall limit unauthorized access to configuration parameters. An analog output of room pressure differential shall be user configurable to either 0 to 10V or 4 to 20 mA. The room pressure monitor shall have an RS 485 communications port, supporting the Modbus or BACnet MS/TP for seamless integration to the building automation system. Systems relying on an external gateway for communications are not acceptable.

q) The room pressure sensor shall be bi-directional with an accuracy of 10% of reading. The sensor shall be capable of being mounted in the corridor (reference space) or the patient room (monitored space). The room pressure sensor shall use two in-line ceramic coated RTDs to measure the pressure differential. The room pressure sensor shall be temperature compensated over a range of 55degF to 95degF. Sensors employing a thermistor-based sensor or that cannot differentiate between positive and negative pressures are not allowed. Field-calibration of the sensor shall be performed through the touchscreen on the room pressure monitor.

r) Systems utilizing pressure transducers to measure room pressure differential must use copper or stainless steel tubing to eliminate kinking. Systems utilizing pressure transducers must provide accuracy statements including non-linearity, hysteresis, non-repeatability, zero offset, span offset, and temperature compensation errors. Systems utilizing pressure transducers must include 10 years of recalibrations using a calibration kit that meets or exceeds Accuracy: ±0.04% FS, precision 0.0002 in H2O, calibration stability of 0.2% Reading/Yr. Calibration kit must have valid NIST-traceable calibration certificate. Calibrations that consist of re-zeroing the sensor without adjusting the sensor span are not acceptable.

s) The room pressure monitor system shall be capable of interfacing with a remote monitor at the nurses' station. The nurses' station monitor shall display alarm status, room mode and room name for up to 8 rooms with room pressure monitor or monitor systems. The nurses' station monitor shall be able to change the room mode or mute alarms for any displayed room. The room monitor shall not communicate to connected room pressure monitors or monitors over the bas wiring to limit network traffic and provide fail-safe operation.

Installation

t) The Automatic Temperature Measures (ATC) contractor shall install the room pressure sensor and monitor in each patient room, as recommended by the manufacturer's installation instructions.

u) The ATC contractor shall connect all measure wiring as required.

v) Equipment Start-Up, Calibration, and Training

w) The manufacturer or a factory-authorized representative shall perform system start up. Start-up shall include calibration of the monitors. Calibration shall be performed only after substantial completion of the building. Ceilings and doors shall be installed and the HVAC systems (exhaust and supply fans) shall be properly air-balanced. The balancing contractor shall be responsible for final verification and reporting of all air flows.

x) The manufacturer or a factory-authorized representative shall provide 8-hours of training for building personnel.

15. Room Pressure Controller (LB-RPC1611-0)

a) Description - A room pressure control system shall be furnished and installed to measure and display the measured room pressurization independent of supply and exhaust flow volumes. The system shall ensure that the air pressure of the space is negative with respect to the corridor to comply with the recommendations put forth in the ANSI/ASHRAE Standard 170-2008, Ventilation of Health Care Facilities, the Facilities Guidelines Institute Guidelines for Design and Construction of Hospitals and Outpatient Facilities and the Guidelines for Environmental Infection Control in Health-Care Facilities - Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC).

b) Warranty - The room pressure control system shall have a limited three-year warranty for all parts. The warranty shall commence on the date of shipment from the manufacturer.

System Performance Requirements

c) The room pressure control system shall be completely independent for each individual patient room. The room pressure control system shall not depend on measurements from other patient room control systems. The room pressure control system shall not control more than one room. Monitor and control functions shall be integrated into one unit.

d) The room pressure control system shall measure the pressure differential between the patient room and reference space. The room pressure sensor shall have a resolution of 5% of the measured value and shall detect any change in the room pressure within 0.1 second, with a minimum reading of 0.00001 inches H2O.

e) The room pressure control system shall accept two pressure sensor inputs. The primary sensor shall measure the pressure differential between the patient room and corridor. The secondary sensor shall measure the pressure differential between the anteroom and corridor.

f) The room pressure control system shall control the room exhaust with a 0 to 10 VDC signal to maintain room pressurization. The room pressure controller shall receive a voltage signal related to the exhaust air flow volume in order to maintain a minimum flow rate.

g) Optional: The room pressure control system shall control the room supply with a 0 to 10 VDC signal to maintain ventilation and room pressurization. The room pressure controller shall receive a voltage signal related to the supply air flow volume in order to maintain a minimum flow rate.

Optional: The room pressure control system shall control the room heating valve with a field-configurable 0 to 10 VDC or 4 to 20 mA signal to maintain room temperature. The room pressure controller shall receive a signal from a 1000 Ω platinum RTD of the room temperature to maintain room temperature. The room pressure controller shall receive a 0 to 10 VDC signal to adjust the room temperature setpoint.

Optional: The room pressure control system shall ensure the supply air temperature does not rise above a field-configurable difference from the room air temperature. The room pressure controller shall receive a 0 to 10 VDC signal of the supply air temperature.

h) To ensure fast, accurate control, the room pressure control system shall have a PID control algorithm with two sets of tuning constants. The two sets of tuning constants enable fast response to large disturbances while maintaining stability at setpoint. The control sensitivity defining the breakpoint between input and steady state response shall be adjustable. The room pressure control system shall update the control output 10 times per second.

i) Each controller shall have a full color touch screen interface with a minimum touchscreen size of 4.3 inches. Screen shall be capable of displaying multiple colors at one time. The controller shall be capable of displaying room mode, alarm status, user-configurable room labels and all measurements for two rooms on a single screen without scrolling. Displays that change the backlighting color or external LEDs to indicate alarm status are not acceptable. Controllers that use keypads are not acceptable.

j) Local audible and visual alarms and relay contacts shall be enabled whenever either measured room pressure differential falls below its user configurable low alarm set point or rises above its user configurable high alarm set point, after a configurable delay. The primary and secondary pressure sensors shall have individual alarm set points for high and low alarms. A mute function shall temporarily silence the audible alarm for a user configured delay. Manual or automatic reset of the alarms shall be configurable.

k) The room pressure control system shall accept 7 inputs configurable as:

i. Input 1:Room 1 Pressure Sensor

ii. Input 2:Room 2 Pressure Sensor or Room 1 Temperature Setpoint

iii. Input 3:Room 1 Supply Flow

iv. Input 4:Room 1 Door switch or Occupancy Switch

v. Input 5:Room 1 Keyswitch or Relative Humidity Sensor

vi. Input 6:Room 1 Temperature or Room 2 Door switch or Occupancy Switch

vii. Input 7:Room 1 Exhaust Flow or Supply Air Temperature or Room 2 Keyswitch

l) The room pressure controller will use the flow station to calculate the Air Changes per Hour ventilation rate for the patient room. Local audible and visual alarms shall be enabled whenever the measured air volume falls below its configurable low alarm set point, after a configurable delay. Supply and exhaust flows shall have individual alarm set points. The audible alarm shall have a mute function to temporarily silence the alarm for a user-configured delay. Manual or automatic reset of the alarms shall be configurable.

m) The room pressure control system shall have Positive Mode, Negative Mode and No Isolation Mode for each room monitored or controlled. Users can change room mode either with an input from a keyswitch or through the touchscreen without accessing the full menu system. The keyswitch or touchscreen shall change the room mode from Positive Mode or Negative Mode to No Isolation Mode (and back), allowing the room to be used for standard patient care. In No Isolation Mode, the room pressure controller will disable all alarms.

n) Calibration of room pressure differential and air flow shall be done electronically through the use of the integral keypad. Calibration shall consist of adjusting the sensor zero point and sensor span to match a reference measurement. Password protection of the calibration items shall limit unauthorized access. Neither remote calibration nor calibrating through the use of potentiometers is acceptable.

o) The room pressure monitor shall have the ability to communicate with a building automation system (BMS) via or BACnet® MS/TP (preferred) or Modbus communication protocols. Communication shall be native to the monitor device and not require an external interface or gateway.

Materials

p) The room pressure control system shall measure the room pressure differential. The system must accept up to 2 room pressure measurements. Systems that exclusively control the supply and exhaust flow volumes to maintain a volumetric offset are not allowed.

q) The room pressure control system shall mount to a standard depth electrical box. The monitor shall not extend more than 0.625 inches from the wall.

r) The room pressure control system shall accept 2 flow measurements. The flow measurements shall be 0 to 10V signals. The flow measurements will be linear with respect to velocity pressure, linear with respect to velocity or venturi valve feedback.

i. Optional: The flow measurements may be airflow proving switches that open or close to indicate the presence of flow.

s) The room pressure controller shall have a digital display of all configuration parameters. Configuration shall be done through the touchscreen display on the controller. Password protection shall limit unauthorized access to configuration parameters. An analog output of room pressure differential shall be user configurable to either 0 to 10V or 4 to 20 mA. The room pressure controller shall have an RS 485 communications port, supporting the Modbus or BACnet MS/TP for seamless integration to the building automation system. Systems relying on an external gateway for communications are not acceptable.

t) The room pressure sensor shall be bi-directional with an accuracy of 10% of reading. The sensor shall be capable of being mounted in the corridor (reference space) or the patient room (controlled space). The room pressure sensor shall use two in-line ceramic coated RTDs to measure the pressure differential. The room pressure sensor shall be temperature compensated over a range of 55degF to 95degF. Sensors employing a thermistor-based sensor or that cannot differentiate between positive and negative pressures are not allowed. Field-calibration of the sensor shall be performed through the touchscreen on the room pressure controller.

u) Systems utilizing pressure transducers to measure room pressure differential must use copper or stainless steel tubing to eliminate kinking. Systems utilizing pressure transducers must provide accuracy statements including non-linearity, hysteresis, non-repeatability, zero offset, span offset, and temperature compensation errors. Systems utilizing pressure transducers must include 10 years of recalibrations using a calibration kit that meets or exceeds Accuracy: ±0.04% FS, precision 0.0002 in H2O,calibration stability of 0.2% Reading/Yr. Calibration kit must have valid NIST-traceable calibration certificate. Calibrations that consist of re-zeroing the sensor without adjusting the sensor span are not acceptable.

v) The room pressure control system shall be capable of interfacing with a remote monitor at the nurses' station. The nurses' station monitor shall display alarm status, room mode and room name for up to 8 rooms with room pressure control or monitor systems. The nurses' station monitor shall be able to change the room mode or mute alarms for any displayed room. The room monitor shall not communicate to connected room pressure monitors or controllers over the bas wiring to limit network traffic and provide fail-safe operation.

Installation

w) The Automatic Temperature Measures (ATC) contractor shall install the room pressure sensor and controller in each patient room, as recommended by the manufacturer's installation instructions.

x) The ATC contractor shall connect all measure wiring as required.

Equipment Start-Up, Calibration, and Training

y) The manufacturer or a factory-authorized representative shall perform system start up. Start-up shall include calibration of the controllers. Calibration shall be performed only after substantial completion of the building. Ceilings and doors shall be installed and the HVAC systems (exhaust and supply fans) shall be properly air-balanced. The balancing contractor shall be responsible for final verification and reporting of all air flows.

z) The manufacturer or a factory-authorized representative shall provide ___ hours of training for building personnel.

16. Nurse's Station Display (**LB-NSD1380-0**)

a) Description - An accessory display shall be furnished and installed to indicate alarm status and room mode from connected room pressure monitors.

b) Warranty - The nurse's station display system shall have a limited three-year warranty for all parts. The warranty shall commence on the date of shipment from the manufacturer.

System Requirements

c) Each display system shall have a full color touch screen interface with a minimum touchscreen size of 4.3 inches. Screen shall be capable of displaying multiple colors at one time. The monitor shall be capable of displaying room mode, alarm status, mute status and user-configurable room labels for eight rooms (from 3 to 8 connected monitors or controllers) on a single screen without scrolling. Displays that change the backlighting color or external LEDs to indicate alarm status are not acceptable. Systems that use keypads are not acceptable.

d) Local audible and visual alarms shall be enabled whenever a connected room monitor or controller enters alarm mode. The nurse's display system shall indicate the alarm type. A mute function shall temporarily silence the audible alarm for a user configured delay. Muting alarms at the nurse's station display will also mute alarms at the connected monitor or controller, just as muting alarms at the connected monitor or controller will also mute alarms at the nurse's station display. Manual or automatic reset of the alarms shall be configurable.

e) The nurse's station display system shall be display the room mode of all rooms for each connected monitor or controller as Positive, Negative or No Isolation. The nurse's station display shall also be able to change the room mode of connected rooms.

f) The nurse's station display system shall communicate with connected room pressure monitors using Modbus communications over a network separate from the building automation. Nurse's station display systems shall not communicate over the building automation system in order to limit network traffic. The nurse's station display shall auto-discover connected room pressure monitors and controllers when initially powered.

Materials

g) The nurse's station display system shall mount to a standard depth electrical box. The display system shall not extend more than 0.625 inches from the wall.

h) The nurse's station display system shall have a digital display of all configuration parameters. Configuration shall be done through the touchscreen on the display system. Password protection shall limit unauthorized access to configuration parameters. The room pressure monitor shall have an RS 485 communications port, supporting the Modbus protocol for communications to connected room monitors and controllers.

Installation

i) The Automatic Temperature Controls (ATC) contractor shall install the nurse's station display system per building plans, as recommended by the manufacturer's installation instructions.

j) The ATC contractor shall connect all measure wiring as required.

G. System Tools

1. System Configuration Tool (SCT)

a) The Configuration Tool shall be a software package enabling a computer platform to be used as a stand-alone engineering configuration tool.

b) The configuration tool shall provide an archive database for the configuration and application data.

c) The configuration tool shall have the same look-and-feel at the User Interface (UI) regardless of whether the configuration is being done online or offline.

d) The configuration tool shall include the following features:

i. Basic system navigation tree for connected networks

ii. Integration of BACnet enabled devices

iii. Customized user navigation trees

iv. Point naming operating parameter setting

v. Graphic diagram configuration

vi. Alarm and event message routing

vii. Graphical logic connector tool for custom programming

viii. Downloading, uploading, and archiving databases

e) The configuration tool shall have the capability to automatically discover field devices on connected buses and networks. Automatic discovery shall be available for the following field devices:

i. BACnet Devices

f) The configuration tool shall be capable of programming the Field Equipment Controllers.

i. The configuration tool shall provide the capability to configure, simulate, and commission the Field Equipment Controllers.

ii. The configuration tool shall allow the FECs to be run in Simulation Mode to verify the applications.

iii. The configuration tool shall contain a library of standard applications to be used for configuration.

g) The configuration tool shall be capable of programming the field devices.

i. The configuration tool shall provide the capability to configure, simulate, and commission the field devices.

ii. The configuration tool shall allow the field devices to be run in Simulation Mode to verify the applications.

iii. The configuration tool shall contain a library of standard applications to be used for configuration

h) A wireless access point shall allow a wireless enabled portable PC to make a temporary Ethernet connection to the automation network.

i. The wireless connection shall allow the PC to access configuration tool through the web browser using the User Interface (UI).

ii. The wireless use of configuration tool shall be the same as a wired connection in every respect.

iii. The wireless connection shall use the Bluetooth Wireless Technology.

2. Wireless MS/TP Converter (BTCVT)

a) The converter shall provide a temporary wireless connection between the SA or FC Bus and a wireless enabled portable PC.

b) The converter shall support downloading and troubleshooting FEC and field devices from the PC over the wireless connection.

c) The converter shall employ Bluetooth Wireless Technology.

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

e) The converter shall operate over a minimum of thirty three (33) feet within a building.

f) The converter shall have LED indicators to provide information regarding the following conditions:

i. Power - On/Off

ii. Fault – Fault/No Fault

iii. SA/FC Bus – Bus Activity/ No Bus Activity

iv. Blue – Bluetooth Communication Established/ Bluetooth Communication Not Established

g) The SWCVT shall comply with FCC Part 15.247 regulations for low-power unlicensed transmitters.

3. Handheld VAV Balancing Sensor (ATV7003)

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

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

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

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

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

f) 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.

g) The sensor shall include the following

i. 5 foot retractable cable

ii. Laminated user guide

iii. Nylon caring case

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

H. Miscellaneous Devices

1. Variable Frequency Motor Speed Control Drives

a) The variable speed drives and all components shall be designed, manufactured and tested in accordance with the latest applicable standards.

i. Institute of Electrical and Electronic Engineers (IEEE)

- IEEE 519-1992: Guide for harmonic content and control

ii. Underwriters Laboratories (UL508C: Power Conversion Equipment)

- UL
- cUL

iii. National Electrical Manufacturer's Association (NEMA)

- ICS 7.0: Industrial Controls & Systems for VSD's.

iv. EN 61000-3-12, EN 61800-3 (1996) +A11 (2000) Category C2

- Fulfill all EMC immunity requirements

b) Variable speed drives through 250 HP shall have the following features:

i. The VSD may be designed in a NEMA Type 1, NEMA 12, or NEMA 3R enclosure.

ii. Incoming Power: Three-phase, 208 / 240 / 480 (+10% to -10%) and 50/60 Hz (+10 to -5%). The VSD shall provide microprocessor-based control for three-phase induction motors. The controller's full load output current rating shall be based on a low overload application at 40° C ambient and 1.5 - 10 kHz switching frequency with automatic switching frequency de-rating in case of overload.

iii. Humidity: 0 to 95% (non-condensing and non-corrosive).

iv. Altitude: 0 to 3,300 feet (1000 meters) above sea level.

v. Ambient Temperature: -10 to 40°C (VT).

vi. Storage Temperature: -40 to 70°C.

vii. The VSD's shall be of the Pulse Width Modulated (PWM) design converting the utility input voltage and frequency to a variable voltage and frequency output via a two-step operation.

viii. The VSD's shall have an efficiency at full load and speed that exceeds 97%. The efficiency shall exceed 90% at 50% speed.

ix. The VSD's shall maintain a minimum line side displacement power factor of 0.96, regardless of speed and load for VSD's less than 75 HP. The VSD's shall maintain a minimum line side displacement power factor of .99, regardless of speed and load for motors greater than 75 HP.

x. The VSD's shall have a one (1) minute overload current rating of 110% for low overload applications.

xi. The current withstand rating of the drive shall be 100,000 AIC.

xii. The VSD's shall be capable of operating any NEMA design B squirrel cage induction motor, regardless of manufacturer, with a horsepower and current rating within the capacity of the VSD.

xiii. The VSD's shall have an integral EMI/RFI filter as standard.

xiv. VSD must contain a circuit breaker or fused disconnect as an option.

xv. Total harmonic distortion shall be calculated based on total demand distortion conditions as defined in IEEE 519-1992.

xvi. Any harmonic calculations shall be done based on the kVA capacity, X/R ratio and the impedance of the utility transformer feeding the installation, as noted on the drawings, and the total system load.

xvii. Built in Communication capability for interface with Ethernet (BACnet/IP) (Modbus/TCP).

xviii. Communication capability via expansion card to support RS-485 includes Johnson Controls Metasys - SA Bus.

2. Local Control Panels

a) 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.

b) 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.

c) All I/O connections on the DDC controller shall be provide via removable or fixed screw terminals.

d) 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.

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

f) A 120 volt convenience outlet, fused on/off power switch, and required transformers shall be provided in each enclosure.

3. Power Supplies

a) DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75% of the rated capacity of the power supply.

b) Input: 120 VAC +10%, 60Hz.

c) Output: 24 VDC.

d) Line Regulation: +0.05% for 10% line change.

e) Load Regulation: +0.05% for 50% load change.

f) Ripple and Noise: 1 mV rms, 5 mV peak to peak.

g) An appropriately sized fuse and fuse block shall be provided and located next to the power supply.

h) A power disconnect switch shall be provided next to the power supply.

PART III - EXECUTION

I. Examination

A. Verify that systems are ready to receive work.

B. Beginning of installation means installer accepts existing conditions.

C. The project plans shall be thoroughly examined for control device and equipment locations, and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

D. The contractor shall inspect the site to verify that equipment is installable as shown and any discrepancies, conflicts, or omissions shall be reported to the Architect/Engineer for resolution before rough-in work is started.

E. The Control System Contractor shall examine the drawings and specifications for other parts of the work, and if head room or space conditions appear inadequate or if any discrepancies occur between the plans and his work and the plans for the work of others, he shall report such discrepancies to the Architect/Engineer and shall obtain written instructions for any changes necessary to accommodate his work with the work of others.

II. General installation requirements

A. Install all control components in accordance with manufacturer's instructions and recommendations.

B. If the controls contractor is responsible for providing the damper then provide mixing dampers of parallel blade construction arranged to mix streams. Provide separate minimum outside air damper section adjacent to variable outside air damper.

C. Mount control panels adjacent to associated equipment on vibration-free walls or freestanding angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide nameplates for instruments and controls inside cabinet and nameplates on cabinet face. See Appendix C for sample panel layout.

D. After completion of installation, test and adjust control equipment. Submit data showing set points and final adjustments of controls.

E. Install equipment, piping, wiring/conduit parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.

F. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

G. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.

H. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

III. ELECTRICAL SYSTEM INSTALLATION

A. Comply with all Division 26 Installation Requirements.

B. Install low voltage power and BACnet and LAN communication trunks in conduit in the following locations regardless of local building code allowances otherwise.

1. Mechanical rooms.
2. Electrical rooms.
3. Vertical risers (exception: fire rated continuous closet like a telephone closet).
4. Open Areas where the wiring will be exposed to view or tampering.

C. Conceal conduit within finished shafts, ceilings and wall as required. Install exposed conduit parallel with or at right angles to the building walls.

D. Where Class 2 wires are in concealed and accessible locations including ceiling return air plenums, approved cables not in raceway may be used provided that:

1. Circuits meet NEC Class 2 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)
2. All cables shall be UL listed for application, i.e., cables used in ceiling plenums shall be UL listed specifically for that purpose.

3. All cables shall have a YELLOW outer jacket to conform to Fullerton College standards.

E. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).

F. Where Class 2 wiring is run exposed, wiring to be run parallel along a surface or perpendicular to it, and NEATLY tied at 3m (10 ft.) intervals.

G. All wire-to-device connections shall be made at a terminal blocks or terminal strip. All wire-to-wire connections shall be at a terminal block, or with a crimped connector. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.Plug or cap all unused conduit openings and stub-ups. Do not use caulking compound.

H. Route all conduits to clear beams, plates, footings and structure members. Do not route conduit through column footings or grade beams.

I. Set conduits as follows:

J. Expanding silicone fire stop material sealed watertight where conduit is run between floors and through walls of fireproof shaft.

K. Oakum and lead, sealed watertight penetration through outside foundation walls.

L. Cap open ends of conduits until conductors are installed.

M. Where conduit is attached to vibrating or rotating equipment, flexible metal conduit with a minimum length of 18 inches and maximum length of 36 inches shall be installed and anchored in such a manner that vibration and equipment noise will not be transmitted to the rigid conduit.

N. Where exposed to the elements or in damp or wet locations, waterproof flexible conduit shall be installed. Installation shall be as specified for flexible metal conduit.

O. Provide floor, wall, and ceiling plates for all conduits passing through walls, floors or ceilings. Use prime coated cast iron, split-ring type plates, except with polished chrome-plated finish in exposed finished spaces.

IV. SEQUENCE OF OPERATIONS

A. Include on drawings all sequences of operations.

B. General.

1. Provide automatic control for system operation as described herein, although word "automatic" or "automatically", is not used.

2. Provide control devices, control software and control wiring as required for automatic operation of each sequence specified.

3. Manual operation shall be limited, only require where absolutely necessary; however, provide manual override for each automatic operation.

4. Where manual start-up is called for, also provide scheduled automatic start-stop capabilities.

5. Functions called for in sequence of operations are minimum requirements and not to limit additional capabilities the DDC system can be provided with.

6. Provide following functions which are not specifically mentioned in each Sequence of Operation

a) For each item of equipment:

i. Start-Stop, manual, and scheduled

ii. On-Off status of each piece of equipment

iii. Run-time

iv. All set points shall be adjustable

b) Sequenced starting of all motors:

i. At initial start-up

ii. For automatic starting on emergency power after power blackout

c) For all Variable Air Volume handler systems, provide the following energy saving control algorithms:

i. Static Pressure Optimization

ii. Supply Air Temperature Reset

iii. Economizer

iv. Staggered Starting of Equipment to reduce Electric Peaking.

V. TEMPERATURE SENSORS

A. Temperature sensor assemblies shall be readily accessible and adaptable to each type of application in such manner as to allow for quick, easy replacement and servicing without special tools or skills.

B. Strap-on mountings shall not be permitted.

C. Outdoor installations shall be; of weatherproof construction or in appropriate NEMA enclosures. These installations shall be protected from solar radiation and wind effects. Protective shield shall be stainless steel.

D. Sensors shall be with enclosure where located in finished space.

E. Sensors in ducts shall be mounted in locations to sense the correct temperature of the air only and shall not be located in dead air spaces or positions obstructed by ducts, equipment, and so forth. Locations where installed shall be within the vibration and velocity limit of the sensing element. Ducts shall be securely sealed where elements or connections penetrate ducts to avoid measuring false conditions.

F. All sensors measuring temperatures in pipes larger than 2 inches in diameter or in pressure vessels shall be supplied with wells properly fabricated for the service. Wells shall be non-corrosive to the medium being measured and shall have sufficient physical strength to withstand pressures and velocities to which they are subjected. Wells shall be installed in the piping at elbows where piping is smaller than the length of the well to effect proper flow across the entire area of the well.

VI. ACTUATORS

A. Mount and link control damper actuators per manufacturer's instructions.

B. Valves - Actuators shall be mounted on valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following manufacturer's recommendations.

VII. IDENTIFICATION OF HARDWARE AND WIRING

A. All wiring and cabling, including that within factory-fabricated panels shall be labeled at each end within 2" of termination with a cable identifier and other descriptive information.

B. Permanently label or code each point of field terminal strips to show the instrument or item served.

C. Identify control panels with minimum 1-inch letters on nameplates.

D. Identify all other control components with permanent labels. Identifiers shall match record documents.

E. Identify room sensors relating to terminal box or valves with nameplates.

VIII. PROGRAMMING

A. Provide sufficient internal memory for the specified control sequences and trend logging.

B. Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index.

C. Software Programming

1. Provide programming for the system as per specifications and adhere to the strategy algorithms provided. The HVAC Control System Contractor shall also provide all other system programming necessary for the operation of the system but not specified in this document. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements reflect the language used in the sequence of operations.

IX. CLEANING

A. This contractor shall clean up all debris resulting from his or her activities daily. The contractor shall remove all cartons, containers, crates, etc. under his control as soon as their contents have been removed. Waste shall be collected and placed in a location designated by the Construction Manager or General Contractor.

B. At the completion of work in any area, the Contractor shall clean all of his/her work, equipment, etc., making it free from dirt and debris, etc.

C. At the completion of work, all equipment furnished under this Section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any metal cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

X. PROTECTION

A. The Contractor shall protect all work and material from damage by his/her work or workers, and shall be liable for all damage thus caused.

B. The Contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The Contractor shall protect his/her work against theft or damage, and shall carefully store material and equipment received on-site that is not immediately installed. The Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

XI. FIELD QUALITY CONTROL

A. All work, materials and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Part 1 of this Section.

B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship. All visible piping and/or wiring runs shall be installed parallel to building lines and properly supported.

C. Contractor shall arrange for field inspections by local and/or state authorities having jurisdiction over the work.

XII. CHECK OUT, START UP AND TESTING

A. The control system shall be properly commissioned before acceptance. The Contractor shall coordinate with others (including mechanical, electrical and test and balance) to properly start up and verify the operation of the system for 2-

weeks prior to connection. Provide as-built documentation as detailed in Part 1 of this Section.

XIII. ACCEPTANCE

A. The control systems will not be accepted as meeting the requirements of Completion until all tests described in this specification have been performed to the satisfaction of both the Engineer and Fullerton College. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the Completion requirements if stated as such in writing by Fullerton College's representative. Such tests shall then be performed as part of the warranty.

PART IV – RESPONSIBILITY MATRIX

I. 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

*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

*4: Smoke Detector also wired to shut down AHU/HVAC by BMS Contractor

*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

APPENDIX

to

HVAC Instrumentation and Controls Design Standards

APPENDIX A

I. Sample Control Points and Sequence (Using Haystack Tagging)

4-Pipe Fan Coil (no VFD)

Fan
Chilled Water Coil
HHW Coil
Filters
Economizer dampers (optional)

Points:

Description	Type	Name
Supply Fan Start / Stop	DO	SF-C
Supply Fan Status (Via CSR)	DI	SF-S
Discharge Air Temperature	AI	DA-T
Discharge Air Temperature Setpoint	AO	DAT-SP
Mixed Air Temperature*	AI	MA-T*
Zone Temperature	AI	ZN-T
Zone Temperature Setpoint	AO	ZN-T-SP
HHW Valve Open Command	DO	HTG-0
HHW Valve Close Command	DO	HTG-C
CHW Valve Open Command	DO	CLG-O
CHW Valve Close Command	DO	CLG-C

* when economizer is present

SEQUENCE OF OPERATIONS

Fan Start / Stop

When the Johnson Controls System schedule call for an occupied condition, the Supply Fan (SF-C) sill start.

Fan Alarms

If ether Supply Fan (SF-C) is commanded on and the run status monitor (SF-S) fails to detect run status or (2100P4RS) a run failure alarm is generated.

Occupied Cooling and Heating Control

The zone temperature from the thermostat (ZN-T) shall be compared against the zone setpoint (ZN-T-SP), when the zone temperature (ZN-T) is less than assigned setpoint (ZN-T-SP), the discharge air temperature setpoint (DAT-SP) shall be adjusted up. If the fan coil discharge air temperature (DA-T) is less than the discharge air temperature setpoint (DAT-SP), the heating valve shall be commanded open by pulsing the heating valve actuator open (HTG-O). As the discharge air temperature (DA-T) exceeds the discharge air temperature setpoint (DAT-SP), the heating valve shall be commanded to close by pulsing the heating valve actuator closed (HTG-C). As the fan coil discharge air temperature (DA-

T) reaches the desired setpoint (DAT-SP), the heating valve shall maintain its position.

If the zone temperature (ZN-T) is greater than assigned zone temperature setpoint (ZN T-SP), then the discharge air temperature setpoint (DAT-SP) shall be adjusted lower. If the discharge air temperature (DA-T) is less than the discharge air temperature setpoint (DAT-SP), then the cooling valve shall be commanded closed by pulsing the cooling valve actuator (CLG-C). As the discharge air temperature (DA-T) exceeds the discharge air temperature setpoint (DAT-SP), the cooling valve shall be commanded to open by pulsing the (CLG-O). As the discharge air temperature (DA-T) reaches the programmed setpoint (DAT-SP), the cooling valve shall maintain its position.

Un-Occupied Cooling and Heating Control

The unoccupied cooling zone temperature setpoint (ZN-T-SP) for cooling mode shall be increased 5-degf as compared to the occupied cooling setpoint.

The unoccupied heating zone temperature setpoint (ZN-T-SP) for cooling mode shall be decreased 5-degf as compared to the occupied heating setpoint.

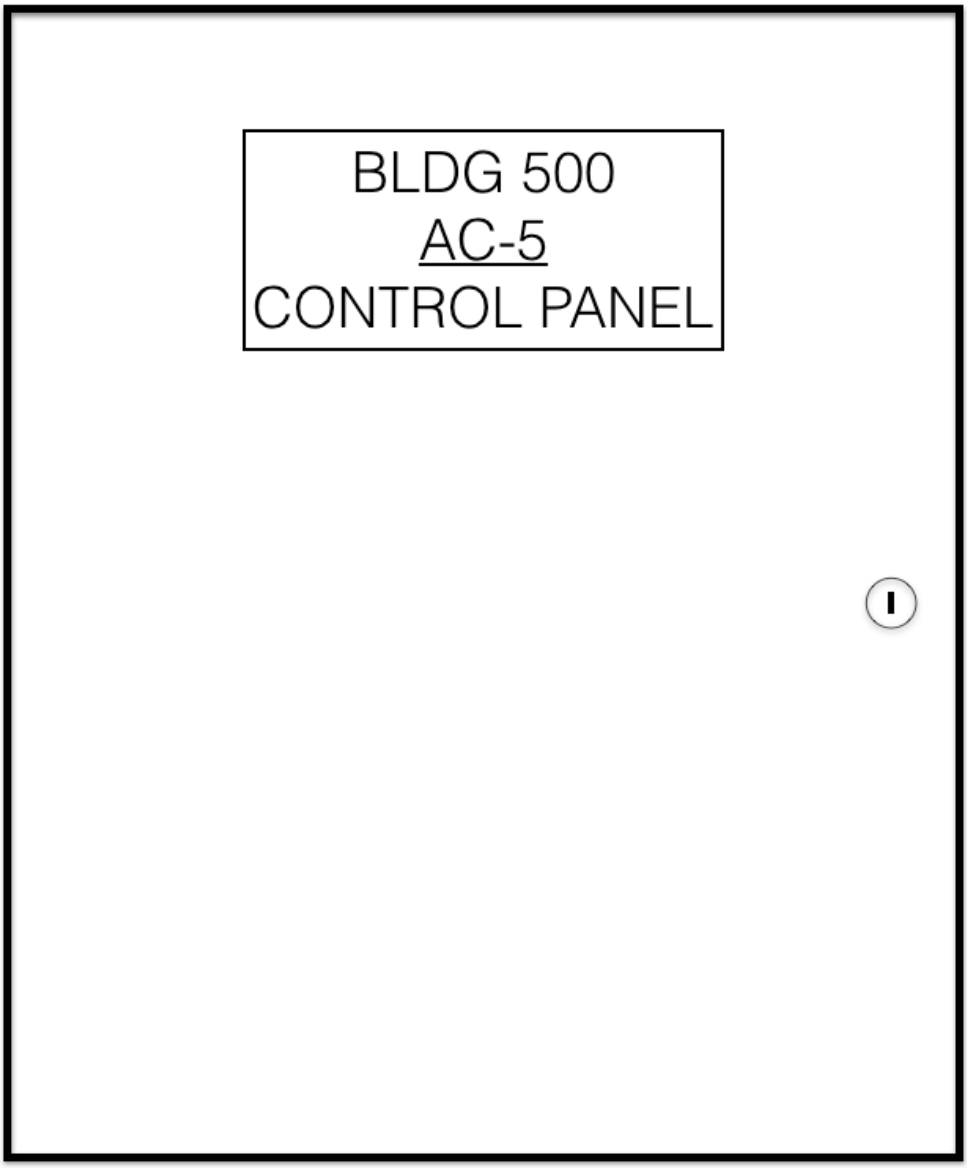
APPENDIX B

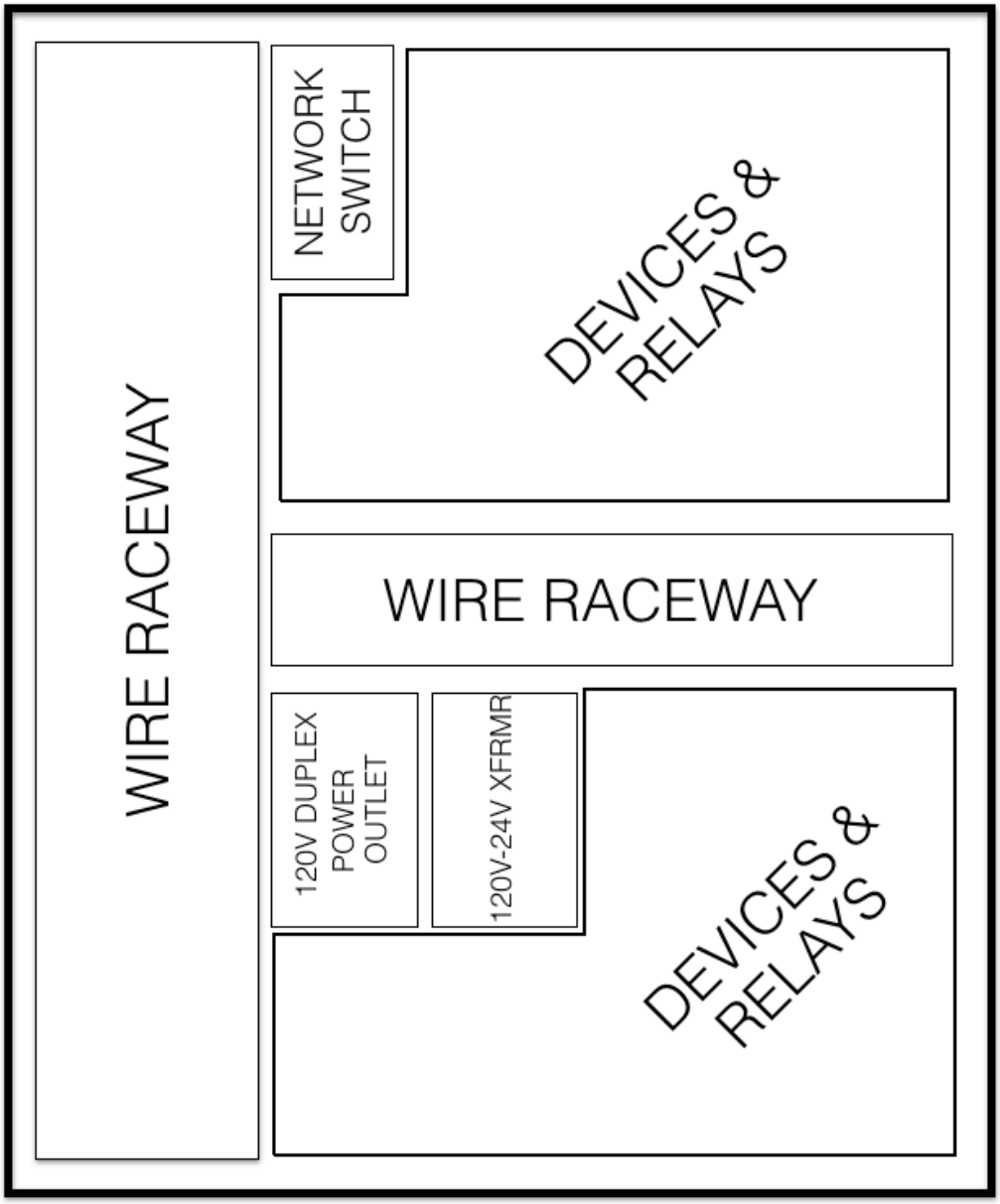
I. Sample Controls Cabinet Layout

Lockable Panel Front with labeling specific to project / equipment.

HVAC Equipment Control Panels shall be minimum 30-inch x 30-inch

(Mfr: Hoffman or equal)



Typical Internal Panel Layout

(NOTE: Provide minimum 1-inch clear space all around at perimeter of cabinet)