SECTION 23 09 00 – INSTRUMENTATION AND CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All work of this Division shall be coordinated and provided by the single Building Management System (BMS) Sub-Contractor.

B. The work of this Division shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference the Division 23 Sections for details.

C. The work of this Division shall be as required by the Specifications, Drawings, Point Schedules and Division 230993.

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

1.2 BMS DESCRIPTION

A. Massillon Local School District building control requirements are as follows:

1. The current conditions within the district with respect to HVAC Controls: An existing enterprise head end system is in operation, and it handles access to the existing control systems/units. Many of the existing controls are older Trane DDC controls. The existing districts controllers within the buildings are tied to the head end through the Niagara enterprise system. Gardiner Automation is engaged in working in the district in the Washington High School building and the district's enterprise front end. The Stark/Portage Area Computer Consortium (SPARCC) has been retained and will be used as district oversite.
2. Any software or components installed must NOT require administrator level or higher access to run. Administrator rights for installation are acceptable.
3. Any software must NOT require JAVA to install or operate.
4. Any software must run on the existing Niagara Supervisor Server and must be compatible with all future upgrades released by Microsoft within three (3) months of the release.
5. Any software must NOT require FLASH to install or operate.

B. General: The control system shall consist of a peer-to-peer network of digital building control panels and Network Area Controller(s) (NAC) within each facility. Access to the system, either locally in each building, or remotely from a central site or sites, shall be accomplished through standard web browsers, via the Internet and/or local area network. Each NAC shall be capable of communication with the OPEN BACNet controllers. The web browser shall provide users with an interface with the system though dynamic color graphics of building areas and systems.

C. The Facility Management and Control System (FMCS) shall be based on the Niagara 4 Framework™ (or "Gardiner KMC brand), a framework technology developed by Tridium, and systems not developed based upon the Niagara 4 Framework™ technology are not acceptable.

D. All control devices furnished within this section shall be programmed directly through the Niagara 4 workbench embedded toolset upon completion of the project.

E. Approved manufacturers listed shall be required to provide programming and configuration tools for the BACNet controllers for the project. The use of proprietary configurable and programmable controllers that require additional software tools for post installation maintenance and programming shall not be acceptable.

F. The Building Management System (BMS) shall be based for use with the enterprise IT systems. This functionality shall extend into the equipment rooms and be capable of providing an integrated solution enhancing the efficiency and life cycle cost through advanced analytics, technical support and service support. Devices residing on the automation network located in equipment rooms and similar shall be fully IT compatible devices that mount and communicate directly on the IT infrastructure in the facility. The contractor shall be responsible for coordination with the owner's IT staff to ensure that the BMS will perform in the owner's environment without disruption to any of the other activities taking place on that LAN. This shall consist of control systems for:

G. All points of user interface shall be on standard PCs that do not require the purchase of any special software from the BMS manufacturer for use as a building operations terminal. The primary point of interface on these PCs will be a standard Web Browser.

H. Where necessary and as dictated elsewhere in these Specifications, Servers shall be used for the purpose of providing a location for extensive archiving of system configuration data, and historical data such as trend data and operator transactions. All data stored will be using a standard database platform: Microsoft Data Engine (MSDE).

I. The work of the single BMS Sub-Contractor shall be as defined individually and collectively in all Sections of this Division specification together with the associated Point Sheets and Drawings, Division 230993 and the associated interfacing work as referenced in the related documents.

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

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

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

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

1. Operator information, alarm management and control functions.

2. Enterprise-level information and control access.

3. Information management includes monitoring, transmission, archiving, retrieval, and reporting functions.

4. Diagnostic monitoring and reporting of BMS functions.

5. Offsite monitoring and management access.

6. Energy management

7. Standard applications for terminal HVAC systems.

8. REMOVED

9. Indoor Air Quality monitoring and control

1.3 QUALITY ASSURANCE

A. General

1. The Building Management System Sub-Contractor shall be the primary manufacturer-owned branch office that is regularly engaged in the engineering, programming, installation and service of total integrated Building Management Systems.

2. The term “manufacturer” when used to identify an automatic temperature control sub-contractor/supplier, shall mean the complete system of building energy management. Components of the completed system shall include but not being limited to, hardware equipment, engineering, wiring, installation, sequence of operations, network architecture, commissioning, training, software programming and warranty.

3. The BMS Sub-Contractor shall be a recognized national manufacturer, installer and service provider of BMS.

4. HVAC Contractors installing their own controls will <u>not</u> be accepted. **NO EXCEPTIONS.**

5. The BMS Sub-Contractor shall have a branch facility within a 100-mile radius of the job site supplying complete maintenance and support services on a 24 hour, 7-day-a-week basis.

6. As evidence and assurance of the contractor’s ability to support the Owner's system with service and parts, the contractor must have been in the BMS business for at least the last ten (10) years and have successfully completed total projects of at least 10 times the value of this contract in each of the preceding five years.

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

B. Workplace Safety and Hazardous Materials

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

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

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

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

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

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

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

8. The Contractor's safety program shall include written policy and arrangements for the handling, storage and management of all hazardous materials to be used in the work in compliance with the requirements of the Authority Having Jurisdiction (AHJ) at the Project site.

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

C. Quality Management Program

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

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

   b. Manage the financial aspects of the BMS Contract.

c. Coordinate as necessary with other trades.

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

1.4 REFERENCES

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

1. National Fire Protection Association (NFPA) Standards.

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

3. Underwriters Laboratories (UL) listing and labels.

4. UL 864 UUKL Smoke Control

5. UL 268 Smoke Detectors.

6. UL 916 Energy Management

7. NFPA 70 - National Electrical Code.

8. NFPA 90A - Standard for The Installation of Air Conditioning And Ventilating Systems.

9. American National Standards Institute (ANSI).

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

11. American Society of Mechanical Engineers (ASME).

12. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) and ASHRAE 62 IAQ as applicable.

13. Air Movement and Control Association (AMCA).

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

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

16. Electronics Industries Association (EIA).

17. Occupational Safety and Health Administration (OSHA).

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

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

20. Americans Disability Act (ADA)

21. ANSI/ASHRAE 135-2016, BACnet® -A Data Communication Protocol for Building Automation and Control Networks.

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

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

1.5 SUBMITTALS

A. Shop Drawings, Product Data, and Samples

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

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

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

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

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

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

7. At a minimum, submit the following:

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

b. Systems schematics, sequences and flow diagrams.

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

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

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

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

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

h. Room Schedule includes a separate line for each VAV box and/or terminal unit indicating location and address and room thermostat specifics.

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

j. Listing of all read and or write points derived via interfaces to mechanical system components as required per project specifications, sequences of operation, points list(s), and/or required for correct systemsoperation and functionality. Points shall be identified as to point type (AI, BI, AO, DO, AV, DV), point source (read, write, commandable), interface type (BACnet, N2, etc.) point ID in BMS and point ID in mechanical system, mechanical system source (VFD, RTU, Chiller, etc.), point (object) name (% speed, fan status, cws temp, etc.) and point description (speed of motor, fan on, chilled water

supply temperature, etc.)

k. Product data sheet section with an index identifying each product utilized in the installed BMS system and product data sheet(s) for each product. The index shall individually list each product with the associated numerically sequenced page number(s) of the product data sheets. For all products including software, provide product data sheet(s) or marked catalog pages that include part number, photo, complete specifications and numerically sequenced page number(s) referenced in the index.

1.6 RECORD DOCUMENTATION

A. Operation and Maintenance Manuals

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

a. Table of contents.

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

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

d. System Operator’s manuals.

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

f. BMS network diagrams.

g. Interfaces to all third-party products and work in other trades.

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

1.7 WARRANTY

A. Standard Material and Labor Warranty:

1. Provide a two-year labor and material warranty on the BMS.

2. If within twenty-four (24) months from the date of final payment, upon written notice from the owner, it is found to be defective in operation, workmanship or materials, it shall be replaced, repaired or adjusted at the option of the BMS Contractor at the cost of the BMS Contractor.

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

1.8 OWNERSHIP OF PROPRIETARY MATERIAL

A. All project-developed hardware and software shall become the property of the Owner. These items include but are not limited to:

1. Project graphic images

2. Record drawings

3. Project database

4. Project-specific application programming code

5. All documentation

6. All programming tools shall be provided to the owner on a laptop computer or embedded within the Niagara system control system.

1.9 BAS/BMS OPEN SYSTEM DESIGN AND QUALIFICATIONS

A. Open System Design: It is the owners expressed goal to implement an open Building Automation System that will allow products from different manufacturers and/or suppliers to be integrated into a single unified system in order to provide flexibility for expansion, maintenance, and service of the system. The BAS manufacturer /contractor must provide proof of open system design as outlined below.

B. Prior to award of the contract, the BAS contractor is to provide proof of "Open System Design" with the following requirements:

1. Provide proof of having a local office within 50 miles of project for at least 5 years, staffed by trained personnel capable of providing

installation, engineering, programming, servicing, commissioning, instruction, routine maintenance, and emergency service on systems.

2. The control system shall utilize the Niagara4 software framework.

The Contractor shall have a minimum of 5 years experience in the sales, installation, engineering, programming servicing and commissioning of Niagara4.
Submit the Niagara Compatibility Statement (NiCS) via a letter from the manufacturer. The NiCS shall have no connectivity restrictions and all aspects of the Niagara Framework will be provided to maintain an Open System Design. The System as provided shall confirm with the following NiCS properties (Station Compatibility In, Station Compatibility Out, Tool Compatibility In, AND Tool Compatibility Out shall each have a value of "All").

C. The controls system shall conform to the following guidelines for communication protocols.

1. BACnet shall be used for all BAS provided controllers.
The manufacturer of the hardware and software components, as well as its subsidiaries, must be a member in good standing of the BACnet International and all controllers used shall be BACnet Listed with documentation on the BACnet website.
(https://www.bacnetinternational.net/btl/search.php)

2. The use of BACnet Communications protocol alone shall NOT warrant an "Open System Design." Manufacturers must adhere to all aspects of "BAS Open System Design and Qualifications" and "Acceptable System Manufacturers" sections to comply.

3. Modbus shall only be acceptable for third party devices.

4. Proprietary communications protocols shall NOT be acceptable.

D. A software programming tool shall be provided for this project and adhere to the following guidelines:

1. All software tools needed for full functional use, including programming of controllers, Niagara4 Framework network management and expansion, and graphical user interface use and development, of the BAS described within these specifications shall be provided to the owner or his designated agent.

2. The software programming tool shall be free of charge and openly available for download from the internet.

3. For any manufacturer that does not have a free programming tool the manufacturer must provide the tool with this project for a minimum of 5 years with proof of availability via letter from the manufacturer.

4. Any licensing required by the manufacturer now and to the completion of the warranty period, including changes to the licensee of the software tools and the addition of hardware corresponding to the licenses, to allow for a complete and operational system for both normal day to day operation and servicing shall be provided.

PART 2 - PRODUCTS

2.1 GENERAL DESCRIPTION

A. The Building Management System (BMS) shall use an open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BMS shall support open communication protocol standards and integrate a wide variety of third-party devices and applications. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other owner provided networks.

1. The Building Management System shall consist of the following:

a. Standalone Network Automation Engine(s)

b. Field Equipment Controller(s)

c. Input/Output Module(s)

d. Local Display Device(s)

e. Distributed User Interface(s)

f. Network processing, data storage and communications equipment

g. REMOVED

h. Other components required for a complete and working BMS

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

C. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

D. Acceptable Manufacturers

1. Distech Controls (Basis of Design)

2. KMC Controls

3. Niagara Edge Controllers

E. All other manufacturers/contactors besides the "Basis of Design" manufacturer. (Including those listed above) must submit a compliance matrix outlining "C- Comply", "D - Does Not Comply", and "E - Exclude" for the entirety of the 230900 and 230993 sections prior to bid award.

1. Being listed as an approved manufacturer/contractor does not preclude the bidder from meeting all aspects and requirements of this specification.

2. Those bidders not prequalified prior to review of bids will not be considered responsive. To be prequalified a bidder must be accepted to bid on the project by the Engineer either by a bid addendum or documented RFI response from the Engineer. No other prequalification shall be acceptable.

G. Quality Assurance

1. All new building automation system products on this project shall be provided by a firm that is a registered ISO 9001 :201508 manufacturer, for a minimum duration of 5 years, at time of bid.

H. Computer Hardware

1. Head End Workstation/Server Requirements

a. The existing head end workstation/server may be re-used if compatible with the proposed new control work, but it will need to be updated/expanded as required. If new equipment is required, the server

and workstation shall adhere to the following minimum requirements: the latest generation Intel Core i5 processor, 16 GB RAM, and a 1TB solid state hard drive. It shall include the latest Windows 64-bit operating system (Windows 10 pro or newer), VM support, and an ethernet adapter (101100MB with RJ45 connector). Connection to the BAS LAN network shall be via an Ethernet network interface card, 100 Mbps.

b. The server shall support all network/building controllers, OWSs, and 3rd party mechanical / electrical systems connected to the Facility Management Control / Building Automation System Local Area Network.

c. Acceptable Manufacturers are:

i. Dell

ii. Lenovo

iii. HP (Hewlett Packard)

I. Workstation Hardware Requirements (If new is required)

1. The Workstation shall adhere to the following minimum requirements: the latest generation Intel Core i5 processor, 8 GB RAM, and a 500GB solid state hard drive. It shall include the latest Windows 64-bit operating system (Windows 10 pro or newer), Microsoft Office programs, VM support, an ethernet adapter (101100MB with RJ45 connector), 32X CD-ROM drive, and 2-USB ports.

2. A minimum 21", HDMI, DVI-D video interfaces, minimum 1024 x 768 resolution, 4x3 widescreen, LED color monitor with a minimum 60 Hz refresh rate shall also be included.

3. A mouse and keyboard shall be provided.

4. Connection to the BAS LAN network shall be via an Ethernet network interface card, 100 Mbps.

5. Workstation(s) should be loaded with Programming Tools

6. Acceptable Manufacturers are:

a. Dell

b. Lenovo

c. HP (Hewlett Packard)

7. Uninterruptable Power Supplies (Provide new)

a. Provide the OWS, Server, and each network/building controller with individual UPS to provide clean, reliable, noise-filtered power at all times and to protect and maintain systems operation throughout short-term power interruptions of up to 15 minutes duration.

b. Acceptable Manufacturer is APC.

J. Remote Access and Cyber Security Best Practices

1. Remote Access

a. The BAS contractor shall comply with the owner’s IT infrastructure security policies for remote access. The owner's IT team shall provide VPN, firewalls, etc. as needed for secure remote access.

b. A VPN and firewall must be used for secure remote access.

2. Cyber Security Best Practices

a. The BAS network shall be separate from the owner’s IT infrastructure besides a single point connection for remote access (owner provided internet access). All ethernet switches and communication backbone required for a fully operational BAS shall be provided by the BAS contractor.

b. Refer to the “Communication Backbone" section of this specification for further details on segmenting the network (VLANs, subnets) and when managed switches (with port security, network user interface, etc.) are required based on building size / type.

c. Do not use factory provided usernames and passwords. Update passwords and usernames regularly for strong system security.

d. Update software and firmware regularly.

e. Adhere to controls manufacturer hardening guidelines where applicable.

K. Operator Software

1. Real-Time Displays

a. Provide a visual graphical representation of buildings, floor layouts, each piece of mechanical equipment and/or mechanical system that duplicates the represented system, presented as a web page via any industry standard web browser, where applicable.

b. Graphics shall include at a minimum the value of each input, each output, each setpoint, alarms and graphical representation of trend logs.

2. On-Line Help

a. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system.

3. Security

a. Each operator shall be required to log on to that system with a username and password in order to view, edit, add, or delete data.

b. System security shall be selectable for each operator.

c. The system administrator shall have the ability to set passwords and security levels for all other operators.

d. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object.

e. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected.

f. This auto log-off time shall be set per operator password.

g. All system security data shall be stored in an encrypted format.

4. System Diagnostics.

a. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building

management panels, and controllers.

b. The failure of any device shall be annunciated to the operator.

5. Third-Party Windows-Based Programs

a. The system shall be capable of utilizing third-party Windows-based programs for such things as spreadsheet analysis, graphing, charting, custom report generation, and graphics design packages.

b. Graphics generation shall be done using standard Windows packages.

c. No proprietary graphics generation software shall be needed.

6. Override

a. It shall be possible for the operator to override automatic analog and digital output commands.

b. Where the BAS software normally originates these outputs, the provision shall exist for the operator to terminate automatic BAS control of any output and to originate a manual analog or digital output command.

c. The provision shall exist for the operator to return analog or digital output command functions to automatic BAS software control.

7. Password Protection

a. Provide a security system that prevents unauthorized use unless the operator is logged on.

8. Trend Data

a. System shall periodically gather historically recorded selected samples of object data stored in the field equipment (global controllers, field controllers) and archive the information on the operator's workstation (server) hard disk.

i. Archived files shall be appended with new sample data, allowing samples to be accumulated over 3 years.

ii. Systems that write over archived data shall not be allowed, unless limited file size is specified.

iii. Samples may be viewed at the operator's terminal in a trend log.

iv. Logged data shall be stored in spreadsheet format.

v. Operator shall be able to scroll through all trend log data.

b. Software shall be included that can graph the trend logged object data. Software shall be capable of creating two-axis (x,y) graphs that display up to six object types at the same time in different colors and these graphs shall show object type value relative to time.

c. Operator shall be able to change trend log setup information such as time intervals and objects logged

9. Graphics

a. The operator's workstation shall display all data associated with the project.

i. Operator's workstation shall display all data using 3-D graphic representations of all mechanical equipment.

b. System shall be capable of displaying graphic file, text, and dynamic object data together on each display.

i. Information shall be labelled with descriptors and shall be shown with the appropriate engineering units.

ii. All information on any display shall be dynamically updated without any action by the user.

iii. Terminal shall allow user to change all field-resident BAS functions associated with the project, such as setpoints, weekly schedules, exception schedules, etc. from any screen no matter if that screen shows all text or a complete graphic display.

iv. Animated graphic objects shall be displayed as a sequence of multiple bitmaps to simulate motion.

v. Analog objects may also be assigned to an area of a system graphic, where the color of the defined area would change

based on the analog objects value.

vi. For example, an area of a floor-plan graphic served by a single control zone would change color with respect to the temperature of the zone or its deviation from setpoint.

c. Separate Displays shall be supplied, specific to the project, to form the following overall presentation style.

d. All Displays will be linked in a logical fashion using hyperlink style (single left mouse click on text/display object/dynamic to load linked display if programmed)

e. Entire system shall operate without dependency on the operator's terminal.

f. Provide graphic generation software at each workstation.

10. Alarms

a. Operator's terminal shall provide audible, visual, electronic and printed means of alarm indication.

b. Any alarm may be handled based on its individual or assigned class actions.

c. Displayed on the Alarm console.

i. The system shall be provided with a dedicated alarm window or console.

ii. This window will notify the operator of an alarm condition and allow the operator to view details of the alarm and acknowledge the alarm.

d. Alarm reports shall be viewable via the BAS system and available for delivery by electronic mail (e-mail) or printing.

e. System shall provide log of alarm messages. Alarm log shall be archived to the hard disk of the system operator's terminal.

i. Each entry shall include a description of the event-initiating object generating the alarm, time and date of alarm occurrence, time and date of object state return to normal, and time and date of alarm acknowledgement.

11. Scheduling

    a. Operator's terminal display of weekly schedules shall show all information in easy-to-read 7-day (weekly) format for each schedule.

    b. Exception schedules (non-normal schedules, such as holidays or special events) shall display all dates that are an exception to the weekly schedules.

    c. At the operator's terminal, the system user shall be able to change all information for a given weekly or exception schedule if logged on with the appropriate security access.

12. Archiving

    a. Store back-up copies of all controller databases in at least one OWS and the server.

    b. Provide continuous supervision of the integrity of all controller databases.

    c. Data base back up and downloading to occur over LAN without operator intervention.

    d. Operator to be able to manually download entire controller database or parts thereof.

13. Reports

    a. Provide a report facility to generate and format for display, printing, or permanent storage, as selected by the operator, the reports as specified in this section.

    b. Provide software to automatically generate any report specified; the user will be able to specify the type of report, start time and date, interval between reports (hourly, daily, weekly, monthly) and output device.

    c. As a minimum, the following reports shall be configured on the system:

        i. Dynamic Reports to allow operator to request a display of the dynamic value for the user specified points which shall indicate the status at the time the request was entered and updated at an operator modifiable scan frequency.

ii. Summary Report: To permit the display or printing of the dynamic values for the user specified points.

iii. Trend Reports: To permit the trending of points selected by the operator, including as a minimum digital input and output, analog input and output, set points, and calculated values.

iv. Historical Data Collection: Provision shall be made to ensure historical data is not lost.

v. Alarm Summary: Provide a summary of all points in alarm and include as a minimum; point acronym, point description, current value, alarm type, limit exceeded, and time and date of occurrence.

vi. Disable Point Summary: Provide a summary of all points in the disabled state and include as a minimum point acronym and point description.

vii. Run Time Summary: Provide a summary of the accumulated running time of selected pieces of equipment with point acronym and description, run time to date, alarm limit setting. The run time shall continue to accumulate until reset individually by means of suitable operator selection.

viii. Schedule Summary: Provide a summary of all schedules and indicate as a minimum, which days are holidays and, for each section, the day of the week, the schedule times and associated values; for digital schedules value will be on or off; for analog schedules value will be an analog value.

ix. User Record Summary: Provide a summary of all user records to include as a minimum; username, password, initials, command access level and point groups assigned.

K. BAS Controllers

1. All controllers on the job shall have the following minimum requirements:

a. IP Communication (BACnet/lP)

i. BACnet/lP communication protocol shall be used for all BAS manufacturer provided controllers (including terminal devices such as VA Vs, FCUs, etc.)

ii. Support for 1Pv4 addressing

iii. DHCP support and Auto DNS

iv. Baud rate of not less than 100 Mbps

v. 2 - RJ45 ports each capable of supporting 10/100 Base-T.

1. Supporting controller daisy chaining on the Ethernet network via integral switch functionality.

2. Integrated fail-safe should allow for communication when the controller is powered down.

vii. All controllers shall be able to communicate peer-to-peer without the need for a Network Control Unit (such as JACE, Supervisor, Etc.) and shall be capable of assuming all responsibilities typically assumed by a Network Control Unit.

b. Any controller on the Ethernet Data Link/Physical layer shall be able to act as a Master to allow for the exchange and sharing of data variables and messages with any other controller connected to the same communication cabling. Slave controllers are not acceptable.

c. The resulting network will be a 'Flat' topology with all devices (controllers, workstations, ...) connecting at the same physical network level

2. Memory and Processing

a. 512KB of RAM and 4GB of non-volatile flash memory.

b. 32-bit microprocessor operating at a minimum of 600 MHz

3. Each individual controller shall have an embedded web based HTML5 visual interface with the following functionality without reliance on any other controller for access:

a. Typical and custom control processes

b. Scheduling

c. Energy management applications

d. Alarm management applications

e. Historical/trend data for points specified

f. Maintenance support applications

g. Graphical interface

4. Shall be capable of monitoring/controlling the following types of inputs/outputs:

a. Digital inputs from dry contact closure, pulse accumulators, voltage sensing.

b. Analog inputs of 4-20 mA, 0-10 Vdc, thermistor and RTD in the range 0 to 350,000 ohm.

c. Digital outputs including Form C relay outputs and Triac outputs

d. Analog outputs of 4-20 mA and 0-10 Vdc.

e. A minimum of 10% spare capacity for each point type for future point connection.

f. Any software required for programming shall be unlicensed and openly available

g. Auto commissioning features shall be available for VA Vs and FCUs to schedule automatic testing and record values (air flows, pressures, temperatures, etc.) for different operating modes. The auto commissioning feature shall be able to email reports and run commissioning on a specified schedule.

h. Power and Environmental Requirements:

i. 24 V AC with local transformer power

ii. The controllers shall also function normally under ambient conditions of -40 "F to 158 "F and 0% to 90% RH (non-condensing).

iii. Provide each controller with a suitable cover or enclosure to protect the intelligence board assembly.

i. Code Compliance:

i. "FIPS 140-2 Level 1 Compliant" cryptographic module

ii. BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building Controller (B-BC) with outlined enhanced features.

iii. UL916 Energy management equipment

iv. FCC rules part 15, subpart B, class B

v. UL94-V0 flammability rating

2.2 INPUT DEVICES

A. General Requirements

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

B. Temperature Sensors

1. General Requirements:

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

b. 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.

c. 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**
Room Temp	± 1.0°F.
Duct Temperature	± 1.0°F.
All Others	± 1.0°F.

2. Room Temperature Sensors

    a. For use in spaces such as classrooms

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

    c. Room sensors shall have the following options when specified:

        i. Setpoint reset slide switch providing a +/-3-degree (adjustable) range.

        ii. Individual heating/cooling setpoint slide switches.

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

3. Room Temperature Sensors with Integral Display

    a. For use in non-classroom spaces such as administrative rooms and offices.

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

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

        i. Display room and outside air temperatures.

        ii. Display and adjust room comfort setpoint.

        iii. Display and adjust fan operation status.

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

        v. Display controller mode.

        vi. Password selectable adjustment of setpoint and override modes.

4. Blank Control Sensor

    a. For use in common space transient areas such as corridors

b. No manual temperature adjustment shall be available. All adjustability shall be from the BAS system.

c. Shall be mounted at a height above the locker height and temperature offset to represent the temperature reading at normal mounting height.

5. Outside Air Sensors

a. 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.

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

c. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.

6. Duct Mount Sensors

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

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

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

7. Averaging Sensors

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

b. For plenum applications, such as mixed air temperature measurements, 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.

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

8. Humidity Sensors

a. The sensor shall be a solid-state type, relative humidity sensor of the 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 5% and 95% RH @ 77 Deg F unless specified elsewhere.

d. Outside air relative humidity sensors shall be installed with a rainproof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with steatite fittings and stainless-steel bushings.

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 Industries, Mamac or engineer approved equal.

9. Duct Shielded Static Pressure Probe

a. Probes shall be complete with mounting brackets, noise suppression chamber and brass compression connector.

10. Differential Pressure Transmitters

a. Air type: Transmitter shall be provided in a NEMA enclosure with barbed fittings for connection of signal lines. Wiring terminations shall be short circuit and reverse polarity protected. Accuracy shall be +/- 1 % full scale with an over pressure rating of 10 psi. Transmitter shall be temperature compensated from 25 to 150 deg.

F. with an operating range of 0 to 175 deg. F. Output shall be 4 to 20 ma.

b. Wet type: Shall be enclosed in a NEMA enclosure with a 5-valve bypass assembly. The transmission shall have an over pressure rating of at least 200 psi on either port without permanent damage. Transmitters shall have externally accessible zero and span adjustments. The transmission shall have a static error band of +/- .5% full scale including linearity, hysteresis and repeatability. Output of transmitter shall be 4 to 20 ma.

c. Industrial Grade: Shall use silicon strain gauge technology and a two-wire d/p Cell transmitter to measure the difference between two pressures and transmit a proportional (or square root) 4-20 mA output signal. Differential pressure transmitters shall be used in conjunction with Venturi Flow Stations and shall be as manufactured by Foxboro, Rosemount or approved equal with the following specification requirements:

d. Zero Suppression: To upper range limit minus the span Ambient Temperature Effect: Total effect for a 100 DEGF change within Normal Operating Conditions limits is + or - (0.2% of URL +0.1% of span) Accuracy (Includes linearity, Hysteresis, and Repeatability): + or - 0.20% of calib. span for spans less than 6.7% of URL Over range Limit (DP) and Maximum Static Pressure: 25 Mpa, 3625 psi, 250 bar or kg/ (cm*cm). Either side may have higher pressure during over range.

11. Flow Monitoring – Supply, Return Fan and Toilet Exhaust

a. Air Flow Monitoring

i. Fan Inlet Air Flow Measuring Stations

1. At the inlet of each fan and near the exit of the inlet sound trap, airflow traverse probes shall be provided that shall continuously monitor the fan air volumes and system velocity pressure.

2. Each traverse probe shall be of a dual manifolded, cylindrical, type 3003 extruded aluminum configuration, having an anodized finish to eliminate surface pitting and unnecessary air friction. The multiple total pressure manifold shall have sensors located along the stagnation plane of the approaching airflow. The manifold should not have forward

projecting sensors into the air stream. The static pressure manifold shall incorporate dual offset static tops 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.

3. The airflow traverse probe shall not induce a measurable pressure drop, nor shall the sound level within the duct be amplified by its singular or multiple presence in the air stream. Each airflow-measuring probe shall contain multiple total and static pressure sensors placed at equal distances along the probe length. The number of sensors on each probe and the quantity of probes utilized at each installation shall comply with the ASHRAE Standards for duct traversing.

4. Airflow measuring stations shall be manufactured by Air Monitor Corp., Tek-Air Systems, Inc., or Ebtron. KMC Outside Air Flow Measuring System shall also be acceptable.

b. 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 hot wire anemometer and utilize two temperature sensors and a heater element temperature. The other sensor shall measure the downstream air temperature. The temperature differential shall be directly related to airflow velocity.

c. Duct Air Flow Measuring Stations

i. 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.

ii. Airflow measuring stations shall be fabricated of 14-gauge galvanized steel welded casing 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 6000 feet per minute. This air directionalizer and parallel cell honeycomb suppressor shall provide 98% free area, equalize the velocity profile, and eliminate turbulent and rotational flow from the air stream prior to the measuring point.

iii. The total pressure measurement side (high side) will be designed and spaced to the Industrial Ventilation Manual 16th Edition, Page 9-5. The self-averaging manifolding will be manufactured of brass and copper components.

iv. The static pressure sensing probes (low side) shall be bullet-nosed shaped, per detailed radius, as illustrated in Industrial Ventilation Manual 16th Edition, Page 9-5.

v. The main take-off point from both the total pressure and the static pressure manifolds must be symmetrical.

vi. 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.

d. Installation Considerations

i. The maximum allowable pressure loss through the Flow and Static Pressure elements shall not exceed .065” w.c. at 1000 feet per minute, or .23” w.c. at 2000 feet per minute. Each unit shall measure the airflow rate within an accuracy of plus 2% as determined by U.S. – GSA certification tests and shall contain a minimum of one total pressure sensor per 36 square inches of unit measuring area.

ii. The units shall have a self-generated sound rating of less than NC40, and the sound level within the duct shall not be amplified nor shall additional sound be generated.

iii. 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 two inches to three inches to facilitate matching connecting ductwork.

iv. Where control dampers are shown as part of the airflow measuring station, opposed blade precision-controlled volume dampers integral to the station and complete with actuator, pilot positioner, and linkage shall be provided.

v. The stations shall be installed in strict accordance with the manufacturer's published requirements, and in accordance with ASME Guidelines affecting non-standard approach conditions.

vi. Acceptable manufacturers: Air Monitor Corp., Tek-Air, Ebtron, and Dietrich Standard. KMC Outside Air Flow Measuring System shall also be acceptable.

e. Static Pressure Traverse Probe

i. Duct static traverse probes shall be provided where required to monitor duct static pressure. The probe shall contain multiple static pressure sensors located along the exterior surface of the cylindrical probe.

ii. Acceptable manufacturers: Cleveland Controls

f. Shielded Static Air Probe

i. 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.

g. Water Flow Monitoring

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

ii. Acceptable manufacturers: Onicon.

12. Smoke Detectors

a. Ionization type air duct detectors shall be furnished as specified elsewhere in Division 26 for installation under Division 23. All wiring for air duct detectors shall be provided under Division 26, Fire Alarm System.

13. 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 interlocked 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 running 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 Industries

c. 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.

d. Differential Pressure Switches

i. Air type: Shall be diaphragm actuated type with a single-pole, double-throw, snap-acting switch. Motion of the diaphragm shall be restrained by a calibrated spring that can be adjusted to set the exact pressure differential at which the electrical switch will be actuated. Motion of the diaphragm shall be transmitted to the switch button by means of a direct mechanical linkage. Electrical rating shall be 6.0 amps at 120 VAC. Pressure range and temperature limits shall be suitable for the application. A switch shall be utilized in conjunction with static pressure probes when utilized across filters, and a static pressure probe on the low side and a velocity probe on the high side when utilized across a fan.

ii. Water type: Shall be diaphragm-actuated type with a single-pole, double-throw snap-acting switch. Motion of the diaphragm shall be restrained by a calibrated spring that can be adjusted to set the exact pressure differential at which the electrical switch will be actuated. The switch shall be utilized in conjunction with shut off valves on the low and high sides of the switch to allow for ease of service.

2.3 OUTPUT DEVICES

A. Actuators

1. General Requirements

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

2. Electronic Damper Actuators

a. Electronic damper actuators shall be direct shaft mount.

b. Modulating and two-position actuators shall be provided as required by the sequence of operations. Damper sections shall be sized Based on actuator manufacturer’s recommendations for face velocity, differential pressure and damper type. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the dampers, as

required. All actuators (except terminal units) shall be furnished with mechanical spring return unless otherwise specified in the sequences of operations. All actuators shall have external. adjustable stops to limit the travel in either direction, or a gear release to allow manual positioning.

c. Modulating actuators shall accept 24 VAC or VDC power supply, consume no more than 15 VA, and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA, and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal and may be used to parallel other actuators and provide true position indication. The feedback signal of one damper actuator for each separately controlled damper shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.

d. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Isolation, smoke, exhaust fan, and other dampers, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop associated fan. Two-position actuators, as specified in sequences of operations as “quick acting,” shall move full stroke within 20 seconds. All smoke damper actuators shall be quick acting.

B. 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 enough 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.

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.

4. Airfoil blade dampers of double skin construction with linkage out of the air stream shall be used whenever the damper face velocity exceeds 1500 FPM or system pressure exceeds 2.5” w.g., but no more than 4000 FPM or 6” w.g. Acceptable manufacturers are Ruskin CD50, and Vent Products 5650.

5. One piece rolled blade dampers with exposed or concealed linkage may be used with face velocities of 1500 FPM or below. Acceptable manufacturers are Ruskin CD36, and Vent Products 5800.

6. 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.

C. Control Relays

1. Control Pilot Relays

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

b. Mounting Bases shall be snap-mount.

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

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

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

f. Acceptable manufacturers: Potter and Brumfield, RIB

2.4 MISCELLANEOUS DEVICES

A. Local Control Panels

1. 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.

2. 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.

3. All panel wiring shall be to and from terminal strips. The use of wire nuts for connection of wiring to or from a common point is not acceptable.

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

5. 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.

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

7. All wiring shall be identified.

8. A convenience 120 VAC duplex receptacle shall be provided in each enclosure, fused on/off power switch, and required transformers.

B. Power Supplies

1. 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.

2. Input: 120 VAC +10%, 60Hz.

3. Output: 24 VDC.

4. Line Regulation: +0.05% for 10%-line change.

5. Load Regulation: +0.05% for 50% load change.

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

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

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

C. Thermostats

1. 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. The finish of covers for all room-type instruments shall match and, unless otherwise indicated or specified, covers shall be manufacturer's standard finish.

D. Lexan Thermostat Guards

1. All thermostats located in public and non supervised areas shall be fitted with tamperproof Lexan guards.

E. CO2 Sensors

1. Where shown on the drawings, CO2 sensors shall have the following features:

a. Jumper select able : 0-20mA, 4-20mA & 0-10VDC output

b. Liquid Crystal Display

2. The CO2 sensors shall have the ability to monitor and output the following variables as required by the systems sequence of operations:

a. Zone carbon-dioxide

3. The CO2 shall transmit the information back to the controller via jumper selectable 0-20mA, 4-20mA & 0-10VDC output signals.

a. The CO2 sensors shall provide a maximum output current of 25mA; Maximum output voltage of 12.5V.

b. The CO2 sensors shall be FCC compliant to CFR47 Part 15 subpart B Class A.

4. The CO2 Sensors shall be available with

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

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

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

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

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

5. The CO2 Sensors may include the following items:
   a. Relay output module

   b. Liquid Crystal Display module

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

PART 3 – PERFROMANCE / EXECUTION

3.1 BMS Specific Requirements

A. Graphic Displays

1. Provide a color graphic system flow diagram display for each system with all points as indicated on the point list. All terminal unit graphic displays shall be from a standard design library.

2. Users shall access the various system schematics via a graphical penetration scheme and/or menu selection.

3. The Temperature Control Contractor shall coordinate all graphics with final room signage.

4. Custom Reports:

   a. Provide custom reports as required for this project:

5. Actuation / Control Type

6. Primary Equipment

   a. Controls shall be provided by the equipment manufacturer as specified herein.

   b. All damper and valve actuation shall be electric.

7. Roof Top Unit Equipment

   a. All roof top units shall be controlled with a HVAC-DDC Controller

   b. All damper and valve actuation shall be electric.

3.2 Installation Practices

A. All control and interlock wiring shall comply with the national and local electrical codes and Division 26 of these specifications. Where the requirements of this section differ from those in Division 26, the requirements of this section shall take precedence.

B. 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.

C. 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).

D. Where class 2 wiring is run exposed, wiring shall be run parallel along a surface or perpendicular to it, and bundled, using approved wire ties at no greater than 3 m [10 ft] intervals. Such bundled cable shall be fastened to the structure, using specified fasteners, at 1.5 m [5 ft] intervals or more often to achieve a neat and workmanlike result.

E. All wire-to-device connections shall be made at terminal blocks or terminal strips. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

F. The maximum allowable voltage for control wiring shall be 120V. If only higher voltages are available, the Control System Contractor shall provide step down transformers.

G. All wiring shall be installed at continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.

H. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations in accordance with other sections of this specification and local codes.

I. Size of conduit and size and type of wire shall be the design responsibility of the Control System Contractor, in keeping with the manufacturer's recommendation and NEC.

J. Control and status relays are to be located in designated enclosures only. These relays may also be located within packaged equipment control panel enclosures. These relays shall not be located within Class 1 starter enclosures.

K. Follow manufacturer's installation recommendations for all communication and network cabling. Network or communication cabling shall be run separately from other wiring.

L. Adhere to Division 26 requirements for installation of raceway.

M. This Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

N. Flexible metal conduits and liquid-tight, flexible metal conduits shall not exceed 3' in length and shall be supported at each end. Flexible metal conduit less than 1/2" electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal conduits shall be used.

3.3 Training

A. The BMS contractor shall provide the following training services:

1. 40 Hours of on-site training broken down into 4-hour sessions by a system technician who is fully knowledgeable of the specific installation details of the project. This orientation shall, at a minimum, consist of a review of the project as-built drawings, the BMS software layout and naming conventions, and a walk through of the facility to identify panel and device locations.

3.4.1 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 Owner. 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 the Owner's representative. Such tests shall then be performed as part of the warranty.

4.5.1 Software License

A. The Owner shall be the named license holder of all software associated with all incremental work on the project(s). The owner, or his appointed agent, shall determine which organizations to be named in the "**orgid**" of all Niagara Framework™ and BAS system software licenses and programming tools required for ongoing system maintenance and reprogramming.

END OF SECTION 230900

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