AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. CONTRACT ID CODE	PAGE OF PAGES
	1 2

2. AMENDMENT/MODIFICATION NO.	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ.NO.	5. PROJECT NO. *(If applicable)*
0001	09/07/2022		

6. ISSUED BY CODE AAQ510ATL-AFN

FEDERAL AVIATION ADMINISTRATION
AAQ-500 - REGIONAL ACQUISITIONS
1701 COLUMBIA AVENUE
COLLEGE PARK GA 30337

7. ADMINISTERED BY *(If other than Item 6)* CODE

8. NAME AND ADDRESS OF CONTRACTOR *(No., street, county, State and ZIP Code)*

CODE FACILITY CODE

(x) 9A. AMENDMENT OF SOLICITATION NO.
697DCK-22-R-00467

X 9B. DATED *(SEE ITEM 11)*
08/10/2022

10A. MODIFICATION OF CONTRACT/ORDER NO.

10B. DATED *(SEE ITEM 13)*

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

☒ The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers ☐ is extended. ☒ is not extended.
Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended , by one of the following methods: (a) By completing Items 8 and 15, and returning 1 copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted ; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment number. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted , such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA *(If required.)*

13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS. IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.

(x) ☐	A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: *(Specify authority)* THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.
☐	B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES *(such as changes in paying office, appropriation date, etc.)* SET FORTH IN ITEM 14.
☐	C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO THE AUTHORITY OF:
☐	D. OTHER *(Specify type of modification and authority)*

E. IMPORTANT: Contractor ☐ is not. ☐ is required to sign this document and return 1 copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION *(Organized by UCF section headings, including solicitation/contract subject matter where feasible.)*

The purpose of this amendment is the following:

1. Incorporate questions and answers document into the solicitation. The newly incorporated questions and answers document contain answers that revised/changed the original specifications/drawings documents. As such, please be sure to review the questions and answers document and sign and return this amendment with your proposal.

2. Incorporate updated Direct Digital Control (DDC) System specifications document, see attachments for DDC document.

Except as provided herein, all terms and conditions of the document referenced in Item 9 A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER *(Type or print)*		16A. NAME AND TITLE OF CONTRACTING OFFICER *(Type or print)*	
		Robert K. Higgins	
15B. CONTRACTOR/OFFEROR	15C. DATE SIGNED	16B. CONTRACT AUTHORITY	16C. DATE SIGNED
(Signature of person authorized to sign)		*(Signature of Contracting Officer)*	

LIST OF CHANGES:

Section J - List of Documents, Exhibits and Other Attachments was revised as follows.

Attachment List was revised as follows.

Table has been revised and now reads as follows:

ATTACHMENT	TITLE	DATE	NO. OF PAGES
01	J-1 Specifications ILM HVAC Upgrade	03/01/2022	662
02	J-1a Drawings ILM HVAC Upgrade	07/21/2022	42
03	J-2 Wage Determinations	02/25/2022	5
04	J-3 Construction Waste Management Form	07/25/2022	1
05	J-4 eInvoicing Vendor Notification Letter	07/25/2022	2
06	J-5 COVID 19 Memo Contractor	08/17/2021	3
07	J-6 COVID-19 Contractual Requirement	08/26/2020	6
08	J-7 FAA Certification Vaccination Blank	07/25/2022	4
09	L1- Past Performance Questionnaire	07/25/2022	1
10	L2 - Price Proposal	07/25/2022	1
11	L3 Form 7460-1	07/25/2022	1
12	J-8 Updated Specs for DDC System for HVAC	09/07/2022	86
13	Q&A Responses/Clarifications	09/07/2022	2

Amendment 1 Q&A Responses/Clarifications:

9/7/22

Please find the most recent DDC Specifications 23 09 23, dated April 2022, which supersedes the Spec requirements in the Solicitation.

1. Specifications – General topology: The specifications are calling for a "LON" topology (FT-10) which hasn't been used in the FAA for several years. The newer FAA systems utilize Ecostruxure hardware (EBO) using Automation Servers (ASP with modules and ASB standalone) type hardware manufactured by Schneider Electric. Keep in mind, the "LON" type controllers by Schneider Electric are being phased out of production with a very limited supply and pricing is significantly higher than the modern EBO hardware.

a. Please provide direction whether or not LON controllers are acceptable for this project.

b. If there is a newer FAA specification for the EBO hardware we can reference, it would be beneficial for pricing purposes.

Please use the modern EBO products. See revised DDC specification.

2. Specification Section L – Control Valves: Energy valves (EV) are called out for all control/Bypass valves. However, the project is calling for 3-way control valves and the EV only come in 2-way control valves. In addition, we do not believe there is enough piping space to accommodate an EV. Keep in mind, the purpose of the EV is for pressure independent / system flow control and it basically defeats the purpose if the complete system is not matched.

a. Please provide direction if any Energy Valves will be required for this project.

b. We propose a 3-way CCV manufactured by Belimo as an industry standard alternate for this application.

Agreed and accepted.

3. Drawing sheet M813 – Cab Defogger: The existing cab defogger system is electronically operated and is not part of the DDC system. The drawings are calling for Binary Inputs to monitor portions of the existing system.

a. Zone status: It is unclear how this is accomplished as there are multiple zones and it is only calling for a single binary input at the console. i. Please advise to the intent of this status indication?

Please include the full DDC integration for the defogging system.

b. Surfactant pump status (Existing pump): this is typically a small enclosed pump that plugs into a 110 vac plug and operates based on flow. As this is something we have not

provided status for in the past, what are the acceptable means for status without altering the self enclosed pump enclosure? As the pump is very small, our current sensors can only measure down to a ¼ amp – we cannot say for certain this is low enough to measure the status. We could install a relay but that would require us to open the pump enclosure and circumvent the wiring to trigger a relay. i. Please advise to the best method of gathering status for this device?

CFP status is not required.

c. For clarity, zone control automation (as done in previous ATCT) via the DDC does not appear to be part of the project. Are we to assume this system is in good working condition and no work is required for this system?

The hot/cold deck system is being replaced by a VAV system and will need all new control in the Base Building. The ATCT will have all new controls as well. Please plan to control all zones.

4. Conduit & wiring - DDC: it is unclear if the existing conduit & wiring can be re-used. During our walk through, we noticed conduit ran throughout the facility.

a. Is it acceptable to re-use the existing conduit when possible? Yes.

b. Is your expectation that all new wire be installed? Yes.

SECTION 23 09 23 - DIRECT DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Scope: Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, configuration and installation for complete building automation system (also identified as BMS, Direct Digital Control System For HVAC) including all necessary hardware and all operating and applications software as required for the complete performance of the Work, as shown on the Drawings, as specified herein.

B. Related Sections: Related sections include, but shall not be limited to, the following:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
2. Applicable general requirements for electrical Work specified within Divisions 23, 26 Specification Sections apply to this Section.

C. Network level components of the system – workstations, servers, etc. shall communicate using the BACnet protocol, as defined by ASHRAE Standard 135-2004, or Modbus protocol. No gateways shall be used for communication to controllers furnished under this section.

D. At a minimum, provide controls for the following:

1. Air Handling Units
2. Boilers including hot water pumps
3. Chilled water system including pumps, chillers, and cooling towers
4. Computer room air handling units
5. Fan Coil Units
6. Exhaust and Supply Fans
7. Finned tube radiation control
8. Monitoring points for packaged equipment such as emergency generators
9. Power wiring to DDC devices, smoke control dampers and BAS panels except as otherwise specified
10. Refrigerant leak detection system
11. Return Air Fans
12. Variable volume and constant volume box control including interlocks with finned tube radiation
13. Variable Frequency Drives

E. Except as otherwise noted, the control system shall consist of all necessary Ethernet Network Controllers, Standalone Digital Control Units, workstations, software, sensors, transducers, relays, valves, dampers, damper operators, control panels, and other accessory equipment, along

with a complete system of electrical interlocking wiring to fill the intent of the specification and provide for a complete and operable system. Except as otherwise specified, provide operators for equipment such as dampers if the equipment manufacturer does not provide these. Coordinate requirements with the various Contractors.

F. The BAS system supplier shall review and study all HVAC drawings and the entire specification to familiarize themselves with the equipment and system operation and to verify the quantities and types of dampers, operators, alarms, etc. to be provided.

G. All interlocking wiring, wiring and installation of control devices associated with the equipment listed below shall be provided under this Contract. When the BAS system is fully installed and operational, the BAS system supplier and representatives of the FAA will review and check out the system – see System Acceptance and Testing section of this document. At that time, the BAS system supplier shall demonstrate the operation of the system and prove that it complies with the intent of the drawings and specifications.

H. Provide services and manpower necessary for commissioning of the system in coordination with the HVAC Contractor, Balancing Contractor and FAA's representative.

I. All work performed under this section of the specifications will comply with all governing codes, laws and governing bodies. If the drawings and/or specifications are in conflict with governing codes, the Contractor, with guidance from the engineer, shall submit a proposal with appropriate modifications to the project to meet code restrictions. If this specification and associated drawings exceed governing code requirements, the specification will govern. The Contractor shall obtain and pay for all necessary construction permits and licenses.

1.2 RELATED SECTIONS

A. This Section includes the Building Management System (BMS) control equipment for HVAC systems and components, including open protocol control components for terminal heating and cooling units. Depending on the scope of the project, the complete specification may have numerous sections that interface to this section, including several from Division, 26, & 28.

B. Additional related sections and sub-sections can apply.

a. 22 11 19 DOMESTIC WATER PIPING SPECIALTIES

1.3 REFERENCES

A. General, Code Compliance: The code listed below form a part of this Specification to the extent referenced. The codes are referred to in the text by the basic designation only. The edition/revision of the referenced code shall be the latest date as of the date of the Contract Documents, unless otherwise specified.

1. Provide BAS components and ancillary equipment, which are UL-916 listed and labeled.
2. All equipment or piping used in conditioned air streams, spaces or return air plenums shall comply with NFPA 90A Flame/Smoke/Fuel contribution rating of 25/50/0 and all applicable building codes or requirements.
3. All wiring shall conform to the National Electrical Code and FAA-C-1217H Electrical Work, Premises Wiring and Division 26 requirements, whichever is more stringent.
4. All smoke dampers shall be rated in accordance with UL 555S.

5. Comply with FCC rules, Part 15 regarding Class A radiation for computing devices and low power communication equipment operating in commercial environments.
6. Comply with FCC, Part 68 rules for telephone modems and data sets.

1.4 DEFINITIONS

A. Unless specifically defined within the Contract Documents, the words or acronyms contained within this specification shall be as defined within, or by the references listed within this specification, the Contract Documents, or, if not listed by either, by common industry practice.
   1. Standard
      a. ASHRAE: American Society Heating, Refrigeration, Air Conditioning Engineers
      b. AHU: Air Handling Unit
      c. BACnet: Building Automation Controls Network
      d. BMS: Building Management System
      e. CRAC: Computer Room Air Conditioning Unit
      f. DDC: Direct Digital Control
      g. EIA: Electronic Industries Alliance
      h. FCU: Fan Coil Unit
      i. GUI: Graphical User Interface
      j. HWC: Hot Water Coil
      k. HVAC: Heating, Ventilation, and Air Conditioning
      l. IEEE: Institute Electrical Electronic Engineers
      m. MER: Mechanical Equipment Room
      n. PID: Proportional, Integral, Derivative
      o. VAV: Variable Air Volume Box
   2. Communications and protocols
      a. ARP: Address Resolution Protocol
      b. BACnet: Building Automation and Control Networks
      c. CORBA: Common Object Request Broker Architecture
      d. CSMA/CD: Carrier Sense Multiple Access/Collision Detect
      e. DDE: Dynamic Data Exchange
      f. FTP: File Transfer Protocol
      g. FTT: Free Topology Transceivers
      h. HTTP: Hyper Text Transfer Protocol
      i. IIOP: Internet Inter-ORB Protocol
      j. IP: Internet Protocol
      k. LAN: Local Area Network
      l. LON: Echelon Communication – Local Operating Network
      m. MS/TP: Master Slave Token Passing
      n. OBIX: Open Building Information Exchange
      o. ODBC: Open Database Connectivity
      p. ORB: Object Request Broker

q. SNVT: Standard Network Variables Types
r. SQL: Structured Query Language
s. UDP: User Datagram Protocol
t. XML: eXtensible Markup Language

3. Controllers
   a. ASD: Application Specific Device
   b. AAC: Advanced Application Controller
   c. AS-B: Automation Server
   d. AS-P: Automation Server Premium
   e. ASC: Application Specific Controller only configurable and not controllable.
   f. CAC: Custom Application Controller
   g. MP-C: Multi-Purpose Controller Has some vulnerability. Would use on AHU. Has a smart bus. Dedicated home run or loop for more than one.
   h. MP-V: Multi-purpose VAV Controller
   i. NSC: Network Server Controller
   j. PEM: Package Equipment Module
   k. RP-C: Room Purpose Controller
   l. SDCU: Standalone Digital Control Units
4. Tools and Software
   a. AFDD: Automated Fault Detection and Diagnostic
   b. APEO: Automated Predictive Energy Optimization
   c. DR: Demand Response
   d. CCDT: Configuration, Commissioning and Diagnostic Tool
   e. BPES: BACnet Portable Engineering Station
   f. LPES: LON Portable Engineering Station
   g. POT: Portable Operator's Terminal
   h. PEMS: Power and Energy Management Software
   i. MTBF: Mean Time Between Failure

1.5 SYSTEM DESCRIPTION

A. In accordance to the scope of work, the system shall also provide a graphical, web-based, operator interface that allows for instant access to any system through a standard browser. The contractor must provide PC-based programming workstations, operator workstations and microcomputer controllers of modular design providing distributed processing capability, and allowing future expansion of both input/output points and processing/control functions.

B. For this project, the system shall consist of the following components:
   1. Administration and Programming Workstation(s): The BAS system supplier shall include Operation software and architecture as described in Part 2 of the specification. These workstations must be running the standard workstation software developed and tested by the manufacturer of the network server controllers and the standalone controllers. No third party front-end workstation software will be acceptable. Workstations must conform to the B-OWS BACnet device profile.

2. Web-Based Operator Workstations: The BAS system supplier shall furnish licenses for web connection to the BAS system. Web-based users shall have access to all system points and graphics, shall be able to receive and acknowledge alarms, and shall be able to control setpoints and other parameters. All engineering work, such as trends, reports, graphics, etc. that are accomplished from the WorkStation shall be available for viewing through the web browser interface without additional changes. The web-based interface must conform to the B-OWS BACnet device profile. There will be no need for any additional computer based hardware to support the web-based user interface.
3. Ethernet-based Network Router and/or Network Server Controller(s): The BAS system supplier shall furnish needed quantity of Ethernet-based Network Server Controllers as described in Part 2 of the specification. These controllers will connect directly to the Operator Workstation over Ethernet at a minimum of 100mbps, and provide communication to the Standalone Digital Control Units and/or other Input/Output Modules. Network Server Controllers shall conform to BACnet device profile B-BC. Network controllers that utilize RS232 serial communications or ARCNET to communicate with the workstations will not be accepted. Network Controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Building Controllers (B-BC).
4. Standalone Digital Control Units (SDCUs): Provide the necessary quantity and types of SDCUs to meet the requirements of the project for mechanical equipment control including air handlers, central plant control, and terminal unit control. Each SDCU will operate completely standalone, containing all of the I/O and programs to control its associated equipment. Each BACnet protocol SDCU shall conform to the BACnet device profile B-AAC. BACnet SDCUs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Advanced Application Controllers (B-AAC).

C. The Local Area Network (LAN) shall be either a 10 or 100 Mpbs Ethernet network supporting BACnet, Modbus, XML and HTTPS for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Server Controllers (NSCs), user workstations and a local host computer system.

D. The Enterprise Ethernet (IEEE 802.3) LAN shall utilize Carrier Sense Multiple/Access/Collision Detect (CSMA/CD), Address Resolution Protocol (ARP) and User Datagram Protocol (UDP) operating at 10 or 100 Mbps.

E. The system shall enable an open architecture that utilizes EIA standard 709.1, the LonTalk™ protocol and/or ANSI / ASHRAE™ Standard 135-2004, BACnet functionality to assure interoperability between all system components. Native support for the LonTalk™ protocol and the ANSI / ASHRAE™ Standard 135-2004, BACnet protocol are required to assure that the project is fully supported by the HVAC open protocols to reduce future building maintenance, upgrade, and expansion costs.

F. The system shall enable an architecture that utilizes a MS/TP selectable 9.6-76.8 KBaud protocol, as a common communication protocol between controllers and integral ANSI / ASHRAE™ Standard 135-2004, BACnet functionality to assure interoperability between all system components. The AAC shall be capable of communicating as a MS/TP device or as a BACnet IP device communicating at 10/100 Mbps on a TCP/IP trunk. The ANSI / ASHRAE™ Standard 135-2004, BACnet protocol is required to assure that the project is fully supported by the leading HVAC open protocol to reduce future building maintenance, upgrade, and expansion costs.

G. LonTalk™ packets may be encapsulated into TCP/IP messages to take advantage of existing infrastructure or to increase network bandwidth where necessary or desired.

1. Any such encapsulation of the LonTalk™ protocol into IP datagrams shall conform to existing LonMark™ guide functionality lines for such encapsulation and shall be based on industry standard protocols.
2. The products used in constructing the BMS shall be LonMark™ compliant.
3. In those instances, in which Lon-Mark™ devices are not available, the BMS system supplier shall provide device resource files and external interface definitions for LonMark devices.

H. The software tools required for network management of the LonTalk™ protocol and the ANSI / ASHRAE™ Standard 135-2004, BACnet protocol must be provided with the system. Drawings are diagrammatic only. Equipment and labor not specifically referred to herein or on the plans and are required to meet the functional intent, shall be provided without additional cost to the FAA. BACnet clients shall comply with the BACnet Operator Workstation (B-OWS) device profile; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet IP or MS/TP. Physical connection of LonWorks devices shall be via Ethernet IP or FTT-10A.

I. The system shall provide support for Modbus TCP and RTU protocols natively, and not require the use of gateways.

J. Complete temperature control system to be DDC with electronic sensors and electronic/electric actuation of Mechanical Equipment Room (MER) valves and dampers and electronic actuation of terminal equipment valves and actuators as specified herein. The BMS is intended to seamlessly connect devices throughout the building regardless of subsystem type, i.e. variable frequency drives, low voltage lighting systems, electrical circuit breakers, power metering and card access should easily coexist on the same network channel.

1. The supplied system must incorporate the ability to access all data using HTML5 enabled browsers without requiring proprietary operator interface and configuration programs. The system shall not require JAVA to be enabled in the browser.
2. Data shall reside on a supplier-installed server for all database access.
3. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer’s internal Intranet network.

K. All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the regular employment of the approved manufacturer's local field office. The approved manufacturer's local field office shall have a minimum of 5 years of installation experience with the manufacturer and shall provide documentation in the bid and submittal package verifying longevity of the installing company's relationship with the manufacturer when requested. Supervision, hardware and software engineering, calibration and checkout of the system shall be by the employees of the approved manufacturer's local field office and shall not be subcontracted. The control contractor shall have an in place support facility with factory certified technicians and engineers, spare parts inventory and all necessary test and diagnostic equipment for the installed system, and the control contractor shall have 24 hours/day, 7 days/week emergency service available. Services may be provided with phone support and remote access.

L. Provide the Commissioning, configuration and diagnostic tool (CCDT), color display personnel computer, software, and interfaces to provide uploading/downloading of High Point Count Controllers (AAC), and VAV controllers (MPV), monitoring all BACnet objects, monitoring overrides of all controller physical input/output points, and editing of controller resident time schedules.

1.6 SUBMITTALS

A. General: Submittals shall be in accordance with the requirements of Section 01 33 00 Submittal Procedures and DIVISION 23 Heating Ventilating and Air Conditioning, in addition to those specified herein.

1. All shop drawings shall be prepared in Visio Professional or AutoCAD software. In addition to the drawings, the Contractor shall furnish a CD containing the identical information. Drawings shall be B size or larger.

2. Shop drawings shall include a riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also included shall be individual schematics of each mechanical system showing all connected points with reference to their associated controller. Typical diagrams will be allowed where appropriate.

3. Submittal data shall contain manufacturer's data on all hardware and software products required by the specification. Valve, damper and air flow station schedules shall indicate size, configuration, capacity and location of all equipment.

4. Software submittals shall contain narrative descriptions of sequences of operation, program listings, point lists, and a complete description of the graphics, reports, alarms and configuration to be furnished with the workstation software. Information shall be bound or in a three ring binder with an index and tabs. Diagrams shall be on 11” by 17” foldouts. If color has been used to differentiate information, the printed copies shall be in color.

5. Submit E-copies of submittal data and shop drawings to the Engineer for review prior to ordering or fabrication of the equipment. The Contractor, prior to submitting, shall check all documents for accuracy.

6. The Engineer will make corrections, if required, and return to the Contractor. The Contractor will then resubmit with the corrected or additional data. This procedure shall be repeated until all corrections are made to the satisfaction of the Engineer and the submittals are fully approved. The full procedure is found in section 01 33 00 Submittal Procedures.

7. The following is a list of post construction submittals that shall be updated to reflect any changes during construction and re-submitted as “As-Built”.
   a. System architecture drawing.
   b. Layout drawing for each control panel
   c. Wiring diagram for individual components
   d. System flow diagram for each controlled system
   e. Instrumentation list for each controlled system
   f. Sequence of control
   g. Binding map
   h. A matrix sheet detailing all system addresses and communication settings for the following:
      1) All IP network addresses & settings

2) All BMS device addresses & communication settings

i. Operation and Maintenance Manuals

8. Information common to the entire system shall be provided. This shall include but not be limited to the following.
   a. Product manuals for the key software tasks.
   b. Operating the system.
   c. Administrating the system.
   d. Engineering the operator workstation.
   e. Application programming.
   f. Engineering the network.
   g. Setting up the web server.
   h. Report creation.
   i. Graphics creation.
   j. All other engineering tasks.
   k. System Architecture Diagram.
   l. List of recommended maintenance tasks associated with the system servers, operator workstations, data servers, web servers and web clients.
   m. Define the task.
   n. Recommend a frequency for the task.
   o. Reference the product manual that includes instructions on executing the task.
   p. Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
   q. Licenses, guarantees, and warranty documents for equipment and systems.
   r. Submit one copy for each building, plus two extra copies.
9. Information common to the systems in a single building shall be provided.
   a. System architecture diagram for components within the building annotated with specific location information.
   b. As-built drawing for each control panel.
   c. As-built wiring design diagram for all components.
   d. Installation design details for each I/O device.
   e. As-built system flow diagram for each system.
   f. Sequence of control for each system.
   g. Binding map for the building.
   h. Product data sheet for each component.
   i. Installation data sheet for each component.
   j. Submit two copies for each building and two extra copies.
10. Software shall be provided:
   a. Submit a copy of all software installed on the servers and workstations.
   b. Submit all licensing information for all software installed on the servers and workstations.

c. Submit a copy of all software used to execute the project even if the software was not installed on the servers and workstations.

d. Submit all licensing information for all of the software used to execute the project.

e. All software revisions shall be as installed at the time of the system acceptance.

f. Firmware Files

g. Submit a copy of all firmware files that were downloaded to or pre-installed on any devices installed as part of this project.

h. This does not apply to firmware that is permanently burned on a chip at the factory and can only be replaced by replacing the chip.

i. Submit a copy of all application files that were created during the execution of the project.

j. Submit a copy of all graphic page files created during the execution of the project.

1.7 QUALITY ASSURANCE

A. All bidders must be building automation contractors in the business of installing direct digital control building automation systems for a minimum of 5 years.

1. The Building Management System contractor shall have a staff with engineers trained and certified by the manufacturer in the configuration, programming and service of the automation system. The contractor’s technicians shall be fully capable of providing instructions and routine emergency maintenance service on all system components.

2. Any installing contractor, not listed as prequalified in the Approved Manufacturer's section, shall submit credentials as detailed in the Pre-bid Submittal section for the engineer’s review 2 weeks prior to bid date. Failure to follow the attached formats shall disqualify potential alternate bidders. Credentials must attest that the contractor meets all requirements of the specification and the Engineers judgment regarding approval to bid as an acceptable installer after reviewing the data will be final.

B. All bidders must be authorized distributors or branch offices of the manufacturers specified.

C. The following bidders have been pre-qualified:

1. Future Controls, Inc., 5719 Zip Drive, Suite 1, Fort Meyers, Florida 33905, 800-330-1303, Attn: Thomas Hansen, Jr.

2. C-Tech, 116 Portland Road, Whitehouse, Tennessee 37188, 615-672-8210, Attn: Jim Brown.

3. Or as approved by Schneider Electric. POC: Jon Cramer, 813-469-0737, jon.cramer@se.com

D. Any installing contractors or manufacturers interested in participating as acceptable bidders for this project that are not pre-qualified shall furnish a detailed technical pre-bid submittal to the consulting engineer. All information must be submitted 2 weeks prior to the published bid date to allow the engineer adequate time to review the bidder’s credentials.

E. The Pre-Bid submittal shall contain the following information as a minimum:

1. A profile of the manufacturer and the local installation and service/organization.

2. Description of how the system meets and achieves all the specified criteria in terms of configuration, operation, and control.

3. System Architecture with single line riser diagram showing all major components (digital controllers, routers, hubs, etc.) that will be required for this project.
4. Procedure for commissioning and time required to startup and commission each of the systems for this project.
5. Contractors approach for the project planning and management.
6. Product Data Sheets for all components, DDC panels, and all accessories listed per the appropriate specification sections herein.
7. Examples of actual graphic screens for other similar projects.
8. Number and types of DDC panels required for this installation.
9. Number and types of spare points provided with the proposed system.
10. Recommended spare parts list for components with list price schedule.
11. List of 2 similar systems in size, point capacity, total installed value, installed and commissioned by the local office with a list of the installers/manufacturers design team members for each project and the FAAs contact information.
12. Samples of service offerings and a list of current similar service contracts with contact information.
13. Resumes for the management team and all employees who will be involved with the project design, commissioning, project management, and after installation service. Resumes should include copies of manufacturer's certifications for the proposed product line.
14. Copy of this Control Specification in its entirety with a check mark beside each paragraph to signify that the manufacturer's equipment and software shall fully conform to the specified requirement. If the requirement cannot be met, indicate the reasons/limitations and the alternative proposed.
15. An interview may be conducted and the bidder will be requested to make a formal presentation concerning the proposed system and possibly provide an installed project tour prior to a final decision.

F. Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BAS will be tested against the appropriate sequence of operation specified herein. Successful completion of the system test shall constitute the beginning of the warranty period. A written report will be submitted to the FAA indicating that the installed system functions in accordance with the plans and specifications.

G. The BAS system supplier shall commission and set in operating condition all major equipment and systems, such as the chilled water, hot water and all air handling systems, in the presence of the equipment manufacturer’s representatives, as applicable, and the FAA and Engineers’s representatives. If the vendor is providing an AFDD/CC system, use of the analytics shall be used to help commission the system.

H. The BAS system supplier shall provide a technician for as needed manpower and engineering services required to assist the HVAC Contractor and Balancing Contractor in testing, adjusting, and balancing all systems in the building. The BAS system supplier shall coordinate all requirements to provide a complete air and water balance with the Balancing Contractor and shall include all labor and materials in his contract.

I. Startup Testing shall be performed for each task on the startup test checklist, which shall be initialed by the technician and dated upon test was completion along with any recorded data such

as voltages, offsets or tuning parameters. Any deviations from the submitted installation plan shall also be recorded.

J. Required elements of the startup testing include:
1. Test equipment shall be calibrated and accuracy verified or validated.
2. Measurement of voltage sources, primary and secondary
3. Verification of proper controller power wiring.
4. Verification of component inventory when compared to the submittals.
5. Verification of labeling on components and wiring.
6. Verification of connection integrity and quality (loose strands and tight connections).
7. Verification of bus topology, grounding of shields and installation of termination devices.
8. Verification of point checkout.
9. Each I/O device is landed per the submittals and functions per the sequence of control.
10. Analog sensors are properly scaled and a value is reported
11. Binary sensors have the correct normal position and the state is correctly reported.
12. Analog outputs have the correct normal position and move full stroke when so commanded.
13. Binary outputs have the correct normal state and respond appropriately to energize/de-energize commands.
14. Documentation of analog sensor calibration (measured value, reported value and calculated offset).
15. Documentation of Loop tuning (sample rate, gain and integral time constant).

K. A performance verification test shall also be completed for the operator interaction with the system. Test elements shall be written to require the verification of all operator interaction tasks including, but not limited to the following.
1. Graphics navigation.
2. Trend data collection and presentation.
3. Alarm handling, acknowledgement and routing.
4. Time schedule editing.
5. Application parameter adjustment.
6. Manual control.
7. Report execution.
8. Automatic backups.
9. Web Client access.

L. A Startup Testing Report and a Performance Verification Testing Report shall be provided upon test completion.

1.8 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate equipment from other divisions including "Motor Control Centers," "Panel boards," and "Fire Alarm" to achieve compatibility with equipment that interfaces with those systems.

C. Coordinate supply of conditioned electrical circuits with electrical contractor/ COR for control units and operator workstation.

1.9 OWNERSHIP

A. The FAA shall retain licenses to software for this project.

B. The FAA shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to the FAA as defined by the manufacturer's license agreement, but shall protect the manufacturer's rights to disclosure of Trade Secrets contained within such software.

C. The licensing agreement shall not preclude the use of the software by individuals under contract to the FAA for commissioning, servicing or altering the system in the future. Use of the software by individuals under contract to the FAA shall be restricted to use on the FAA's computers and only for the purpose of commissioning, servicing, or altering the installed system.

D. All project developed software, files and documentation shall become the property of the FAA. These include but are not limited to:

1. Server and workstation software
2. Application programming tools
3. All passwords including administrative hierarchy to include full admin rights.
4. Configuration tools
5. Network diagnostic tools
6. Addressing tools
7. Application files
8. Configuration files
9. Graphic files
10. Report files
11. Graphic symbol libraries
12. All documentation

1.10 WORK BY OTHERS

A. The BAS system supplier shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others' work.

B. The BAS system supplier shall furnish all devices that are part of the DDC system including, but not limited to, Airflow Stations, Control Dampers Actuators, Control Valves, Flow Meters, Flow Switches, Refrigerant Pressure/Transducers, Sensor Wells for installation by the Mechanical Contractor and/or others.

C. The BAS system supplier shall provide field supervision to the designated contractor for the installation of the following:

1. Automatic control dampers
2. Blank-off plates for dampers that are smaller than duct size.

3. Sheet metal baffles plates to eliminate stratification.
4. The Electrical Contractor/ Fire Alarm Contractor shall provide:
    a. All 120VAC power wiring to motors, heat trace, junction boxes for power to BAS panels.
    b. Furnish smoke detectors and wire to the building fire alarm system. HVAC Contractor to mount devices. BAS system supplier to hardwire to fan shut down.
    c. Auxiliary contact (pulse initiator) on the electric meter for central monitoring of kWh and KW. Electrical Contractor shall provide the pulse rate for remote readout to the BAS. BAS system supplier to coordinate this with the electrical contractor.

D. Prior to delivery to the Project site, ensure that suitable storage space is available to store materials in a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, and corrosive atmospheres. Materials shall be protected during delivery and storage and shall not exceed the manufacturer stated storage requirements. As a minimum, store indoors in clean, dry space with uniform temperature to prevent condensation. In addition, protect electronics from all forms of electrical and magnetic energy that could reasonably cause damage.

E. Deliver materials to the Project site in supplier’s or manufacturer’s original wrappings and containers, labeled with supplier’s or manufacturer’s name, material or product brand name, and equipment tag number or service name as identified within the Contract Documents.

F. Inspect and report any concealed damage or violation of delivery storage, and handling requirements to the Engineer.

1.11 WARRANTY

A. All components, system software, and parts furnished and installed by the BMS system supplier shall be guaranteed against defects in materials and workmanship for 1 year of substantial completion. Where the standard manufacture warranty exceeds the 1 year warranty such warranty shall be passed on to the FAA for the full length provided. Labor to repair, reprogram, or replace these components shall be furnished by the BMS system supplier at no charge during normal working hours during the warranty period. Materials furnished but not installed by the BMS system supplier shall be covered to the extent of the product only. Installation labor shall be the responsibility of the trade contractor performing the installation. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software disks. The Contractor shall respond to the FAA's request for warranty service within 24 standard working hours.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design Product: Subject to compliance with requirements, provide products by one of the following pre-qualified manufacturers:
1. Electric Components
    a. Schneider-Electric Field Devices
    b. Or approved equal
2. Electronic Components

a. Schneider-Electric Field Devices

b. Or approved equal.

3. Direct Digital Control Systems Field Controller Devices:

a. Schneider Electric EcoStruxure Building MP/RP BACnet series, EcoStructure Building Operations

b. Or approved equal.

2.2 OPEN, INTEROPERABLE SYSTEM ARCHITECTURE

A. General

1. The Building Automation System (BAS) shall consist of Network Server/Controllers (NSCs), a family of Standalone Digital Control Units (SDCUs), Administration and Programming Workstations (APWs), and Web-based Operator Workstations (WOWs). The BAS shall provide control, alarm detection, scheduling, reporting and information management for the entire facility within local BMS network.
2. An Enterprise Level BAS shall consist of an Enterprise Server, which enables multiple NSCs (including all graphics, alarms, schedules, trends, programming, and configuration) to be accessible from a single Workstation simultaneously for operations and engineering tasks.
3. The Enterprise Level BAS shall support built-in reporting functionality without dependency on other software.
4. The Enterprise Level BAS shall support standard accessing of data for third party reporting or analytics software.
5. The Enterprise Level BAS shall be able to host up to 250 servers, or NSCs, beneath it.
6. For Enterprise reporting capability and robust reporting capability outside of the trend chart and listing ability of the Workstation, a Reports Server shall be installed on a Microsoft Windows SQL based computer. The Reports Server can be installed on the same computer as the Enterprise Server.
7. The system shall be designed with a top-level 10/100bT Ethernet network, using the BACnet/IP, LonWorks IP, and/or Modbus TCP protocol.

B. Modbus RTU/ASCII (and J-bus), Modbus TCP, BACnet MS/TP, BACnet IP, LonTalk FTT-10A, and WebServices shall be native to the NSCs. There shall not be a need to provide multiple NSCs to support all the network protocols, nor should there be a need to supply additional software to allow all three protocols to be natively supported.

C. A sub-network of SDCUs using the BACnet IP, BACnet MS/TP and/or Modbus RTU protocol shall connect the local, stand-alone controllers with Ethernet-level Network Server Controllers/IP Routers.

D. The TCP/IP layer connects all of the buildings on a single Wide Area Network (WAN) isolated behind the campus firewall. Fixed IP addresses for connections to the campus WAN shall be used for each device that connects to the WAN.

E. The fieldbus layer shall support all of the following types of SDCUs:

1. BACnet IP SDCU requirements: The system shall consist of one or more BACnet/IP field buses managed by the Network Server Controller. The field bus layer shall consist of up to 50 IP SDCUs in daisy chain topology, or 39 if using RSTP, per layer, with a max of 5 sub

networks in daisy chain for a total of 250 SDCUs or 6 sub networks in RSTP for a total of 234 SDCUs.

2. BACnet MS/TP SDCU requirements: The system shall consist of one or more BACnet MS/TP field buses managed by the Network Server Controller. Minimum speed shall be 76.8kbps. The field bus layer consists of an RS485, token passing bus that supports up to 127 Standalone Digital Control Units (SDCUs) for operation of HVAC and lighting equipment. These devices shall conform to BACnet standard 135-2004. The NSCs shall be capable of at least two BACnet MS/TP field buses for a total capability of 254 SDCUs per NSC.

3. Modbus SDCU requirements: The system shall consist of one or more Modbus RTU (RS-485 or RS-232) field buses managed by the Network Server Controller. The field bus layer shall consist of up to 31 SDCUs for operation of HVAC, power metering, and lighting equipment. If utilizing Modbus TCP, the field bus layer shall consist of up to 100 SDCUs for operation of HVAC, power metering, and lighting equipment. The NSCs shall be capable of at least two Modbus RTU field buses for a total capability of 62 SDCUs per NSC.

F. The BAS shall be capable of being segmented, through software, into multiple local area networks (LANs) distributed over a wide area network (WAN). Workstations can manage a single LAN (or building), and/or the entire system with all portions of that LAN maintaining its own, current database.

G. All NSCs, Workstation(s) and Servers will be on a stand alone BMS network provided by the contractor. Furthermore, the NSC's, Workstation(s), and Server(s) shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches and hubs.

H. System Expansion

1. The BAS system shall be scalable and expandable at all levels of the system using the same software interface, and the same TCP/IP level and fieldbus level controllers. Systems that require replacement of either the workstation software or field controllers in order to expand the system shall not be acceptable.

2. Web-based operation shall be supported directly by the NSCs and require no additional software.

3. The system shall be capable of using graphical and line application programming language for the Network Server Controllers.

4. The system shall be able to operate normally and without restriction at multiple software version levels with the only requirement that each element of the hierarchy be at least as new a version as the newest version in the level below it. In other words, Enterprise Servers will be able to manage NSCs of different version provided that the Enterprise Server was the same or more recent version than the most recent NSC version.

I. All Network Server Controllers must natively support the BACnet IP, BACnet MS/TP, LonWorks FTT-10, Modbus TCP, Modbus RTU (RS-485 and RS-232), and Modbus ASCII protocols.

2.3 OPERATOR WORKSTATION REQUIREMENTS

A. General

1. The operator workstation portion of the BAS shall consist of one or more full-powered configuration and programming workstations, and one or more web-based operator workstations. For this project provide a minimum of 4 concurrent client licenses at the enterprise level. Client licenses are licenses that can be used for variable designations of the users choosing; i.e. operator, engineering, or web capabilities.
2. The programming and configuration workstation software shall allow any user with adequate permission to create and/or modify any or all parts of the NSC and/or Enterprise Server database.
3. At the NSC level, there shall be no cap on concurrent web-based workstations (webstations) other than what the CPU capacity can support.
4. All configuration workstations shall be personal computers operating under the Microsoft Windows operating system. The application software shall be capable of communication to all Network Server Controllers and shall feature high-resolution color graphics, alarming, trend charting. It shall be user configurable for all data collection and data presentation functions.
5. A minimum of 2 physical Workstations shall be allowed on the Ethernet network. In this client/server configuration, any changes or additions made from one workstation will automatically appear on all other workstations since the changes are accomplished to the databases within the NSC. Systems with a central database will not be acceptable.

B. Enterprise Server, Administration/Programming Workstation, and Webstation Requirements
1. The Enterprise Server shall consist of the following:
   a. Processor
      1) Minimum: Intel Core i5 @ 3.0 GHz or better
   b. Memory
      1) Minimum: 8GB or higher
   c. Operating systems:
      1) Microsoft Windows 10 64-bit
   d. 10/100MBPS Ethernet NIC
   e. Storage
      1) Minimum: 1TB
      2) Solid State Drive
   f. Required additional software:
      1) Microsoft .Net 4.7.2 and later
   g. License agreement for all applicable software
2. The Workstation shall consist of the following:
   a. Processor
      1) Minimum: Intel Core i5 @ 3.0 GHz or better
   b. Memory
      1) Minimum: 8GB or higher
   c. Operating systems:
      1) Microsoft Windows 10 64-bit
   d. 10/100MBPS Ethernet NIC
   e. Storage
      1) Minimum: 1TB

2) Solid State Drive

f. Required additional software:
1) Microsoft .Net 4.7.2 and later

g. License agreement for all applicable software

3. Web-Based Operator PC Requirements

a. Any user on the network can access the system, using the following software:

b. Minimum:
1) Google Chrome 61 or higher
2) Mozilla Firefox 60 or higher
3) Microsoft Edge (EdgeHTML) 16 or higher
4) Safari 11.1 or higher

c. Recommended:
1) Google Chrome 71 or higher
2) Mozilla Firefox 64 or higher
3) Microsoft Edge (EdgeHTML) 17 or higher
4) Safari 11.4 or higher

C. General Administration and Programming Workstation Software

1. System architecture shall be truly client server in that the Workstation shall operate as the client while the NSCs shall operate as the servers. The client is responsible for the data presentation and validation of inputs while the server is responsible for data gathering and delivery.

2. The workstation functions shall include monitoring and programming of all DDC controllers. Monitoring consists of alarming, reporting, graphic displays, long term data storage, automatic data collection, and operator-initiated control actions such as schedule and setpoint adjustments.

3. Programming of SDCUs shall be capable of being done either off-line or on-line from any operator workstation. All information will be available in graphic or text displays stored at the NSC. Graphic displays will feature animation effects to enhance the presentation of the data, to alert operators of problems, and to facilitate location of information throughout the DDC system. All operator functions shall be selectable through a mouse.

D. User Interface:

1. The BAS workstation software shall allow the creation of a custom, browser-style interface linked to the user when logging into any workstation. Additionally, it shall be possible to create customized workspaces that can be assigned to user groups. This interface shall support the creation of “hot-spots” that the user may link to view/edit any object in the system or run any object editor or configuration tool contained in the software. Furthermore, this interface must be able to be configured to become a user’s “PC Desktop” – with all the links that a user needs to run other applications. This, along with the Windows user security capabilities, will enable a system administrator to setup workstation accounts that not only limit the capabilities of the user within the BAS software, but may also limit what a user can do on the PC and/or LAN/WAN. This might be used to ensure, for example, that the user of an alarm monitoring workstation is unable to shutdown the active alarm viewer and/or unable to load software onto the PC.

2. System shall be able to automatically switch between displayed metric vs. imperial units based on the workstation/webstations localization.
3. The BMS workstation/webstations shall be capable of multiple language display, including English, Spanish, German, French, Japanese, Italian, Finnish, Portuguese, Swedish, Russian, and traditional and simplified Chinese. The multiple languages shall not require additional add on software from the standard workstation installer and shall be selectable within said workstation.
4. Webstations shall have the capability to automatically re-direct to an HTTPS connection to ensure more secure communications.
5. Personalized layouts and panels within workstations shall be extended to webstations to ensure consistent user experiences between the two user interfaces.
6. Webstations shall give the user the same capabilities within the graphics pages as are given within the workstation but shall be mobile responsive for use on smaller devices.
7. Workstation shall indicate at all times the communication status between it and the server.
8. The BMS web interface shall enable presentation mode whereby any functionality for interactivity shall be disabled.
9. The BMS web interface shall automatically detect light mode and dark mode settings in the operating system and adapt accordingly.
10. The BMS web interface shall allow override of the operating systems light/dark mode settings so that the setting can be enabled independent of the operating system's setting.
11. The BMS web interface shall automatically respond and adapt to different screen sizes and orientations from smart phone to smart televisions of any size.
12. The BMS web interface shall support slideshow functionality.
13. The BMS web interface shall support full screen mode displaying Alarm views / graphics / dashboards / Custom Reports.

E. User Access and Permissions

1. The BMS system shall allow for creation of one account per user.
2. The BMS shall support Groups where User Accounts associated with the group can inherit group permissions.
3. The BMS shall be able to specify each user account / group accessibility to each object in the system.
4. The BMS permission system shall be possible to integrate with Windows Active directory.
5. The BMS shall be able to report on the permission level across account / group for review / archiving / audit.
6. This username/password combination shall be linked to a set of capabilities within the software, set and editable only by user with system administrator privileges. The sets of capabilities shall include: edit or View only, Acknowledge alarms, Enable/disable Program and change values.
7. The system shall allow the above capabilities to be applied independently to each and every class of object in the system.
8. The BMS shall support integration with Windows Active Directory for user log on credentials.
9. The BMS shall support configurable reminder for "Days until password expires".
10. The BMS shall support configurable password policy across:

a. Minimum number of characters

b. Minimum number of lowercase characters

c. Minimum number of numeric characters

d. Minimum number of special characters

e. Number of consecutive unique passwords before reuse

f. No more than three repeating identical characters

11. The BMS user account management shall support password policy with the following components:

a. Mandatory change of password at first logon with default credentials

b. Disabling of all imported user accounts by default

c. Custom password complexity rules and its enforcement

d. Custom password reuse and its enforcement

e. Configurable black listing of passwords to limit the use of common known passwords (e.g. password)

f. Password aging rules

12. The BMS shall be capable of enabling an anonymous access (guest account) to previously engineered views such as dashboards, graphics, etc. with configurable permissions and without username or password.

13. It shall be possible to configure the BMS system so that the guest account is used by default to simplify presentation of Kiosk Mode across multiple screens

14. The BMS shall provide time configurability to logout the user and to revert to a preconfigured presentation view, such as offered by the Guest account functionality.

15. The BMS shall provide configurability in managing access and permission levels based on location, IP addresses and address ranges, Schedule and Time of day and combination thereof.

F. System Security

1. The BMS system supplier The BMS vendor shall be certified to Security Development Lifecycle process that is certified to IEC 62443-4-1 by a reputable third party independent lab.

2. The BMS system supplier shall be subjected to regular and verifiable best practice cyber security testing by the system supplier. Results of this testing shall be made available upon request prior to deployment of the system.

3. The BMS system supplier shall provide cyber security service incident escalation through help desk on a 7/24/365 basis.

4. The BMS shall support configuration for inactivity auto log-off of logged clients

5. The BMS system shall support Self-Signed Certificates, Default Certificates and/or Certification Authority (CA) certificates.

6. The BMS client communications (web access or rich client access) shall support TLS 1.2 encryption or higher

7. The BMS shall allow configuration in disabling all devices and software that support HTTP and require access via HTTPS.
8. The BMS must be able to Alarm or generate notification on failed access attempts
9. The BMS Servers shall support SNMP V3 monitoring of network performance and stack statistics for the purpose of managing denial of service attacks
10. The Integrated Control Platform shall support the feature to alarm on a predetermined period of time until the default password for each device is changed from the default factory setting.
11. The Integrated Control Platform shall support encrypted password authentication for all web services whether serving or consuming.
12. The BMS shall have the capability to use blacklisted and whitelisted IPs/MAC addresses to gate access
13. The BMS shall have the capability to differentiate, limit or enable, user access depending on Client's IP address/range (where) and time of day (when) the user is accessing the system.

G. Configuration Interface
1. The workstation software shall use a familiar Windows Explorer style interface for an operator or programmer to view and/or edit any object (controller, point, alarm, report, schedule, etc.) in the entire system. In addition, this interface shall present a "network map" of all controllers and their associated points, programs, graphics, alarms, and reports in an easy to understand structure. All object names shall be alphanumeric and use Windows long filename conventions.
2. The configuration interface shall also include support for user defined object types. These object types shall be used as building blocks for the creation of the BAS database. They shall be created from the base object types within the system input, output, string variables, setpoints, etc., alarm algorithms, alarm notification objects, reports, graphics displays, schedules, and programs. Groups of user defined object types shall be able to be set up as a predefined aggregate of subsystems and systems. The configuration interface shall support copying/pasting and exporting/importing portions of the database for additional efficiency. The system shall also maintain a link to all "child" objects created. If a user wishes to make a change to a parent object, the software shall ask the user if he/she wants to update all of the child objects with the change.

H. Color Graphic Displays
1. The system shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems, or building schematics. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition, operators shall be able to command equipment or change setpoints from a graphic through the use of the mouse.
2. Requirements of the color graphic subsystem include:
   a. At a minimum, the user shall have the ability to import .gif, .png, .bmp, .jpeg, .tif, and CAD generated picture files as background displays, and layering shall be possible.
   b. The system shall support HTML5 enabled graphics.

c. It shall be possible for the user to use JavaScript to customize the behavior of each graphic.

d. The editor shall use Scalable Vector Graphics (SVG) technology.

e. A built-in library of animated objects such as dampers, fans, pumps, buttons, knobs, gauges, ad graphs which can be "dropped" on a graphic through the use of a software configuration "wizard". These objects shall enable operators to interact with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels.

f. Support for high DPI icons shall be included and automatically chosen if viewing on a high definition display such as Retina or 4K displays.

g. Using the mouse, operators shall be able to adjust setpoints, start or stop equipment, modify PID loop parameters, or change schedules.

h. Status changes or alarm conditions must be able to be highlighted by objects changing screen location, size, color, text, blinking or changing from one display to another.

i. Ability to link graphic displays through user defined objects, alarm testing, or the result of a mathematical expression. Operators must be able to change from one graphic to another by selecting an object with a mouse - no menus will be required.

j. It shall be possible to create and save graphical components and JavaScript code in reusable and transferrable, customized libraries.

k. Graphics should rescale based on whatever monitor or viewing device is being used.

l. Be able to create graphics on varying layers that can be moved and repeated.

m. Be able to create graphics within varying window panes that can be moved and/or re-referenced. For example, creating the graphical menu within a pane and referencing it on every graphics page, therefore not rebuilding thus allowing for a single spot for updates that get pushed to all the pages that reference it.

n. The ability to create re-usable cascading menus.

o. The ability to have multiple instances of a graphic and edit one instance to change all.

3. Additionally, the Graphics Editor portion of the Engineering Software shall provide the following capabilities:

a. Create and save pages.

b. Group and ungroup symbols.

c. Modify an existing symbol.

d. Modify an existing graphic page.

e. Rotate and mirror a symbol.

f. Place a symbol on a page.

g. Place analog dynamic data in decimal format on a page.

h. Place binary dynamic data using state descriptors on a page.

i. Create motion through the use of animated .gif files or JavaScript.

j. Place test mode indication on a page.

k. Place manual mode indication on a page.

l. Place links using a fixed symbol or flyover on a page.

m. Links to other graphics.

n. Links to web sites.
o. Links to notes.
p. Links to time schedules.
q. Links to any .exe file on the operator work station.
r. Links to .doc files.
s. Assign a background color.
t. Assign a foreground color.
u. Place alarm indicators on a page.
v. Change symbol/text/value color as a function of an analog variable.
w. Change a symbol/text/value color as a function of a binary state.
x. Change symbol/text/value as a function of a binary state.
y. All symbols used by Schneider Electric EcoBuilding Business in the creation of graphic pages shall be saved to a library file for use by the FAA.

I. The software shall allow for the automatic collection of data and reporting from any controller or NSC. The frequency of data collection shall be user-configurable.

J. Alarm Management

1. The software shall be capable of accepting alarms directly from NSCs or controllers, or generating alarms based on evaluation of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm (regardless of its origination) will be integrated into the overall alarm management system and will appear in all standard alarm reports, be available for operator acknowledgment, and have the option for displaying graphics, or reports.
2. Alarm management features shall include:
   a. A minimum of 1000 alarm notification levels at the NSC, workstation, and webstation levels.
   b. Each notification level will establish a unique set of parameters for controlling alarm display, distribution, acknowledgment, keyboard annunciation, and record keeping.
   c. At the Enterprise level the minimum number of active and viewable alarms shall be 10,000.
   d. It shall be possible for the user to sort, filter and search on any available criteria such as priority, category, origin, alarm type, etc.
   e. An active alarm viewer shall be included which can be customized for each user or user type to a hide or display any alarm attributes.
   f. It shall be possible to present alarms with configurable colors based on priority, category, origin, alarm type, etc.
   g. It shall be possible to linking files/documents/hyperlinks/navigation links/graphics link to an alarm for easy access upon occurrence
   h. Automatic logging in the database of the alarm message, point name, point value, source device, timestamp of alarm, username and time of acknowledgement, username and time of alarm silence (soft acknowledgement).
   i. Alarm notifications must support multiple distribution methods within one notification

j. On alarm, it shall be possible to notify via email to a preconfigured list of recipients. through a Simple Mail Transfer Protocol (SMTP) or secure email using Simple Mail Transfer Protocol Secure (SMTPS). No special software interfaces shall be required and no email client software must be running in order for email to be distributed. The email notification shall be able to be sent to an individual user or a user group.

k. On alarm, it shall be possible to notify via SNMP

l. On alarm, it shall be possible to notify via file (on disk) that would be consumable by other alarm management services

m. An operator shall have the capability to assign an alarm to another user of the system.

n. Individual alarms shall be able to be assigned to a user automatically via a preconfigured list of users and date/time. For example, a critical high temp alarm can be configured to be assigned to a Facilities Dept or to a Central Alarming workstation depending on time/date.

o. Playing an audible sound on alarm initiation or return to normal.

p. It shall be possible assigning a custom audio sound to each alarm / alarm-criteria (priority, category, origin, alarm type, etc.)

q. The active alarm viewer can be configured such that an operator must confirm that all of the steps in a check list have been accomplished prior to acknowledging the alarm.

r. The active alarm viewer shall, if filtered, show the quantity of visible and total number of alarms that are not equal to ‘normal’ and the quantity of disabled and hidden alarms.

s. The alarm viewer can be configured to auto hide alarms when triggered.

t. An operator shall have the capability to save and apply alarm favorites.

u. Alarms shall be configurable such that an operator must type in text in an alarm entry and/or pick from a drop-down list of user actions for certain alarms.

v. Alarms shall be configurable such that an operator must type in text in an alarm entry and/or pick from a drop-down list of causes for certain alarms. This ensures accountability (audit trail) for the response to critical alarms.

w. It shall be possible to configure user-actions via user/group permissions when responding to an alarm

x. All operator actions responding to an alarm must be audit trailed.

K. Static Paginated Reporting / Custom Reporting

1. The BMS Software and Network Servers shall support built-in native reporting capability without dependency on any external software

2. It shall be possible to generate custom reports manually, via Schedule, Alarm triggered or custom conditions (e.g. program/schedule/etc.)

3. The Custom Reporting shall have no dependency on external database

4. The Custom Reporting shall have the capability of reporting on the full range of available data, most recent to historical data.

5. It shall be possible to generate reports containing current active alarms

6. The Building Management System software shall natively be capable of producing custom repots in txt, xlxs and pdf file formats.

7. The Custom Report capability at the BMS software shall support digital signing of pdf for traceability and authenticity.

L. Scheduling

1. From the workstation or webstation, it shall be possible to configure and download schedules for any of the controllers on the network.
2. Time of day schedules shall be in a calendar style and viewable in both a graphical and tabular view.
3. Schedules shall be programmable for a minimum of one year in advance.
4. To change the schedule for a particular day, a user shall simply select the day and make the desired modifications.
5. Additionally, from the operator webstations, each schedule will appear on the screen viewable as the entire year, monthly, week and day. A simple mouse click shall allow switching between views. It shall also be possible to scroll from one month to the next and view or alter any of the schedule times.
6. Schedules will be assigned to specific controllers and stored in their local RAM memory. Any changes made at the workstation will be automatically updated to the corresponding schedule in the controller.
7. It shall be possible to assign a lead schedule such that shadow/local schedules are updated based upon changes in the Lead.
8. It shall be possible to assign a list(s) of exception event days, dates, date ranges to a schedule.
9. It shall be possible to view combined views showing the calendar and all prioritized exemptions on one screen.
10. It should accommodate a minimum of 16 priority levels.
11. Values should be able to be controlled directly from a schedule, without the need for special program logic.

M. Programmer's Environment

1. Programming in the NSC shall be either in graphical block format or line-programming format or both.
2. Programming of the NSC shall be available offline from system prior to deployment into the field. All engineering tasks shall be possible, except, of course, the viewing of live tasks or values.
3. The programmer's environment will include access to a superset of the same programming language supported in the SDCUs.
4. NSC devices will support both script programming language as well as the graphical function block programming language. For both languages, the programmer will be able to configure application software for custom program development, and write global control programs. Both languages will have debugging capabilities in their editors.
5. It shall be possible to save custom programs as libraries for reuse throughout the system. A wizard tool shall be available for loading programs from a library file in the program editor.
6. The system shall be capable of creating ‘custom types’. These types can be created within the programming environment, graphics, or as full controller ‘templates’ that can be pushed to any other variable pertaining to it to allow for singular reference to multiple objects.

This allows easing of updating/changes allowing the use to make a singular change and push to all connected instances.

7. It shall be possible to view graphical programming live and real-time from the Workstation.
8. The system shall be capable of creating 'binding templates' allowing the user to bind multiple points to multiple objects all at once.
9. Key terms should appear when typing (IntelliType).
10. Applications should be able to be assigned different priorities and cycle times for a prioritized execution of different function.
11. The system shall be able to create objects that allow common objects such as power meters, VFD drives, etc. to be integrated into the system with simple import actions without the need of complicated programming or configuration setups.

N. Saving/Reloading

1. The workstation software shall have an application to save and restore NSC and field controller memory files.
2. For the NSC, this application shall not be limited to saving and reloading an entire controller – it must also be able to save/reload individual objects in the controller. This allows off-line debugging of control programs, for example, and then reloading of just the modified information.

O. Audit Trail

1. The workstation software shall automatically log and timestamp every operation that a user performs at a workstation, from logging on and off a workstation to changing a point value, modifying a program, enabling/disabling an object, viewing a graphic display, running a report, modifying a schedule, etc.
2. It shall be possible to view a history of alarms, user actions, and commands for any system object individually or at least the last 5000 records of all events for the entire system from Workstation.
3. The Enterprise server shall be able to store up to 5 million events.
4. The event view shall support viewing of up to 100,000 events.
5. It shall be possible to save custom filtered views of event information that are viewable and configurable in Workstation.
6. It shall be capable to search and view all forced values within the system.

P. Fault Tolerant Enterprise Server Operation (Top level NSC)

1. A single component failure in the system shall not cause the entire system to fail. All system users shall be informed of any detectable component failure via an alarm event. System users shall not be logged off as a result of a system failure or switchover.

Q. Web-based Operator Software

1. General:
    a. Day-to-day operation of the system shall be accessible through a standard web browser interface, allowing technicians and operators to view any part of the system from anywhere on the network.
    b. Through the browser interface, operators must be able to view pre-defined groups of points, with their values updated automatically.

2. Graphic Displays
   a. The browser-based interface must share the same graphical displays as the Administration and Programming Workstations, presenting dynamic data on site layouts, floor plans, and equipment graphics. The browser's graphics shall support commands to change setpoints, enable/disable equipment and start/stop equipment.
   b. Through the browser-based interface, operators must be able to navigate through the entire system, and change the value or status of any point in any controller. Changes are effective immediately to the controller, with a record of the change stored in the system database.
   c. System shall have out-of-the-box dashboards that enable customizable views of live data which can be public to all users or capable to make them specific to a user based on log in credentials.
   d. The user shall have the ability to create custom dashboards.
3. Alarm Management
   a. Systems requiring additional client software to be installed on a PC for viewing the webstation from that PC will not be considered.
   b. Through the browser interface, a live alarm viewer identical to the alarm viewer on the Administration and Programming workstation shall be presented, if the user's password allows it. Users must be able to receive alarms, silence alarms, and acknowledge alarms through a browser. If desired, specific operator text must be able to be added to the alarm record before acknowledgement, attachments shall be viewable, and alarm checklists shall be available.

R. Groups and Schedules
1. Through the browser interface, operators must be able to view pre-defined groups of points, with their values updated automatically.
2. Through the browser interface, operators must be able to change schedules – change start and stop times, add new times to a schedule, and modify calendars.

S. User Accounts and Audit Trail
1. The same user accounts shall be used for the browser interface and for the operator workstations. Operators must not be forced to memorize multiple passwords.
2. All commands and user activity through the browser interface shall be recorded in the system's activity log, which can be later searched and retrieved by user, date, or both.

T. Web Services
1. The installed system shall be able to use web services to "consume" information within the Network Server/Controllers (NSCs) with other products and systems. Inability to perform web services within the NSCs will be unacceptable.
   a. Shall be able to "consume" data into the system via SOAP and REST web services

2.4 NETWORK SERVER CONTROLLERS (NSC)

A. Network Server Controllers shall combine both network routing functions, control functions, and server functions into a single unit.

B. The BACnet NSC shall be classified as a "native" BACnet device, supporting the BACnet Network Server Controller (B-BC) profile. Controllers that support a lesser profile such as B-SA are not acceptable. NSCs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Network Server Controllers (B-BC).

C. The Network Server Controller shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NRS.

D. The NSCs shall be capable of whitelisting IPs to restrict access to a pre-defined list of hosts or devices.

E. Whitelisting of file extensions for documents shall be capable.

F. Encrypted and authenticated communication shall be configurable for non-open protocol communications using TLS 1.2.

G. The NSCs shall support Simple Network Management Protocol version 3 (SNMPv3) for monitoring of the NSCs using a Network Management Tool.

H. The NSCs shall support remote system logging for used by System Information and Event Monitoring (SIEM) software.

I. They shall also be responsible for monitoring and controlling their own HVAC equipment such as an AHU or boiler.

J. They shall also contain graphics, trends, trend charts, alarm views, and other similar presentation objects that can be served to workstations or web-based interfaces. A sufficient number of NSCs shall be supplied to fully meet the requirements of this specification and the attached point list.

K. It shall be capable of executing application control programs to provide:
   1. Calendar functions
   2. Scheduling
   3. Trending
   4. Alarm monitoring and routing
   5. Time synchronization by means of an Internet site including automatic synchronization
   6. Native integration of LonWorks controller data and Modbus controller data or BACnet controller data and Modbus controller data
   7. Network Management functions for all LonWorks based devices

L. Hardware Specifications
   1. Memory:
      a. The operating system of the controller, application programs, and all other portions of the configuration database, shall be stored in non-volatile, FLASH memory. Servers/Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory.
   2. Each NRC shall provide the following on-board hardware for communication:

a. Two 10/100b Ethernet for communication to Workstations, other NRCs, IP field bus controllers, other SDCUs, and onto the internet.
   1) The two Ethernet ports shall support active switch and BACnet/IP communication protocols.
   2) Support IPv4 addressing
   3) Ethernet port 1 shall support static or DHCP client configuration for communication to Workstation or other NSCs
   4) Ethernet port 2 shall support switch mode or DHCP server to set addressing of DHCP client devices
   5) It shall be possible to disable Ethernet port 2
   6) In DHCP server mode, the Ethernet port 2 shall support 50 BACnet/IP field controllers in daisy chain configuration directly from the port
   7) Each NSC shall be able to support a total of 250 IP SDCUs in daisy chain configuration (5 sub networks via switch)
   8) If using RSTP (Rapid Spanning Tree Protocol) with a managed switch (with IEEE 802.1W or IEEE 802.1Q-2014 support), Ethernet port 2 shall support up to 39 devices
   9) Each NSC shall be able to support a total of 234 IP SDCUs in RSTP configuration (6 sub networks via managed switch)
   10) Where a switch is needed, use a Cisco 9000 Catalyst or IE switch, EtherWAN EX63402-01B, or other equal and approved equivalent.

b. Two RS-485 ports for communication to BACnet MSTP bus or serial Modbus (software configurable)

c. One TP/FT port for communication to LonWorks devices.

d. One device USB port

e. One host USB port

3. The NSC shall conform to a small footprint no larger than 100W x 125H x 75D mm (3.94W x 4.92H x 2.95D in).

M. Modular Expandability:

1. The system shall employ a modular I/O design to allow expansion. Input and output capacity is to be provided through plug-in modules of various types. It shall be possible to combine I/O modules as desired to meet the I/O requirements for individual control applications.
2. One shall be able to “hot-change” (hot-swap) the I/O modules preserving the system on-line without any intervention on the software; addressing and configuration shall be automatic.
3. If for any reason the backplane of the modular I/O system were to fail, I/O module addresses will be protected.

N. Hardware Override Switches:

1. All digital outputs shall, optionally, include three position manual override switches to allow selection of the ON, OFF, or AUTO output state. These switches shall be built into the unit and shall provide feedback to the controller so that the position of the override switch can be obtained through software. In addition each analog output shall be equipped with an override potentiometer to allow manual adjustment of the analog output signal over its full range, when the 3 position manual override switch is placed in the ON position.

O. Universal Input Temperatures
   1. All universal inputs directly connected to the NSC via modular expansion shall be capable of using the following thermistors for use in the system without any external converters needed.
      a. 10 kohm Type I (Continuum)
      b. 10 kohm Type II (I/NET)
      c. 10 kohm Type III (Satchwell)
      d. 10 kohm Type IV (FD)
      e. Linearized 10 kohm Type V (FD w/11k shunt)
      f. Linearized 10 kohm (Satchwell)
      g. 1.8 kohm (Xenta)
      h. 1 kohm (Balco)
      i. 20 kohm (Honeywell)
      j. 2.2 kohm (Johnson)
   2. In addition to the above, the system shall be capable of using the below RTD sensors, however it is not required that all universal inputs be compatible with them.
      a. PT100 (Siemens)
      b. PT1000 (Sauter)
      c. Ni1000 (Danfoss)

P. Local Status Indicator Lamps:
   1. The NSC shall provide as a minimum LED indication of CPU status, Ethernet LAN status, and field bus status. For each input or output, provide LED indication of the value of the point (On/Off). The LED indication shall support software configuration to set whether the illumination of the LED corresponds to On or Off or whether the color when illuminated is Red or Green.

Q. Real Time Clock (RTC):
   1. Each NSC shall include a real time clock, accurate to 10 seconds per day. The RTC shall provide the following: time of day, day, month, year, and day of week. Each NSC will allow for its own UTC offset, depending upon the time zone. When the time zone is set, the NSC will also store the appropriate times for daylight savings time.
   2. The RTC date and time shall also be accurate, up to 10 days, when the NSC is powerless.
   3. No batteries may be used to for the backup of the RTC.

R. Power Supply:
   1. The 24 VDC power supply for the NSCs shall provide 30 watts of available power for the NSC and associated IO modules. The system shall support the use of more than one power supply if heavily power consuming modules are required.
   2. The power supply, NSC, and I/O modules shall connect power wise and communication wise via the separate terminal base allowing for ease of replacement and no separate or loose wiring.

S. Automatic Restart After Power Failure:

1. Upon restoration of power after an outage, the NSC shall automatically and without human intervention update all monitored functions, resume operation based on current, synchronize time and status, and implement special start-up strategies as required.

T. Data Retention:

1. During a power failure, the NSC shall retain all programs, configuration data, historical data, and all other data that is configured to be retained. There shall be no time restriction for this retention and it must not use batteries to achieve it.

U. Software Specifications

1. The operating system of the controller, application programs, and all other portions of the configuration database such as graphics, trends, alarms, views, etc., shall be stored in non-volatile, FLASH memory. There will be no restrictions placed on the type of application programs in the system. Each NSC shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.
2. Each NSC shall have an available capacity of 4 GB of memory. This shall represent 2 GB for application and historical data and 2 GB dedicated for backup storage.

V. User Programming Language:

1. The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be either a script-based structured text or graphical function block based and fully programmable by the user. The language shall be structured to allow for the configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, and histories. Users shall be able to place comments anywhere in the body of either script or function block programs.
2. Network Server Controllers that use a “canned” program method will not be accepted.

W. Control Software:

1. The NSC shall have the ability to perform the following pre-tested control algorithms:
   a. Proportional, Integral plus Derivative Control (PID)
   b. Two Position Control
   c. Digital Filter
   d. Ratio Calculator
   e. Equipment Cycling Protection

X. Mathematical Functions:

1. Each controller shall be capable of performing basic mathematical functions (+, -, *, /), squares, square roots, exponential, logarithms, Boolean logic statements, or combinations of both. The controllers shall be capable of performing complex logical statements including operators such as >, <, =, and, or, exclusive or, etc. These must be able to be used in the same equations with the mathematical operators and nested up to five parentheses deep.

Y. NSCs shall have the ability to perform any or all of the following energy management routines:

1. Time of Day Scheduling
2. Calendar Based Scheduling
3. Holiday Scheduling
4. Temporary Schedule Overrides
5. Optimal Start
6. Optimal Stop
7. Night Setback Control
8. Enthalpy Switchover (Economizer)
9. Peak Demand Limiting
10. Temperature Compensated Duty Cycling
11. CFM Tracking
12. Heating/Cooling Interlock
13. Hot/Cold Deck Reset
14. Hot Water Reset
15. Chilled Water Reset
16. Condenser Water Reset
17. Chiller Sequencing

Z. History Logging:

1. Each NSC controller shall be capable of LOCALLY logging any input, output, calculated value or other system variable either over user defined time intervals ranging from 1 second to 1440 minutes or based upon a user configurable change of value. A minimum of 1000 logs, with a minimum of 100,000 records, shall be stored. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to a higher level NSC long term archiving based upon user-defined time intervals, or manual command.
2. For extended trend logging a minimum of 1500 trends shall be capable, with a minimum number of 600,000 records within.
3. Management of a power meter replacement to ensure meter log data is accurate shall be possible in the NSC.
4. Every hardware input and output point, hosted within the NSC and attached I/O modules, shall be trended automatically without the requirement for manual creation, and each of these logs shall log values based upon a change of value and store at least 500 trend samples before replacing the oldest sample with new data.
5. The presentation of logged data shall be built into the server capabilities of the NSC. Presentation can be in time stamped list formats or in a chart format with fully configurable pen colors, weights, scales and time spans.
6. Tooltips shall be present, magnetic, and visible based on users preference.
7. Comments shall be visible whenever viewing the trend log list.
8. System shall give indication of memory usage and be able to alert the user if too many logs are allocated.
9. The BMS software and Network Servers shall support recording of all historical data, independent of any limitation in its local memory, which will be readily available for reporting and analysis without additional configurations or actions.

10. All historical data shall be available for use by the operator to access in BMS or a third-party reporting systems.

AA. Alarm Management:

1. For each system point, alarms can be created based on high/low limits or in comparison to other point values. All alarms will be tested each scan of the NSC and can result in the display of one or more alarm messages or reports.
2. There is no limit to the number of alarms that can be created for any point
3. Alarms can be configured to be generated based upon a single system condition or multiple system conditions.
4. Alarms will be generated based on an evaluation of the alarm conditions and can be presented to the user in a fully configurable order, by priority, by time, by category, etc. These configurable alarm views will be presented to a user upon logging into the system regardless of whether the log in takes place at a WorkStation or a Webstation.
5. The alarm management system shall support the ability to create and select cause and action notes to be selected and associated with an alarm event. Checklists shall also be possible in order to present to an operator a suggested mode of troubleshooting. When acknowledging an alarm, it shall be possible to assign it to a user of the system such that the user is notified of the assignment and is made responsible for the alarm resolution.
6. Alarms must be capable of being routed to any BACnet workstation that conforms to the B-OWS device profile and uses the BACnet/IP protocol.

BB. Embedded Web Server

1. Each NSC must have the ability to serve out web pages containing the same information that is available from the WorkStation. The development of the screens to accomplish shall not require any additional engineering labor over that required to show them at the WorkStation itself.
2. The NSC shall be configurable to logging all Embedded Web Server access attempts
3. The NSC shall have the option to redirect HTTP based Embedded Web Server connections to secure, HTTPS connections.
4. The NSC shall authenticate and authorize all users connecting to the Embedded Web Server
5. The NSC shall provide to ability to configure an automatic logoff for Embedded Web Server users that have not had any activity for an adjustable time period.

CC. The NSC controller shall comply with the following regulatory certifications

1. CE – EN 61000-6-3
2. CE – EN 61000-6-2
3. CE – EN 61010-1
4. CE – EN 61326-1
5. FCC CFR 47 Part 15 Class A
6. RCM
7. RoHS 2011/65/EU
8. China RoHS SJ/T 11364-2014

9. UL916 Energy Management equipment

DD. Zoning (software defined zoning)

1. It shall be possible for BMS software and Network Servers (NSCs) to support synchronized control of lights, blinds and HVAC across multiple floorplan scenarios.
2. It shall be possible to create multiple synchronized control scenarios of lights/blinds/HVAC based to accommodate different floor plan scenarios.
3. It shall be possible to change synchronized control of lights/blinds/HVAC from one floorplan scenario to another manually or automatically.
4. It shall be possible to adapt synchronized controls of lights, blinds and HVAC to a different floorplan scenario using any device running a standard web browser.
5. It shall be possible for the administrator to manage user and group permissions to view / re-configure floor plan scenarios.

2.5 BACNET IP FIELDBUS CONTROLLERS (MP-C, MP-V, RP-C)

A. Controllers – BACnet/IP Protocol

1. All BACnet/IP Fieldbus controllers shall be BACnet Testing Laboratory listed (v12 or later) as specified BACnet Advanced Application Controller (B-AAC)
2. All BACnet/IP Fieldbus controllers shall use the following communication specifications and achieve performance as specified herein:
   a. All controllers shall be able to communicate peer-to-peer without the need for a NSC
   b. Any BACnet/IP Fieldbus controllers 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 on the same communication cabling. Slave controllers are not acceptable.

B. The BACnet/IP Fieldbus controllers shall be equipped with 2x 10/100bT Ethernet communication ports with active switch and will support BACnet/IP communication protocols with the following configurations:

1. Supporting IPv4 addressing
2. Supporting Static IP setting, DHCP client and Auto-IP address acquisition
3. It shall be possible to disable Ethernet port 2

C. Topologies

1. BACnet/IP Fieldbus Controllers shall support RSTP loop whereby up to 39 controllers are supported.
   a. In case of any disruption there shall be no communication interruption
   b. In case of any disruption there shall be system alarms that will inform the operator of the disruption

D. Performance

1. Each BACnet/IP Fieldbus Controllers shall have a 32-bit microprocessor operating at 500 MHz and support a BACnet protocol stack in accordance with the ANSI/ASHRAE Standard 135-2008 and the BACnet Device Profile supported.

2. They shall be multi-tasking, real-time digital control processors consisting of communication controllers, controls processing, power supplies with built-in inputs and outputs.

E. Programmability

1. The BACnet/IP Fieldbus controllers shall support both script programming language and functional block that will be consistent with the NSC.
2. The control program will reside within the same enclosure as the input/output circuitry, that reads inputs and controls outputs
3. All control sequences programmed into the BACnet/IP Fieldbus Controllers shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.
4. BACnet/IP Fieldbus controllers shall communicate with the Network Server Controller (NSC) via a BACnet/IP connection at a baud rate of not less than 100 Mbps
5. BACnet/IP Fieldbus controllers shall support a dedicated communications port for connecting and supplying power to a matching room temperature and/or humidity sensor and/or CO2 and/or presence detector that does not utilize any of the I/O points of the controller.
6. BACnet/IP Fieldbus controllers (Excluding VAV) shall support an add-on display to supply and provide access in real-time for monitoring inputs and overriding of outputs
7. The override functionality must be supported by a dedicated processor to assure reliable operation (overriding of output)
8. Each BACnet/IP Fieldbus controller shall have sufficient memory, to support its own operating system and databases, including:
    a. Control processes
    b. Energy management applications
    c. Alarm management
    d. Historical/trend data
    e. Maintenance support applications
    f. Custom processes
    g. Manal override monitoring
9. Each BACnet/IP Fieldbus controller shall support local trend data up to 2x the built-in I/O and at a minimum be capable of holding 5 days @ 15 min intervals locally.
10. The BACnet/IP Fieldbus controller analog or universal input shall use a 16 bit A/D converter.
11. The BACnet/IP Fieldbus controller analog or universal output shall use a 10 bit D/A converter.
12. Built-in I/O: each BACnet/IP Fieldbus controllers shall support:
    a. At minimum 8 and up to 20 configurable IO channels to monitor and to control the following types of inputs and outputs without the addition of equipment inside or outside the DDC Controller cabinet.
        1) Universal Inputs – the following thermistors for use in the system without any external converters needed.
            a) 10 kohm Type I (Continuum)
            b) 10 kohm Type II (I/NET)
            c) 10 kohm Type III (Satchwell)

d) 10 kohm Type IV (FD)
e) Linearized 10 kohm Type V (FD w/11k shunt)
f) Linearized 10 kohm (Satchwell)
g) 1.8 kohm (Xenta)
h) 1 kohm (Balco)
i) 20 kohm (Honeywell)
j) 2.2 kohm (Johnson)
k) PT100 (Siemens)
l) PT1000 (Sauter)
m) Ni1000 (Danfoss)

2) Analog inputs
   a) Current Input - 0-20 mA
   b) Voltage Input 0-10 Vdc
3) Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
4) Digital outputs
5) Analog outputs of 4-20 mA and/or 0-10 Vdc

13. Real Time Clock (RTC):
    a. Provide internal clocks for all BACnet Controllers (B-AAC) using BACnet time synchronization services.
       1) Automatically synchronize system clocks daily from an operator-designated controller.
       2) The system shall automatically adjust for daylight saving time.
    b. Each BACnet/IP Fieldbus controller shall include a real time clock, accurate to +/-1 minute per month.
    c. The RTC shall provide the following: time of day, day, month, year, and day of week.
    d. The RTC date and time shall also be accurate up to 7 days, from when the BACnet/IP Fieldbus controller has lost power with no reliance on.
14. The BACnet/IP Fieldbus controller for Variable Air Volume (VAV) applications(MP-V)
    a. The BACnet/IP Fieldbus controller for VAV applications shall include a built-in ‘flow thru’ differential pressure transducer
    b. The VAV differential pressure transducer shall have a measurement range of 0 to 1 in. W.C. and measurement accuracy of ±5% at 0.001 to 1 in. W.C. and a minimum resolution of 0.001 in. W.C., insuring primary air flow conditions shall be controlled and maintained to within ±5% of setpoint at the specified minimum and maximum air flow parameters
    c. The BACnet/IP FieldBus controller for VAV applications shall support a dedicated commissioning tool for air flow balancing
    d. The BACnet/IP Fieldbus controller for VAV applications shall require no programing for air balancing algorithm
    e. All balancing parameters shall be synchronized in NSC
15. Each BACnet/IP Fieldbus controller shall have a minimum of 10% spare capacity for each point type represented on the controller for future point connection
16. Power Requirements. 24VDC (21 to 33 VDC) and 24 VAC +/-20% with local transformer power

17. Each BACnet/IP Fieldbus controller shall be accredited for smoke control and smoke management within a fully IP control solution

18. The BACnet/IP Fieldbus controller shall comply with the following regulatory certifications

    a. CE - EMCD 2014/30/EU

    b. CE LVD 2014/35/EU

    c. FCC CFR 47 Part 15 Class B

    d. RCM

    e. RoHS 2011/65/EU

    f. China RoHS SJ/T 11364-2014

    g. UL2043 (Plenum space mounting)

    h. UL916 Open-Energy Management equipment

    i. UL916 Energy Management equipment

19. Intelligent Space Sensor Interface –

    a. The BACnet/IP Fieldbus controllers shall support a dedicated RJ45 communication port to communicate and power up to 4 intelligent wall mount sensors without the use of on-board inputs or outputs

    b. It shall be possible to disable the RJ45 communication port.

20. Integrations - Connected Room (RP-C)

    a. The controller shall be capable of controlling lighting fixtures thru various open protocols listed below. this shall be achieved thru on-board I/O on the controller or via expansion modules (of the BACnet/IP controller) and will be capable of supporting the following:

        1) The DALI expansion module shall be certified and capable of full DALI2 control for individual and groups of lights (up to 32 ballasts or LED drivers and a maximum of 16 groups).

        2) During zero light output it shall be possible to fully shut down the ballasts thereby minimizing any leakage current.

        3) The controller / expansion module shall be certified for multi-master functionality thereby allowing DALI pushbuttons sensors and dimmers to be mounted on the DALI communication bus.

        4) The DALI expansion module shall be rated to 10A in total (Max 5A per channel)

        5) The DALI expansion module shall support DALI version-1 control gear

        6) The DALI expansion module shall support DALI-1 version control gear.

        7) The DALI expansion module shall support Discharge lamps

        8) The DALI expansion module shall support LED

        9) The DALI expansion module shall support color control (Device type 8)

        10) The DALI expansion module shall support feedback from control gear (including lamp failure feedback)

11) The DALI expansion module shall support addressing and grouping of control gear.

12) The 0-10V expansion modules shall be capable of on/off/dim of light using 0-10V dimming signal.

13) During zero light output it shall be possible to fully shut down the ballasts thereby minimizing any leakage current.

14) It shall be possible to interface and control lighting that are dimmed using Phase cut dimming the controller/interface shall be capable of automatically detecting the appropriate leading or trailing edge control mechanism that may be needed depending on the type of load.

b. The controller shall be capable of controlling blinds and shades thru various open protocols listed below. this shall be achieved thru on-board I/O on the controller or via expansion modules (of the BACnet/IP controller) and will be capable of supporting the following:

1) The controller/ expansion modules shall be capable of interfacing with and controlling blind motors that uses low voltage Standard Motor Interface (SMI) communication.

2) The controller/ expansion modules shall be capable of interfacing with and controlling blind motors that use high voltage SMI communication.

3) The controller/ expansion modules shall be capable of interfacing with and controlling blind motors using low voltage (24V) relays.

4) The controller/ expansion modules shall be capable of interfacing with and controlling blind motors using line voltage relays.

c. It shall be possible for the controller to interface with third party Modbus devices sensors, pushbuttons and glass touch panels

d. It shall be possible for the controller to interface with KNX sensors and push button devices

e. It shall be possible for the controller to communicate to wireless devices such as sensors, power meters, and wireless lighting control gateways via Zigbee 3.0.

1) Controllers using earlier Zigbee standards shall not be acceptable.

f. It shall be possible to rezone and partition spaces using a graphical software, that works using floor plan maps and allows the user to create zones by positioning HVAC equipment, lights, blinds and sensors directly on the map. It shall then be possible to assign them to zones

g. It shall be possible to connect to four advanced sensors with capability for sensing occupancy and light levels. The sensor shall be powered by the controller and will not require batteries for operation.

h. It shall be possible to control lights/ blinds and HVAC functions such as fan speed and temperature via an optional remote control that can be located anywhere conveniently within the room or mounted on the wall and communicates to the controller securely via blue-tooth

i. It shall be possible for the controller to measure the power consumed by the different devices connected to the controller such as lighting HVAC and blinds

j. Lighting Control Interfaces

1) Mobile Based Personal Control Interface - an integrated mobile application shall provide current status of the light and blind in the room and enable each room occupant with the ability to:
2) Dim, brighten lights and turn them on and off
3) And for blinds: tilt, vertical up or down
4) Ability to select scenes
5) Control HVAC

k. The Connected Room Solution will be fully programmable capable of supporting different control strategies locally.

l. Standard applications shall be available for download from a central repository, which will allow common configurations such as those listed below to be easily configured.
1) Occupied state
2) Unoccupied state
3) Load Shed Mode
4) Daylight Harvesting
5) Time Clock Scheduling

m. The integration modules shall comply with the following regulatory certifications
1) CE - EMCD 2014/30/EU
2) CE LVD 2014/35/EU
3) FCC CFR 47 Part 15 Class B
4) RCM
5) RoHS 2011/65/EU
6) China RoHS SJ/T 11364-2014
7) UL2043 (Plenum space mounting)
8) UL916 Energy Management

21. The BACnet/IP Fieldbus controller for remote IO

a. It shall be possible to extend Inputs / Outputs required in NSC or BACnet/IP Fieldbus Controllers over the IP network

b. The BACnet/IP IO expansion device shall be equipped with 2x 10/100bT Ethernet communication ports with active switch supporting the following configurations:
1) Supporting IPv4 addressing
2) Supporting Static IP setting, DHCP client and Auto-IP address acquisition
3) It shall be possible to disable Ethernet port 2

c. The BACnet/IP IO expansion device shall support daisy and RSTP topologies

d. The BACnet/IP I/O expansion device shall be capable of sharing its local I/O resources with one or multiple applications distributed across one or multiple NSCs or BACnet/IP Fieldbus Controllers.

e. The BACnet/IP I/O expansion device shall support BACnet Alarm and Trend locally

f. Outputs of the BACnet/IP I/O expansion device shall support user configurable fallback value that is triggered in case of communication disruption.

F. Commissioning Tool - The BACnet/IP Fieldbus controllers shall be supported via a dedicate mobile based commissioning tool for configuration, programming, air balancing and I/O checkout:

1. The Commissioning Tool shall be supported across: iOS, Android and Windows 10 platforms
2. The Commissioning Tool shall be available for download on App Store, Google Store and Windows Store
3. Commissioning Tool Interface to BACnet/IP Fieldbus controllers shall be via Bluetooth or via a Wi-Fi access point on the LAN
4. Functionality
    a. Device Configuration – the Commissioning Tool shall be able to set or edit all Network configurations associated with the BACnet/IP Fieldbus controller
    b. Programming – The Commissioning Tool shall be able to load offline engineered applications directly in to the controller directly
    c. Air Balancing
        1) The Commissioning Tool shall allow the air balancer to manually control the action of the actuator including the following function: open VAV damper, close VAV damper, open all VAV dampers, and close all VAV dampers.
        2) The Commissioning Tool shall be able to generate Air Balancing report
5. IO Checkout
    a. The Commissioning Tool shall be able to support overriding of the outputs and reading value of inputs live that includes light and blind points and their configuration
    b. The Commissioning Tool shall be able to support generation of I/O checkout report
6. There shall be no limit to the number of Commissioning Tools that can be used on a network segment.

G. Intelligent Space Sensors - The BACnet/IP Fieldbus controller shall support a dedicated RJ45 communication port to communicate and power up to 4 intelligent wall mount sensors without the use of on board inputs or outputs

1. The Intelligent Space Sensor shall communicate with the BACnet/IP Fieldbus controller through the sensor port and via category 5 or category 6 cable
2. The Intelligent Space Sensor shall provide 2 RJ45 communication ports that will allow communication with parent BACnet/IP Field controller upstream and additional Intelligent Space Sensors downstream
3. The Intelligent Space Sensor shall provide ambient space condition sensing without the use of hardware I/O

H. Each Intelligent Space Sensor shall provide a color touch display with:

1. Minimum 61 mm (2.4”) by 61 mm (2.4”) display
2. Backlit

I. The Intelligent Space Sensor shall be capable of displaying measured space temperature from 0 to 50 °C (32 to 122 °F) with accuracy of ±0.2 °C (±0.4 °F) selectable for 0.1 or 1 degree display resolution of °F or °C

1. Sensing Element: 10k Type 3 Thermistor
2. Accuracy of ±0.2 °C (±0.4 °F)
3. Resolution: 0.1 or 1 degree display resolution
4. Range: 0 to 50 °C (32 to 122 °F)

J. The Intelligent Space Sensor shall have the option for humidity sensor support sensing humidity from 0 % RH to 100 % RH Digital humidity indication (selectable for 0.1 or 1% RH with selectable display resolution of 0.1 or 1 % RH

1. Accuracy: ±2 % RH
2. Resolution: 0.1 or 1 % RH
3. Range: 0 % RH to 100 % RH

K. The Intelligent Space Sensor shall have the option for support of CO2 sensor with display resolution with 0 to 2000 ppm resolution

1. Accuracy: ±30 ppm ±2% of measured value
2. Range: 0 to 2,000 ppm
3. Operating elevation: 0 to 16,000 ft.
4. Temperature dependence: 0.11% FS per ˚F
5. Stability: <2% of FS over life of sensor (15 years)
6. Sensing method: Non-dispersive infrared (NDIR), diffusion sampling

L. The Intelligent Space Sensor shall have the option for motion sensor

M. Display options: The Intelligent Space Sensor shall be capable of displaying the following elements:

1. Space temperature
2. Cooling space temperature set point
3. Heating space temperature set point
4. Current heating or cooling mode
5. Current occupancy mode
6. Fan speed
7. Current time
8. Light control
9. Blind adjustment
10. Scene selection

2.6 BACNET FIELDBUS AND BACNET SDCUS

A. Networking

1. IP Network: All devices that connect to the WAN shall be capable of operating at 10 megabits per second or 100 megabits per second.
2. IP To Field Bus Routing Devices

a. A Network Server Controller shall be used to provide this functionality.

b. These devices shall be configurable locally with IP crossover cable and configurable via the IP network.

c. The routing configuration shall be such that only data packets from the field bus devices that need to travel over the IP level of the architecture are forwarded.

B. Field Bus Wiring and Termination

1. The wiring of components shall use a bus or daisy chain concept with no tees, stubs, or free topology.

2. Each field bus shall have a termination resistor at both ends of each segment.

3. The field bus shall support the use of wireless communications.

C. Repeaters

1. Repeaters are required to connect two segments.

2. Repeaters shall be installed in an enclosure. The enclosure may be in an interstitial space.

D. Field Bus Devices

1. General Requirements

a. Devices shall have a light indicating that they are powered.

b. Devices shall be locally powered. Link powered devices (power is furnished from a central source over the field bus cable) are not acceptable.

c. Application programs shall be stored in a manner such that a loss of power does not result in a loss of the application program or configuration parameter settings. (Battery backup, flash memory, etc.)

E. Advance Application Controllers (B-AAC)

1. The key characteristics of a B-AAC are:

a. They have physical input and output circuits for the connection of analog input devices, binary input devices, pulse input devices, analog output devices, and binary output devices. The number and type of input and output devices supported will vary by model.

b. They may or may not provide support for additional input and output devices beyond the number of circuits that are provided on the basic circuit board. Support for additional I/O shall be provided by additional circuit boards that physically connect to the basic controller.

c. The application to be executed by a B-AAC is created by an application engineer using the vendor’s application programming tool.

d. If local time schedules are embedded, the B-AAC shall support the editing of time schedule entries from any BACnet OWS that supports the BACnet service for writing of time schedule parameters.

e. If local trend logging is embedded, the B-AAC shall support the exporting of trend log data to any BACnet OWS that supports the read range BACnet service for trending.

f. If local alarm message initiation is embedded, the B-AAC shall:

1) Deliver alarm messages to any BACnet OWS that supports the BACnet service for receiving alarm messages and is configured to be a recipient off the alarm message.
2) Support alarm acknowledgement from any BACnet OWS that supports the BACnet service for executing alarm/event acknowledgement,

g. Shall support the reading of analog and binary data from any BACnet OWS or Building Controller that supports the BACnet service for the reading of data.

h. Shall support the control of the out of service property and assignment of value or state to analog and binary objects from any BACnet OWS that supports writing to the out of service property and the value property of analog and binary objects.

i. Shall support the receipt and response to Time Synchronization commands from a BACnet Building Controller.

j. Shall support the "Who is" and "I am." BACnet services.

k. Shall support the "Who has" and "I have." BACnet services.

2. Analog Input Circuits

a. The resolution of the A/D chip shall not be greater than 0.01 Volts per increment. For an A/D converter that has a measurement range of 0 to 10 VDC and is 10 bit, the resolution is 10/1024 or 0.00976 Volts per increment.

b. For non-flow sensors, the control logic shall provide support for the use of a calibration offset such that the raw measured value is added to the (+/-) offset to create a calibration value to be used by the control logic and reported to the Operator Workstation (OWS).

c. For flow sensors, the control logic shall provide support for the use of an adjustable gain and an adjustable offset such that a two point calibration concept can be executed (both a low range value and a high range value are adjusted to match values determined by a calibration instrument).

d. For non-linear sensors such as thermistors and flow sensors the B-AAC shall provide software support for the linearization of the input signal.

3. Binary Input Circuits

a. Dry contact sensors shall wire to the controller with two wires.

b. An external power supply in the sensor circuit shall not be required.

4. Pulse Input Circuits

a. Pulse input sensors shall wire to the controller with two wires.

b. An external power supply in the sensor circuit shall not be required.

c. The pulse input circuit shall be able to process up to 20 pulses per second.

5. True Analog Output Circuits

a. The logical commands shall be processed by a digital to analog (D/A) converter chip. The 0% to 100% control signal shall be scalable to the full output range which shall be either 0 to 10 VDC, 4 to 20 milliamps or 0 to 20 milliamps or to ranges within the full output range (Example: 0 to 100% creates 3 to 6 VDC where the full output range is 0 to 10 VDC).

b. The resolution of the D/A chip shall not be greater than 0.04 Volts per increment or 0.08 milliamps per increment.

6. Binary Output Circuits

a. Single pole, single throw or single pole, double throw relays with support for up to 230 VAC and a maximum current of 2 amps.

b. Voltage sourcing or externally powered triacs with support for up to 30 VAC and 0.5 amps at 24 VAC.

7. Program Execution

a. Process control loops shall operate in parallel and not in sequence unless specifically required to operate in sequence by the sequence of control.

b. The sample rate for a process control loop shall be adjustable and shall support a minimum sample rate of 1 second.

c. The sample rate for process variables shall be adjustable and shall support a minimum sample rate of 1 second.

d. The sample rate for algorithm updates shall be adjustable and shall support a minimum sample rate of 1 second.

e. The application shall have the ability to determine if a power cycle to the controller has occurred and the application programmer shall be able to use the indication of a power cycle to modify the sequence of controller immediately following a power cycle.

8. Local Interface

a. The controller shall support the connection of a portable interface device such as a laptop computer or vendor unique hand-held device. The ability to execute any tasks other than viewing data shall be password protected. Via this local interface, an operator shall be able to:

1) Adjust application parameters.
2) Execute manual control of input and output points.
3) View dynamic data.

F. Application Specific Devices

1. Application specific devices shall have fixed function configurable applications.
2. If the application can be altered by the vendor's application programmable tool, the device is an advanced application controller and not an application specific device.
3. Application specific devices shall be BTL certified.

2.7 FIBER OPTIC CABLE

A. shall meet the following requirements (Known acceptable source: PDPK006EB3010/25 manufactured by Berk-Teck);

a. Riser distribution cable, interlocking aluminum armored riser jacket

1) Construction Type: Armored, Gel Free.
2) Cable Type: Tight Buffered
3) Jacket: Plenum rated, color aqua
4) Fiber Type Solution: OM3 Multimode Fiber (G.652.D, G.657.A1)
5) Fiber Count: 6
6) Armor Type: Interlocking Aluminum
7) Fire Rating: Riser
8) Qualification Standards: ANSI/ICEA S-83-596

9) Regulatory Compliance: RoHS 2011/65/EU

b. Cable shall have a minimum of 6 fibers and have outer BX or inner duct protection..

c. Only glass fiber is acceptable, no plastic.

2.8 SURGE PROTECTION DEVICES

A. Control wiring (Known acceptable source: DTK-2LVLPLV manufactured by Ditek).

1. Metal Oxide Varistor (MOV)
2. Self-restoring after each surge within ratings.
3. Let through voltage rating: 38 VRMS
4. Response Time: <5 ns
5. Surge Current: 2000 amps/pair
6. Energy dissipation: 17 joules/pair
7. Safety Approvals: UL 497B
8. The ground shall be tied to the high energy ground system when available and provided by division 26.

B. Ethernet (CAT 5e/ CAT 6) (Known acceptable source: UPS-PNET1GB manufactured by APC.

1. Let through voltage rating: < 60v
2. Data line Protection: RJ45 10/100/1000 Base-T Ethernet Protection
3. Date lines Protected: 1-8
4. Safety Approvals: UL 497B

C. Power feed shall have surge protection (Known acceptable source: DTK-120HW manufactured by Ditek).

1. Metal Oxide Varistor (MOV)
2. Self-restoring after each surge within ratings.
3. Clamping level: 130 VRMS/ 185V peak
4. Response Time: <5 ns
5. Surger Current: 19,500 amps
6. Energy dissipation: 255 joules
7. Agency Approvals: UL 1449, IEEE C62.41B

D. Control Panel UPS (known acceptable source: SUA500PDR-S manufactured by APC) Note: A UPS is not required when one of the power sources is critical power.

1. Nominal Input Voltage: 120V
2. Input Connections: Hardwired Input (3-Wire: H-N-G)
3. Nominal Output Capacity: 500 VA/ 325 W
4. Nominal Output Voltage 120V

5. Output Connections: Hardwired Output (3-Wire; H-N-G)
6. Surge Energy Rating: 540 Joules
7. Filtering: Full time multi-pole noise filtering:
    a. 0.3% surge let-through
    b. Zero clamping response time.
    c. Meets UL 1449
8. Certifications: cUl, UL 1778, FCC (Class A), CE (Class A) VDE
9. Runtime (full load): 8.5 minutes
10. Integrated Dry Contact I/O

2.9 DDC SENSORS AND POINT HARDWARE

A. Temperature Sensors
1. Acceptable Manufacturers: Veris Industries
2. All temperature devices shall use precision thermistors accurate to +/- 1 degree F over a range of –30 to 230 degrees F. Space temperature sensors shall be accurate to +/- .5 degrees F over a range of 40 to 100 degrees F.
3. Room Sensor: Standard space sensors shall be available in an off white enclosure made of high impact ABS plastic for mounting on a standard electrical box. Basis of Design: Veris TW Series
    a. Where manual overrides are required, the sensor housing shall feature both an optional sliding mechanism for adjusting the space temperature setpoint, as well as a push button for selecting after hours operation.
    b. Where a local display is specified, the sensor shall incorporate an LCD display for viewing the space temperature, setpoint and other operator selectable parameters. Using built in buttons, operators shall be able to adjust setpoints directly from the sensor.
4. Duct Probe Sensor: Sensing element shall be fully encapsulated in potting material within a stainless steel probe. Useable in air handling applications where the coil or duct area is less than 14 square feet. Basis of Design: Veris TD Series
5. Duct Averaging Sensor: Averaging sensors shall be employed in ducts which are larger than 14 square feet. The averaging sensor tube shall contain at least one thermistor for every 3 feet, with a minimum tube length of 6 feet. The averaging sensor shall be constructed of rigid or flexible copper tubing. Basis of Design: Veris TA Series
6. Pipe Immersion Sensor: Immersion sensors shall be employed for measurement of temperature in all chilled and hot water applications as well as refrigerant applications. Provide sensor probe length suitable for application. Provide each sensor with a corresponding pipe-mounted sensor well, unless indicated otherwise. Sensor wells shall be stainless steel for non-corrosive fluids below 250 degrees F and 300 series stainless steel for all other applications. Basis of Design: Veris TI Series
7. Outside Air Sensor: Sensing element shall be fully encapsulated in potting material within a stainless steel probe. Probe shall be encased in PVC solar radiation shield and mounted in a weatherproof enclosure. Operating range -40 to 122 F, Basis of Design: Veris TO Series

8. A pneumatic signal shall not be allowed for sensing temperature.

B. Humidity Wall Transmitter
1. Acceptable Manufacturer: Veris Industries
2. Transmitters shall be accurate to +/- 2 % at full scale.
3. Transmitter shall have replaceable sensing element.
4. Sensor type shall be thin-film capacitive.
5. Sensor element shall contain multipoint calibration on-board in nonvolatile memory
6. Operating range shall be 0 - 100% RH noncondensing, 50 to 95 F
7. Output shall be field selectable 4-20 mA or 0-5/0-10 VDC.
8. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
9. Transmitter shall be available in an off white enclosure made of high impact ABS plastic for mounting on a standard electrical box.
10. Transmitter shall have option of having an LCD display
11. Transmitter shall have option of being NIST certified
12. Transmitter shall have option of an integrated temperature sensor
13. Basis of Design: Veris HWL Series

C. Humidity Duct Transmitter
1. Acceptable Manufacturer: Veris Industries
2. Transmitters shall be accurate to +/- 2 % at full scale.
3. Transmitter shall be fully encapsulated in potting material within a stainless steel probe.
4. Transmitter shall have replaceable sensing element.
5. Sensor type shall be thin-film capacitive.
6. Sensor element shall contain multipoint calibration on-board in nonvolatile memory
7. Operating range shall be 0 - 100% RH noncondensing, -40 to 122 F
8. Output shall be 4-20 mA or 0-5/0-10 VDC.
9. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
10. Transmitter shall have option of being NIST certified
11. Transmitter shall have option of an integrated temperature sensor
12. Basis of Design: Veris HD Series

D. Humidity Outdoor Transmitter
1. Acceptable Manufacturer: Veris Industries
2. Transmitters shall be accurate to +/- 2% at full scale.
3. Transmitter shall be fully encapsulated in potting material within a stainless steel probe. Probe shall be encased in PVC solar radiation shield and mounted in a weatherproof enclosure.
4. Transmitter shall have replaceable sensing element.
5. Sensor type shall be thin-film capacitive.
6. Sensor element shall contain multipoint calibration on-board in nonvolatile memory
7. Operating range shall be 0 - 100% RH noncondensing, -40 to 122 F
8. Output shall be 4-20 mA or 0-5/0-10 VDC.

9. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
10. Transmitter shall have option of being NIST certified
11. Transmitter shall have option of an integrated temperature sensor
12. Basis of Design: Veris HO Series

E. Carbon Dioxide Wall Transmitter:
1. Acceptable Manufacturer: Veris Industries
2. Sensor type shall be Non-dispersive infrared (NDIR).
3. Accuracy shall be ±30 ppm ±2% of measured value with annual drift of ±10 ppm. Minimum five year recommended calibration interval.
4. Repeatability shall be ±20 ppm ±1% of measured value
5. Response Time shall be <60 seconds for 90% step change
6. Outputs shall be field selectable [Analog: 4-20mA or 0-5/0-10VDC][Protocol: Modbus or BACnet] with [SPDT Relay 1A@30VDC][temperature setpoint slider]
7. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
8. Temperature Range: [32° to 122°F (CO2 only)][50° to 95°F (with humidity option)]
9. Output range shall be programmable 0-2000 or 0-5000 ppm
10. Transmitter shall be available in an off white enclosure for mounting on a standard electrical box.
11. Transmitter shall have an option of an LCD display for commissioning and provide additional faceplate to conceal LCD display where occupants may misinterpret CO2 readings.
12. Transmitter shall have option of an integrated temperature sensor and/or humidity sensor
13. Basis of Design: Veris CWL

F. Carbon Dioxide Duct Transmitter:
1. Acceptable Manufacturer: Veris Industries
2. Sensor type shall be Non-dispersive infrared (NDIR).
3. Accuracy shall be ±30 ppm ±2% of measured value with annual drift of ±10 ppm. Minimum five year recommended calibration interval.
4. Repeatability shall be ±20 ppm ±1% of measured value
5. Response Time shall be <60 seconds for 90% step change
6. Outputs shall be field selectable Analog: 4-20mA or 0-5/0-10VDC with SPDT Relay 1A@30VDC
7. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
8. Temperature Range: 32° to 122°F
9. Output range shall be programmable 0-2000 or 0-5000 ppm
10. Enclosure shall not require remote pickup tubes and make use of integrated H-beam probe to channel air flow to sensor.
11. Enclosure lid shall require no screws and make use of snap on features for attachment
12. Enclosure shall be made of high impact ABS plastic
13. Transmitter shall have option of an LCD display
14. Transmitter shall have option of an integrated temperature sensor and/or humidity sensor

15. Basis of Design: Veris CDL

G. Air Pressure Transmitters.
1. Acceptable Manufacturers: Veris Industries
2. Sensor shall be microprocessor profiled ceramic capacitive sensing element
3. Transmitter shall have 14 selectable ranges from 0.1 – 10" WC
4. Transmitter shall be +/- 1% accurate in each selected range including linearity, repeatability, hysteresis, stability, and temperature compensation.
5. Transmitter shall be field configurable to mount on wall or duct with static probe
6. Transmitter shall be field selectable for Unidirectional or Bidirectional
7. Maximum operating pressure shall be 200% of design pressure.
8. Output shall be field selectable 4-20 mA or 0-5/0-10 VDC linear.
9. Transmitter shall accept 12-30 VDC or 24 VAC supply power
10. Response time shall be field selectable T95 in 20 sec or T95 in 2 sec
11. Transmitter shall have an LCD display
12. Units shall be field selectable for WC or PA
13. Transmitter shall have provision for zeroing by pushbutton or digital input.
14. Transmitter shall be available with a certification of NIST calibration
15. Basis of Design: Veris model PXU.

H. Liquid Differential Pressure Transmitters:
1. Acceptable Manufacturer: Veris Industries
2. Transmitter shall be microprocessor based
3. Transmitter shall use two independent gauge pressure sensors to measure and calculate differential pressure
4. Transmitter shall have 4 switch selectable ranges
5. Transmitter shall have test mode to produce full-scale output automatically.
6. Transmitter shall have provision for zeroing by pushbutton or digital input.
7. Transmitter shall have field selectable outputs of 0-5V, 0-10V, and 4-20mA.
8. Transmitter shall have field selectable electronic surge damping
9. Transmitter shall have an electronic port swap feature
10. Transmitter shall accept 12-30 VDC or 24 VAC supply power
11. Sensor shall be 17-4 PH stainless steel where it contacts the working fluid.
12. Performance:
    a. Accuracy shall be ±1% F.S. and ±2% F.S. for lowest selectable range
    b. Long term stability shall be ±0.25%
    c. Sensor temperature operating range shall be -4° to 185°F
    d. Operating environment shall be 14° to 131°F; 10-90% RH noncondensing
    e. Proof pressure shall be 2x max. F.S. range
    f. Burst pressure shall be 5x max. F.S. range
13. Transmitter shall be encased in a NEMA 4 enclosure
14. Enclosure shall be white powder-coated aluminum

15. Transmitter shall be available with a certification of NIST calibration
16. Transmitter shall be preinstalled on a bypass valve manifold
17. Basis of Design: Veris PW

I. Current Sensors
1. Current status switches shall be used to monitor fans, pumps, motors and electrical loads. Current switches shall be available in split core models, and offer either a digital or an analog signal to the automation system. Acceptable manufacturer is Veris Industries

J. Current Status Switches for Constant Load Devices
1. Acceptable Manufacturer: Veris Industries
2. General: Factory programmed current sensor to detect motor undercurrent situations such as belt or coupling loss on constant loads. Sensor shall store motor current as operating parameter in non-volatile memory. Push-button to clear memory.
3. Visual LED indicator for status.
4. Split core sensor, induced powered from monitored load and isolated to 600 VAC rms. Sensor shall indicate status from 0.5 A to 175 A.
5. Normally open current sensor output. 0.1A at 30 VAC/DC.
6. Basis of Design: Veris Model H608.

K. Current Status Switches for Constant Load Devices (Auto Calibration)
1. Acceptable Manufacturer: Veris Industries.
2. General: Microprocessor based, self-learning, self-calibrating current switch. Calibration-free status for both under and overcurrent, LCD display, and slide-switch selectable trip point limits. At initial power-up automatically learns average current on the line with no action required by the installer
3. Split core sensor, induced powered from monitored load and isolated to 600 VAC rms. Sensor shall indicate status from 2.5 A to 200 A.
4. Display: Backlit LCD; illuminates when monitored current exceeds 4.5A
5. Nominal Trip Point: ±40%, ±60%, or on/off (user selectable)
6. Normally open current sensor output. 0.1A at 30 VAC/DC.
7. Basis of Design: Veris Model H11D.

L. Current Status Switches for Variable Frequency Drive Application
1. Acceptable Manufacturer: Veris Industries.
2. General: Microprocessor controlled, self-learning, self-calibrating current sensor to detect motor undercurrent and overcurrent situations such as belt loss, coupling shear, and mechanical failure on variable loads. Sensor shall store motor current as operating parameter in non-volatile memory. Push-button to clear memory and relearn.
3. Visual LED indicator for status.
4. Alarm Limits: ±20% of learned current in every 5 Hz freq. band
5. Split core sensor, induced powered from monitored load and isolated to 600 VAC rms. Sensor shall indicate status from 1.5 A to 150 A and from 12 to 115 Hz.
6. Normally open current sensor output. 0.1A at 30 VAC/DC.
7. Basis of Design: Veris Model H614.

M. Liquid Flow, Insertion Type Turbine Flowmeter:

1. Description: Provide an insertion turbine flowmeter complete with NIST traceable, wet calibrated flow-measuring element, integral transmitter, installation valves, depth gage and calibration certificate. Flowmeter shall be wet tappable, allowing insertion and removal from the flow stream without system shutdown.
2. Application Range: This contractor shall be responsible for selecting the flowmeter options submitted based on the application. Flowmeter shall be constructed, calibrated, and scaled for the intended application in terms of pipe size, pipe material, installation requirements, expected flow rate, ambient conditions and fluid characteristics which include but are not limited to pressure, temperature, conductivity, and viscosity.
3. Sensing Technology: Axial Turbine flow-measuring element; either single or dual turbine based on application requirements.
4. Design: Axial insertion turbine design with electronic impedance-based sensing circuit. Dual insertion turbine shall incorporate two contra rotating turbines and an averaging circuit to reduce measurement errors due to flow distortions, such as swirl, when installed in piping configurations with reduced straight run.
    a. Single axial turbine sensing element acceptable for line sizes 1.25” and larger.
    b. Dual axial turbine sensing element acceptable for line sizes 2.5” and larger.
5. Construction: Plated brass or 316L stainless steel with attached tag indicating calibration information.
    a. Maximum Pressure Rating: 400 psig
    b. Maximum Temperature Rating: 280 deg F
6. End Connections:
    a. For NPS 1” and Smaller: Threaded or sweat.
    b. For NPS 1.25” and Larger: 1” Male NPT for use with 1” full port Isolation Valve, Minimum.
7. Flow Range: Flow-measuring element and transmitter shall cover operating range of equipment or system served.
8. Accuracy: Flowmeter shall provide calibrated outputs, directly from the integral transmitter, throughout the operating range with the accuracy stated as follows:
    a. Plus or minus 0.5% of rate at calibrated velocity
    b. Plus or minus 1.0% of rate from 3.0 to 30.0 ft/sec velocity (10:1 turndown).
    c. Plus or minus 2.0% of rate from 0.4 to 20 ft/sec velocity (50:1 turndown).
9. Calibration: Each flowmeter shall receive a wet calibration, within the expected operating range, against a primary volumetric standard that is traceable to NIST.
10. Optional Local Display: Local display shall provide instantaneous flow rate information, totalized flow information and shall be factory configured for connection to a specific flowmeter.
11. Operating and Installation Instructions: Installation and operating instructions shall be provided for each flowmeter.
12. Warranty: Each flowmeter shall be covered by the manufacturer’s one year no fault and three year warranty.

13. Basis of Design: ONICON Model F-1000 Series Insertion Turbine Flowmeter. Manufacturer approved to bid, subject to proven compliance with requirements and specification:

N. Ultrasonic Flowmeters:

1. Basis of Design: ONICON Model F-4600 Series Inline Ultrasonic Flowmeter. Manufacturers approved to bid, subject to proven compliance with requirements and specification:
2. Description: Provide an inline flowmeter complete with direct beam wetted ultrasonic transducers, temperature sensor, mounting hardware and calibration certificate.
3. Application Range: This contractor shall be responsible for selecting the flowmeter options submitted based on the application. Flowmeter shall be selected for the intended application in terms of pipe size, pipe material, installation requirements, expected flow rate, ambient conditions and fluid characteristics which include but are not limited to pressure, temperature, and viscosity.
4. Design - Sensing Technology: Ultrasonic flow sensing element shall utilize matched direct path, wetted ultrasonic transducers and 1000 OHM Platinum RTD.
    a. Construction: Flowmeter shall consist of a drop forged corrosion resistant metal flow body with process connections, integral transducers and a processor / transmitter. All wetted materials shall be NSF 372 compliant.
    b. Maximum Pressure Rating: 400psi
    c. Maximum Temperature Rating: 250F
5. Mounting Connections: For NPS ½" – 2", piping connections shall be male NPT threads; for NPS 2 ½" provide ANSI class flange, rated for maximum system temperature and pressure.
6. Flow Range: Flow-measuring element and transmitter shall cover operating range of equipment or system served.
7. Accuracy: Flowmeter shall provide calibrated outputs directly from the transmitter, throughout the operating range with the accuracy stated as follows:
    a. Plus or minus 1.0% of flow rate over a 25:1 turndown
    b. Plus or minus 2.0% of flow rate over a 100:1 turndown
    c. Overall turndown of 500:1
8. Transmitter: Transmitter shall provide instantaneous flow rate information over a 4-20mA scale and a pulse output for totalized flow information.
9. Optional Transmitter with Integral Display and Operator Interface: Provide an operator interface consisting of three push-buttons. Display shall visually indicate total fluid volume, instantaneous flow rate and fluid temperature. Output signals shall be either serial network protocol, pulse output, analog output or combination. Pulse output for totalization of flow, Gallons typical. Optional serial communications output shall be native to the BTU meter, BACnet meters shall be BTL certified, secondary communication gateways shall not be permitted. Information provided via the serial communication network shall include: Flow rate, flow total, fluid temperature and a trend including peak values. Meters with serial communications shall be able to provide up to three additional auxiliary pulses configured as inputs or outputs.

10. Operating and Installation Instructions: Installation and operating instructions shall be provided for each flowmeter.
11. Warranty: Flowmeter shall be covered by the manufacturer's three-year warranty.

O. Analog Electric/Pneumatic Transducer:
1. Acceptable Manufacturer: Veris Industries
2. General: Micro-controlled poppet valve for high accuracy and with no air loss in the system. Field configurable for pressure sensing in multiple applications.
3. Power Supply: 22-30VDC, 20-30VAC
4. Control Input: 4-20mA, 0-10V, 0-5V; jumper selectable
5. Performance:
   a. Accuracy: 1% full scale; combined linearity, hysteresis, repeatability
   b. Compensated Temperature Range: 25° to 140°F
   c. Temp Coefficient: ±0.05%°C
   d. Operating Environment: 10-90% RH, non-condensing; 25° to 140°F
6. Supply Pressure: 45 psig max.
7. Manual Override: Jumper selectable mode, digital pushbutton adjust
8. Alarm Contact: 100mA@30VAC/DC (Optional)
9. Control Range 0-20 psig or 3-15 psig; jumper selectable
10. Pressure Differential 0.1 psig (supply to branch)
11. Pressure Indication Electronic, 3-1/2 digit LCD
12. Housing: Mounted on standard SnapTrack; Optional clear dust cover
13. Basis of Design: Veris EP Series

2.10 CONTROL VALVES ASSEMBLIES SHALL BE PROVIDED AND DELIVERED FROM A SINGLE MANUFACTURER AS A COMPLETE ASSEMBLY.

A. The manufacturer shall warrant all components for a period of 5 years from the date of production with the first two years unconditional.

B. All valve assemblies shall be provided with a corrosion-resistant nameplate indicating.
1. Manufacturer's name and model number.
2. Body size.
3. Flow directional arrow and/or port numbers.
4. Production date.

C. Ball-Style Control Valves

1. Manufactured, brand labeled or distributed by Belimo.
2. NPS 2 and Smaller: Provide a pipe package supplied by the valve manufacturer. The supply side of the coil shall contain a strainer/shut-off ball valve/drain [an integrated isolation ball valve/manual air vent] with P/T port. The return side of the coil shall contain a union fitting with a P/T port, ball-style control valve, an integrated manual balancing valve/union/isolation ball valve/manual air vent with P/T port. Shut-off valves as an integrated part of the ball-style control valve shall not be permitted.

D. FCU, HWC, and VAV Pressure-Independent Ball Valves NPS 3/4 and Smaller for Coils Less Than 10 GPM:

1. Performance:
   a. Pressure Rating: 360 psig.
   b. Close-off pressure of 200 psig.
   c. Process Temperature Range: Between 36 deg F to 212 deg F.
2. Body: Forged brass with NPT female ends.
3. Ball: Stainless steel.
4. Stem and Stem Extension: Stainless steel, blowout-proof design.
5. Ball Seats: PTFE.
6. Stem Seal: Dual EPDM O-rings (lubricated).
7. Flow characteristic: Equal percentage
8. Corrosion-resistant nameplate
9. Integral Pressure Regulator: Located upstream of ball to regulate pressure, to maintain a constant pressure differential while operating within a pressure differential range of 5 to 50 psig . Two internal P/T ports shall be incorporated for differential pressure verification. Replaceable cartridges are not permitted.

E. AHU, FCU, CRAC Unit, HWC, Heat Exchanger and Bypass Pressure-Independent Ball Valves with Coil Optimization Technology NPS 6 and Smaller for Applications Greater Than 10 GPM:

1. Performance:
   a. Pressure Rating for NPS 2 and smaller: 360 psig.
   b. Pressure Rating for NPS 2-1/2 through NPS 6: ANSI 125, Class B.
   c. Close-off pressure for NPS 2 and smaller: 200 psi.
   d. Close-off pressure for NPS 2-1/2 through NPS 6: 100 psig.
   e. Process Temperature Range: Between 14 deg F to 250 deg F
2. Body: NPS 2-1/2 through NPS 6 Cast iron with pattern to mate with ANSI 125 flange.
3. Ball: Stainless steel.
4. Stem and Stem Extension: Stainless steel, blowout-proof design.
5. Ball Seats: Teflon PTFE.
6. Stem Seal: Dual EPDM O-rings (lubricated).
7. Flow Meter and Temperature Sensors: A characterized control valve shall be integrated with an ultrasonic flow sensor (accuracy +/- 2%) providing analog flow feedback and two temperature sensors providing feedback of coil inlet and outlet water temperatures. The valve shall reposition to maintain the required flow with a +/- 5% accuracy over a pressure differential range of 1 to 50 psig.
8. Coil Optimization: Software shall control the valve to avoid the coil differential temperature from falling below a programmed setpoint. Real-time data and configuration of valve operating parameters shall be available by BTL listed BACnet MS/TP, BACnet/IP, MODBUS or HTTP. Monitored points shall include inlet and outlet coil water temperatures, absolute flow, absolute valve position, absolute coil power and total heating/cooling energy in BTU/hr. Configuration points shall include valve, flow and power settings. Historical trend data shall be stored for up to 13 months and be retrievable in a standard time-stamped format.
9. Glycol Monitoring: The control valve assembly shall incorporate an algorithm to automatically calculate the glycol concentration and be readable by a local device, BACnet or MODBUS.
10. ANSI 125 flange.

F. Control Valves

1. Provide automatic control valves suitable for the specified controlled media (water or glycol). Provide valves which mate and match the material of the connected piping. Equipment control valves with the actuators of required input power type and control signal type to accurately position the flow control element and provide sufficient force to achieve required leakage specification.

2. Control valves shall meet the heating and cooling loads specified, and close off against the differential pressure conditions within the application. Valves should be sized to operate accurately and with stability from 10 to 100% of the maximum design flow.

3. All control/bypass valves shall be Belimo Energy Valves and shall meet the following:

   a. Pressure independent control valves (Water Coil Optimization).

   b. NPS 2” and smaller: Forged brass body rated at no less than 250 psi, stainless steel ball and stem female NPT union ends, dual EPDM lubricated O-rings and a brass or TEFZEL characterizing disc.

   c. NPS2-1/2” through 6”: GG25 cast iron body according to ANSI Class 125, Standard Class B, stainless steel ball and blowout proof stem, flange to match ANSI 125 with a dual EPDM O-ring packing design, PTFE seats, and a stainless steel flow characterizing disc.

   d. Accuracy: Control valves shall accurately control the flow from 0 to 100% of the rated flow with an operating pressure differential range of 5 to 50 psi differential across the valve with a valve body flow accuracy of =/- 5 total assembly error incorporating differential pressure fluctuation, manufacturing tolerances and valve hysteresis.

   e. Flow Characteristics: Equal percentage characteristic.

   f. All actuators shall be capable of being electronically programmed in the field by use of external computer software or a dedicated handheld tool for the adjustment of flow. Programming using actuator mounted switches or multi-turn actuators are not acceptable.

   g. Water coil optimization shall be accomplished by utilizing a pressure independent control valve assembly; two temperature sensors providing feedback of coil inlet and outlet water temperatures; and an electronic flow meter to provide analog flow feedback. Software shall control the valve to avoid the coil differential temperature from falling below a programmed set point, the valve assembly shall be capable of accepting an analog signal representing the coil power required. Real-time data and configuration of valve operating parameters shall be available by means of BACnet MS/TP, BACnet/IP or HTTP. Monitored points shall include, but not be limited to inlet and outlet coil water temperatures, absolute flow, absolute valve position, absolute coil power and total heating/cooling energy in BTU/hr. Configuration points shall include but not be limited to valve, flow, and power settings. Historical trend data shall be stored for up to 13 months and be retrievable in a standard time-stamped format.

   h. The manufacturer shall provide a published commissioning procedure following the guidelines of the National Environmental Balancing Bureau (NEBB) and the Testing Adjusting Balancing Bureau (TABB).

i. A wet calibrated electronic flow meter shall provide dynamic feedback to measure flow and verify performance.

j. The control valve shall require no maintenance and shall not include replaceable cartridges.

k. Known Acceptable Source: Belimo EV050s-055=LRX24-EV.

2.11 ELECTRIC AND ELECTRONIC CONTROL VALVE ACTUATORS

A. Manufactured, brand labeled or distributed by Belimo.

B. The valve assembly (control valve and actuator) shall be provided and delivered from a single manufacturer.

C. Agency Listings: ISO 9001, cULus, CE, CSA, and UL 2043The manufacturer shall warrant all components for a period of 5 years from the date of production with the first two years unconditional.

D. Actuators for Hydronic Control Valves: Capable of closing valve against system pump shutoff head.

E. Actuators for Steam Control Valves: Shutoff against 1.2 times steam design pressure.

F. Position indicator and graduated scale on each actuator.

G. Type: Motor operated, with gears, electric and electronic. Overload protected electronically throughout rotation.

H. Voltage: 24 VAC or compliant with system requirements.

I. Deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage at the valve close-off pressure for system design.

J. Function properly within a range of 80 to 120 percent of nameplate voltage.

K. Two-Position Actuators: Single direction, fail safe or reversing type.

L. Modulating Actuators:
1. Operation: Capable of stopping at all points across full range and starting in either direction from any point in range.
2. Control Input Signal:
   a. Three Point, Tristate, or Floating Point: Clockwise and counterclockwise inputs. One input drives actuator to open position and other input drives actuator to close position. No signal of either input remains in last position.
   b. Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for 0 – 10 VDC or 2 – 10 VDC signals.
   c. Programmable Multi-Function:
      1) Control Input, Position Feedback, Mechanical Travel, and Running Time: Factory or field software programmable without the use of actuator mounted switches.

2) Adaptation: Upon adjustment of operating parameters. Adaptation shall be initiated to adapt the input, feedback, and run time, to the actual mechanical angle of rotation or travel.
3) Diagnostic: Feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
4) Service Data: Include, at a minimum, number of hours powered and number of hours in motion.

M. Position Feedback:

1. Two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of open and closed position.
2. Modulating actuators with a position feedback through VDC signal for remote monitoring.
3. Provide a position indicator and graduated scale on each actuator indicating open and closed travel limits.

N. Fail-Safe:

1. Where indicated, provide actuator to fail to an end position.
2. Mechanical spring return mechanism to drive controlled device to an end position (open or close) on loss of power.
3. Electronic fail-safe shall incorporate an active balancing circuit to maintain equal charging rates among the Super Capacitors. The power fail position shall be adjustable between 0 to 100% in 10 degree increments with a 2 second operational delay.

O. Integral Overload Protection:

1. Provide electronic overload protection throughout the entire operating range in both directions.

P. Valve Attachment:

1. Attach actuator to valve drive shaft in a way that ensures maximum transfer of power and torque without slippage.
2. Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required.
3. V-bolt dual nut clamp with a V-shaped toothed cradle; directly couple and mount to the valve bonnet stem; or ISO-style direct-coupled mounting pad.

Q. Temperature and Humidity:

1. Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of minus 22 to plus 122 deg F .
2. Humidity: Suitable for maximum 95% RH, non-condensing.

R. Enclosure:

1. Suitable for ambient conditions encountered by application.
2. NEMA Type 2 for indoor and protected applications.
3. NEMA Type 4 or Type 4X for outdoor and unprotected applications.
4. Provide actuator enclosure with heater and control where required by application.

S. Stroke Time:

1. All spring return, two position valve actuators operate the valve from fully closed to fully open within 75 seconds or less. All spring return, two position valve actuators operate the valve from fully open to fully closed within 75 seconds or less.
2. All non-failsafe, two position valve actuators operate the valve from fully closed to fully open within 95 seconds or less. All non-failsafe, two position valve actuators operate the valve from fully open to fully closed within 95 seconds or less.
3. All modulating valve actuators operate the valve from fully closed to fully open within 95 seconds or less. All modulating valve actuators operate the valve from fully open to fully closed within 95 seconds or less.
4. All mechanical failsafe actuators move the valve to its full failsafe position (100% CCW or CW) within 25 seconds or less via the mechanical spring. All electronic failsafe actuators move the valve to its selected failsafe position in 35 seconds or less via the super capacitor.
5. For specific applications the maximum stroke time of modulating actuators is adjustable time between 70s – 220s.
6. Select operating speed to be compatible with equipment and system operation.

2.12 GENERAL CONTROL-DAMPER ACTUATORS REQUIREMENTS

1. Actuators shall operate related damper(s) with sufficient reserve power to provide smooth modulating action or two-position action and proper speed of response at velocity and pressure conditions to which the damper is subjected.
2. Actuators shall produce sufficient power and torque to close off against the maximum system pressures encountered. Actuators shall be sized to close off against the designed fan shutoff pressure as a minimum requirement.
3. The total damper area operated by an actuator shall not exceed 80 percent of damper manufacturer's maximum area rating.
4. Provide one actuator for each damper assembly where possible. Multiple actuators required to drive a single damper assembly shall operate in unison.
5. Avoid the use of excessively oversized actuators which could overdrive and cause linkage failure when the damper blade has reached either its fully open or closed position.
6. Use jackshafts and shaft couplings in lieu of blade-to-blade linkages when driving axially aligned damper sections.
7. Provide mounting hardware and linkages for connecting actuator to damper.
8. Select actuators to fail in desired position in the event of a power failure.

A. Electric and Electronic Actuators

1. Manufactured, brand labeled or distributed by Belimo or Equivalent.
   a. Basis of design: AFX24-S, SR, MFT (180 In/Lb)
2. Agency Listngs: ISO 9001, cULus, CE, and CSA.
3. The manufacturer shall warrant all components for a period of 5 years from the date of production with the first two years unconditional.
4. Type: Motor operated, with gears, electric and electronic.
5. Voltage:
   a. Voltage selection is delegated to professional designing control system 24 V is basis of design - [120Vac][230Vac]
   b. Actuator shall deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.
6. Two-Position Actuators: Single direction, spring return or reversing type. All two position actuators must be provided with two single pole double throw auxiliary switches rated for 3 A resistive (0.5 A inductive) @ 250 VAC.

7. Modulating Actuators:
   a. Capable of stopping at all points across full range, and starting in either direction from any point in range.
   b. Control Input Signal:
      1) Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position, and other input drives actuator to close position. No signal of either input, the actuator remains in the last position.
      2) Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for [0 to 10vdc] or [2 to 10vdc] and [4- to 20-mA] signals.
      3) Pulse Width Modulation (PWM): Actuator drives to a specified position according to a pulse duration (length) of signal from a dry-contact closure, triac sink or source controller.
      4) Programmable Multi-Function:
         a) Control Input, Position Feedback, Mechanical Travel, and Running Time: Factory or field software programmable without the use of actuator mounted switches.
         b) Adaptation: Upon adjustment of operating parameters. Adaptation shall be available to initiate adaption of the input, feedback and run time, to the actual mechanical angle of rotation or travel.
         c) Diagnostic: Feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
         d) Service Data: Include, at a minimum, number of hours powered and number of hours in motion.
8. Position Feedback:
   a. Two-position actuators with duel auxiliary switches or other positive means of a position indication signal for remote monitoring of open and close position.
   b. Modulating actuators with position feedback through [voltage] signal for remote monitoring.
   c. Provide a position indicator and graduated scale on each actuator indicating open and closed travel limits.
9. Fail-Safe: (All actuators shall be failsafe for dampers, louvers, etc unless otherwise noted)
   a. Where indicated, provide actuator to fail to an end position.
   b. Mechanical spring return mechanism to drive controlled device to an end position (open or close) on loss of power.
   c. Electronic fail-safe shall incorporate an active balancing circuit to maintain equal charging rates among the Super Capacitors. The power fail position shall be proportionally adjustable between 0 to 100% in 10 degree increments with a 2 second operational delay.
10. Integral Overload Protection:
    a. Provide electronic overload protection throughout the entire operating range in both directions.
11. Damper Attachment:
    a. Unless otherwise required for damper interface, provide actuator designed to be directly coupled to damper shaft without need for connecting linkages.
    b. Attach actuator to damper drive shaft in a way that ensures maximum transfer of power and torque without slippage.
    c. Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.

12. Temperature and Humidity:
    a. Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of minus 22 to plus 122 deg F
    b. Humidity: Suitable for humidity range encountered by application; minimum operating range shall be to maximum 95 percent relative humidity, non- condensing.
13. Enclosure:
    a. Suitable for ambient conditions encountered by application.
    b. NEMA Type 2 for indoor and protected applications.
    c. NEMA Type 4 or Type 4X for outdoor and unprotected applications.
    d. Provide actuator enclosure with a heater and controller where required by application.
14. Stroke Time:
    a. All spring return, two position damper actuators operate the damper from fully closed to fully open within 75 seconds or less. All spring return, two position damper actuators operate the damper from fully open to fully closed within 75 seconds or less.
    b. All non-failsafe, two position damper actuators operate the damper from fully closed to fully open within 95 seconds. All non-failsafe, two position damper actuators operate the damper from fully open to fully closed within 95.
    c. All modulating damper actuators operate the damper from fully closed to fully open within 95 seconds. All modulating damper actuators operate the damper from fully open to fully closed within 95 seconds.
    d. All mechanical failsafe actuators move the damper to its full failsafe position (100% CCW or CW) within 20 seconds or less via the mechanical spring. All electronic failsafe actuators move the damper to its selected failsafe position in 35 seconds via the super capacitor.
    e. For specific applications the maximum stroke time of modulating actuators is adjustable time between 70s – 220s. Select operating speed to be compatible with equipment and system operation.
    f. Actuators operating in smoke control systems comply with governing code and NFPA requirements.

B. Outdoor Air Duct And Plenum AMD With Temperature And Humidity Measurement And Remote Transmitter

1. Basis of Design Product: Subject to compliance with requirements, provide Ebtron or comparable product by one of the following:
    a. Sage Metering
    b. Sierra Instruments
2. Description:
    a. The Air Measurement Device (AMD) shall consist of a microprocessor-based transmitter and one or more sensor probes. The AMD shall use the principle of thermal dispersion with one self-heated and one zero power bead in glass thermistor at each sensing node. Only the thermistor shall be located within the sensing node, all other electronic components shall be outside the airstream. The transmitter (Gold Series Only) shall be provided a Bluetooth, low-energy interface, and free Android® or iOS® software that allows real-time airflow and temperature monitoring and airflow and temperature traverses. Software shall capture, save and/or e-mail airflow/temperature data, transmitter settings and diagnostics information.

b. The AMD shall achieve an installed accuracy when installed in accordance with the manufactures recommended sensor density and placement guidelines as follows:
   1) Ducted Applications: +/- 3% of Reading
   2) Non-Ducted Applications: +/- 3% to 5%

c. Upon request the manufacture shall provide for approval and verification a written copy of the following:
   1) 16-point NIST traceable report of calibration used for the reference standard.
   2) UL 60730-1 or UL873.
   3) Independent laboratory test report results of 100% survival rate in a 30-day saltwater and acid vapor test.

C. Airflow Measuring Stations
1. Provide a thermal anemometer using instrument grade self heated thermistor sensors with thermistor temperature sensors.
2. The flow station shall operate over a range of 0 to 5,000 feet/min with an accuracy of +/- 2% over 500 feet/min and +/- 10 ft/min for reading less than 500 feet/min.

2.13 ELECTRICAL POWER MEASUREMENT

A. Electrical Power Monitors, Single Point (Easy Install):
1. Acceptable Manufacturer: Schneider Electric, Veris Industries.
2. General: Consist of three split-core CTs, factory calibrated as a system, hinged at both axes with the electronics embedded inside the master CT. The transducer shall measure true (rms.RMS) power demand real power (kW) consumption (kWh). Conform to ANSI C12.1 metering accuracy standards.
3. Voltage Input: Load capacity as shown on drawings. 208-480 VAC, 60 Hz
4. Maximum Current Input: Up to 2400A
5. Performance:
   a. Accuracy: +/- 1% system from 10% to 100% of the rated current of the CT's
   b. Operating Temperature Range: 32-140°F, 122°F for 2400A.
6. Output: 4 to 20 mA, Pulse. or Modbus RTU
7. Ratings:
   a. Agency: UL508 or equivalent
   b. Transducer internally isolated to 2000 VAC.
   c. Case isolation shall be 600 VAC.
8. Basis of Design: Similar to Enercept H80xx Series, E23 Series
9. Accessories: Current transducers (CTs): split-core (E681/H681/U004) series, solid-core (E682/U004 series) and Rogowski Coils – rope style (E683 series); Communications gateways: Modbus to Ethernet (EGX150)

B. Electrical Power Monitors, Single Point (High Accuracy):
1. Acceptable Manufacturer: Schneider Electric, Veris Industries.
2. General: Revenue grade meter. Measures voltage, amperage, real power (kW), consumption (kWh), and reactive power (kVARar), and power factor (PF) per phase and

total load for a single load. Factory calibrated as a system using split core CT's. Neutral voltage connection is required.

3. Voltage Input: 208-480 VAC, 60 Hz
4. Current Input: Up to 2400A
5. Performance:
   a. Accuracy: +/- 1% system from 2% to 100% of the rated current of the CT's
   b. Operating Temperature Range: 32-122°F
6. Output: Pulse, BACnet, Modbus RTU
7. Display: Backlit LCD
8. Enclosure: NEMA 1
9. Agency Rating: UL508 or equivalent
10. Basis of Design: Veris Industries H81xx00 series.
11. Accessories: Current transducers (CTs): split-core (E681/H681/U004) series, solid-core (E682/U004 series)

C. Electrical Power Monitors, Single Point (High Accuracy/Versatility):
1. Acceptable Manufacturer: Schneider Electric, Veris Industries.
2. General: Revenue grade meter. Measures voltage, amperage, real power (kW), consumption (kWh), reactive power (kVAR), apparent power (kVA) and power factor (PF) per phase and total load for a single load. Available with data logging , Bi-directional (4-quadrant) metering, and pulse contact accumulator inputs.
3. Voltage Input: 90-600 VAC, 50/60 Hz, 125-300 VDC
4. Current Input: 5A – 32,000A, selectable 1/3V or 1V CT inputs
5. Performance:
   a. Accuracy shall be +/- [0.2%][0.5%] revenue grade
   b. Operating Temperature Range: -22-158°F
6. Output shall be [Pulse][BACnet][Modbus RTU][LON][Modbus TCP] [BACnet/IP] [Modbus RTU/TCP][SNMP]
7. Display: Backlit LCD
8. Enclosure: NEMA 4x optional
9. Agency Rating: UL508, ANSI C12.20
10. Basis of Design: Veris E50 series, Veris E60 Series or Schneider Electric PM5000 Series
11. Accessories: Current transducers (CTs): split-core (E681/H681/U004) series, solid-core (E682/U004 series) and Rogowski Coils – rope style (E683 series)

D. Electrical Power Monitors, Multiple Point (92 loads, High Accuracy):
1. Acceptable Manufacturer: Schneider Electric, Veris Industries.
2. General: Revenue grade meter. Measures volts, amps, power and energy for each circuit. 1/4 amp to 200 amp monitoring. 4 configurable alarm threshold registers
3. Voltage Input: 90-277 VAC, 60 Hz
4. Current Input: 5A – 32,000A, 1/3V CT inputs
5. Performance:
   a. Accuracy: +/- 0.5% meter (split core), +/- 1% system from 1/4-100A (solid core)

b. Operating Temperature Range: 32-140°F

6. Output: [BACnet][Modbus RTU][ModbusTCP][BACnet/IP][Modbus RTU/TCP][SNMP]
7. Agency Rating: UL508, ANSI C12.10, IEC Class 1
8. Basis of Design: Veris E3xxx series.

PART 3 - EXECUTION

3.1 GENERAL

A. In addition to the requirements specified herein, execution shall be in accordance with the requirements of Specification Division 23 and Drawings.

B. Examine equipment exterior and interior prior to installation. Report any damage and do not install any equipment that is structurally, moisture, or mildew damaged.

C. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contracting Officer in writing, with a copy to the COR and the Engineer, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

D. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

E. Install equipment in accordance with reviewed product data, final shop drawings, manufacturer’s written instructions and recommendations, and as indicated on the Drawings.

F. Provide final protection and maintain conditions in a manner acceptable to the manufacturer that shall help ensure that the equipment is without damage at time of Substantial Completion.

G. Demolition

1. Remove controls which do not remain as part of the building automation system, all associated abandoned wiring and conduit, and all associated pneumatic tubing. The FAA will inform the Contractor of any equipment which is to be removed that will remain the property of the FAA. All other equipment which is removed will be legally disposed of by the Contractor.

H. Access to Site

1. Unless notified otherwise, entrance to building is restricted. No one will be permitted to enter the building unless their names have been cleared with the FAA or the Contracting Officers’s Representative.

I. Code Compliance

1. All wiring shall be installed in accordance with all applicable electrical codes and will comply with equipment manufacturer's recommendations. Comply with Division 26 requirements.

J. Cleanup

1. At the completion of the work, all equipment pertinent to this contract shall be checked and thoroughly cleaned, and all other areas shall be cleaned around equipment provided under this contract.

K. Site Meetings:

1. The Project Manager for the Contractor shall attend a weekly site coordination meeting that will be attended by all of the contractors involved in this project. The Contractor shall allocate a minimum of 3 hours for this meeting. At the first meeting of each month, the status report submittals shall be delivered to the Owner.

L. General Workmanship:

1. The Contractor shall install all wiring in accordance with all applicable electrical codes and will comply with equipment manufacturer's recommendations.
2. Where discrepancies are found between wiring specifications in Division 23 and Division 26, wiring requirements of Division 23 shall prevail for work specified in Division 23.
3. The Contractor shall install equipment, piping, and wiring/raceways parallel to building lines (i.e. horizontal, vertical and parallel to walls) wherever possible.
4. The Contractor shall provide sufficient slack and flexible connections to allow for vibration of piping and equipment such that the vibration shall not cause electrical connections to break.
5. The Contractor shall verify the integrity of all wiring to ensure continuity and freedom from shorts and grounds.
6. 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.

M. Field Quality Control:

1. The Contractor shall continually monitor the field installation for code compliance and quality of workmanship.
2. The Contractor shall have work inspected by local and/or state authorities having jurisdiction over the work.

N. Coordination With Other Contractors:

1. The Contractor shall assist in coordinating space conditions to accommodate the work under this contract and work by others.
2. Where options exist, the Contractor shall choose execution methodologies that minimize interference with the execution of work by others.
3. The Contractor shall coordinate work schedules with the other contractors that work in the same area to facilitate mutual progress.

O. Coordination With Test and Balance Contractor:

1. The Contractor shall coordinate work progress with the Test and Balance Contractor such that systems and controls are operational when the Test and Balance Contractor arrives to perform the test and balance tasks. If the Test and Balance Contractor schedules his work

without regard to the work progress information provided, and cannot complete the tasks, no liability shall accrue to the Contractor.

2. If the Test and Balance Contractor requires technician support for the test and balance tasks, the availability of the technician shall be coordinated with the Test and Balance Contractor. The Contractor shall not impede the completion of test and balance tasks once systems are ready for test and balance.

3. If the Test and Balance Contractor requires training on the BMS system in order to execute the test and balance tasks, the Contractor shall schedule and deliver this training at an appropriate time relative to the test and balance schedule of work.

P. Coordination With Commissioning Contractor:

1. The Contractor shall coordinate work progress with the Commissioning Contractor such that systems and controls are ready for commissioning when the Commissioning Contractor arrives to perform the test and balance tasks. If the Commissioning Contractor schedules his work without regard to the work progress information provided, and cannot complete tasks, no liability shall accrue to the Contractor.

2. When a system is ready for commissioning, the Contractor shall provide the technician support described in this document in a timely manner.

3. If the Commission Contractor requires training on the BMS system in order to execute the commissioning tasks, the Contractor shall schedule and deliver this training at an appropriate time relative to the commissioning schedule of work.

Q. Coordination With the Owner for Operator Training

1. The Contractor shall advise the Owner when the system is sufficiently complete for the operator training to be scheduled.

2. The Owner shall then provide a minimum of two week notice that the owner’s personnel are available for the training.

3.2 SYSTEM ACCEPTANCE TESTING

A. All application software will be verified and compared against the sequences of operation.

B. Control loops will be exercised by inducing a setpoint shift of at least 10% and observing whether the system successfully returns the process variable to setpoint. Record all test results and attach to the Test Results Sheet.

C. Test each alarm in the system and validate that the system generates the appropriate alarm message, that the message appears at all prescribed destinations (workstations or printers), and that any other related actions occur as defined (i.e. graphic panels are invoked, reports are generated, etc.). Submit a Test Results Sheet to the COR.

D. Perform an operational test of each unique graphic display and report to verify that the item exists, that the appearance and content are correct, and that any special features work as intended. Submit a Test Results Sheet to the COR.

E. Perform an operational test of each third party interface that has been included as part of the automation system. Verify that all points are properly polled, that alarms have been configured, and that any associated graphics and reports have been completed. If the interface involves a file

transfer over Ethernet, test any logic that controls the transmission of the file, and verify the content of the specified information.

3.3 INSTALLATION REQUIREMENTS

A. Wiring, Conduit, Cable Characteristics and Installation Details

1. All wire shall be copper and meet the minimum wire size and insulation class listed below:

Wire Class	Wire Size	Isolation Class
Power	12 Gauge	600 Volt
Class One	14 Gauge Standard	600 Volt
Class Two	18 Gauge Standard	300 Volt
Class Three	18 Gauge Standard	300 Volt
Communications	Per the Manufacturer	Per the Manufacturer

2. Power and Class One wiring may be run in the same conduit.

3. Class Two and Class Three wiring and communications wiring may be run in the same conduit.

4. Where different wiring classes terminate within the same enclosure, maintain clearances and install barriers per the National Electric Code.

5. Unless a written exception provided by the FAA COR, all system wiring must be in conduit or an acceptable wire way/cable tray wiring support system J hooks may be acceptable in certain areas as approved by the COR ALL conduit must be a minimum of 3/4” and shall be installed in the following manner:

   a. Parallel and perpendicular to all building lines.

   b. EMT is acceptable in interior locations not subject to physical damage and above 10’ for surface mount applications.

   c. All conduit shall be BLUE in color to clearly identify control system raceways.

      1) 2 inch and larger can be identified with blue vinyl taping at intervals of more than 10 feet and within 1 foot of conduit terminations. Box covers shall be machine printed labeled and painted blue.

      2) Existing conduit that is approved by the COR for reuse can be identified with blue vinyl taping at intervals of more than 10 feet and within 1 foot of conduit terminations. Box covers shall be machine printed labeled and painted blue.

   d. All conduit/flexible conduit and other raceways must be strapped and fastened as per NEC Electrical Code requirements.

      1) Flexible conduit shall be liquid tight(seal tight) flexible metal conduit.

   e. Rigid conduit shall be utilized for all exterior locations and interior locations below 10’.

   f. All exterior installations shall utilize stainless steel hardware and J-boxes. As an alternate, an approved weather shield may be provided as part of an assembly by a single manufacture.

g. Control wiring and conduit shall not block or restrict access to any serviceable areas (doors, openings, etc.)

6. Flexible metallic conduit with a maximum length of 6 feet shall be used for connections to motors, actuators, controllers and sensors mounted on vibrations producing equipment. Liquid-tight flexible conduit shall be used in exterior locations and interior locations subject to moisture.

7. Junction boxes: Where junction boxes are permissible. Interior J-boxes shall be galvanized pressed steel, nominal four inch square with blue cover. Exterior and damp location JH-boxes shall be cast alloy FS boxes with threaded hubs and covers with gaskets.

8. Where the space above the ceiling is a supply or return air plenum, the wiring shall be plenum rated. Teflon wiring can be run without conduit above suspended ceilings.

   a. Exception: Any wire run in suspended ceilings that must be intact for the fire management system to control building systems, shall be installed in conduit.

9. Low voltage wiring shall meet National Electric Code Class 2 requirements. Sub-fuse low voltage power circuits as required to meet Class 2 current limits.

10. All wiring in mechanical, electrical, or service rooms, or where subject to mechanical damage, shall be installed in RGC at levels below 10 feet.

11. Where Class 2 wiring is exposed, wiring is to be run parallel along a surface or perpendicular to it and neatly tied at 10 foot intervals. The wire shall be taunt and not have excessive loops.

12. Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.

13. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire to wire connections shall be at a terminal block.

14. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

15. Maximum allowable voltage for control wiring shall be 77 Volts. If only higher voltages are available, the contractor shall provide step-down transformers.

16. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.

17. Install plenum wiring in sleeves where it passes through walls and floors. Maintain the fire rating at all penetrations.

18. The size of raceway and size and type of wire shall be the responsibility of the contractor, in keeping with the manufacturer's recommendations and National Electric Code requirements, except as noted elsewhere.

19. Include one pull string in each raceway that is 1 inch in diameter or larger.

20. Use coded conductors throughout with conductors of different colors.

21. Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.

22. Conceal all raceways, except within mechanical, electrical, or service rooms. Install raceway, to maintain a minimum clearance of 6 inches from high-temperature equipment such as steam pipes or flues.

23. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.

24. Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of all vertical raceways.

25. Install grounding bushings on all raceway ends and openings to enclosures that carry 120 or above power cables.

26. The contractor shall terminate all control and/or interlock wiring and shall maintain updated as-built wiring diagrams with terminations identified at the job site.

27. Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with coupling according to code. Terminations must be made with fittings at boxes and ends not terminating in boxes shall have bushings installed.

B. Communication Wiring:

1. The contractor shall adhere to the items listed in the previous section on WIRING.

2. The contractor shall install all cabling in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.

3. The contractor shall not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.

4. Communication and signal wiring cables shall be protected by a surge arrestor device in the following instances:

   a. Vertical conduit/wiring. 100 feet or more (Known acceptable source: DTK-2LVLPLV manufactured by Ditek).
      1) Metal Oxide Varistor (MOV)
      2) Self-restoring after each surge within ratings.
      3) Let through voltage rating: 38 VRMS
      4) Response Time: <5 ns
      5) Surge Current: 2000 amps/pair
      6) Energy dissipation: 17 joules/pair
      7) Safety Approvals: UL 497B
      8) The ground shall be tied to the high energy ground system when available and provided by division 26.

   b. Underground conduit/wiring and above ground conduit/wiring exiting and/or entering the building envelope (Known acceptable source: DTK-2LVLPLV manufactured by Ditek).
      1) Metal Oxide Varistor (MOV)
      2) Self-restoring after each surge within ratings.
      3) Let through voltage rating: 38 VRMS

4) Response Time: <5 ns
5) Surge Current: 2000 amps/pair
6) Energy dissipation: 17 joules/pair
7) Safety Approvals: UL 497B

c. Ethernet (CAT 5e/ CAT 6) cabling that leaves the room it serves from panel to panel – for vertical runs and leaving the exterior of the building. (Known acceptable source: UPS-PNET1GB manufactured by APC.
1) Let through voltage rating: < 60v
2) Data line Protection: RJ45 10/100/1000 Base-T Ethernet Protection
3) Date lines Protected: 1-8
4) Safety Approvals: UL 497B

5. The contractor shall install all runs of communication wiring with un-spliced lengths when that length is commercially available.

6. The contractor shall label all communication wiring to indicate origination and destination data. All labels shall be shrink wrap machine printed. Hand written labels are not allowed.

7. When shielded wiring is use, the contractor shall ground the shield only once for each continuous segment of cable.

a. The shield shall be grounded at the NSC for the RS485 cable that connects to the NSC.

b. The shield shall be grounded at the RS485 router when a router is used to add a downstream RS485 LAN.

8. All wiring shall be terminated in an approved junction box, condulet or other approved enclosure.

9. All wiring shall be run continuously from origin to its final termination point.

10. Fiber Optic Cabling shall be used for any communication wiring runs longer than 300 feet and all vertical runs longer than 100 feet.

a. Fiber optic cable shall only be installed and terminated by an experienced contractor. The BMS contractor shall submit to the FAA the name of the intended contractor of the fiber optic cable with the project submittals.

b. Terminations shall be ST type using fusion splicing equipment. NICET certified.

c. Cable shall be tested with a light source and power meter to demonstrate acceptable performance.

d. The cable termination and converter shall be housed in a separate enclosure and provided with a power source.

C. General installation Practices for DDCP.

1. Critical Equipment controllers

a. Each critical space or system must be served by a dedicated AS-P/AS-B (NSC).

b. Redundant systems may be served by a dedicated AS-P/AS-B (NSC)

1) Where redundant systems are on the same AS-P the equipment shall be wired to be fail safe. In addition, each piece of equipment shall be connected to a

separate IO module such that a single IO module failure will not result in loss of service. In the event of a controller failure the system shall enable any equipment and operate the system on full cooling. Typical application would be chilled water and hot water systems including pumps.

2) Where redundant systems are on the same AS-B the equipment shall be wired to be fail safe. The equipment on a shared AS-B shall be self-controlling such that loss of controller function will not result in equipment being disabled. In the event of a controller failure the system shall enable any equipment and operate the system on full cooling. Typical application would be CRU's serving a single room.

c. For project specific critical areas coordinate with COR.

2. Non-Critical Controllers

a. Non-critical areas may use MP-C/RP-C/MP-V.

1) Controllers must be connected via RSTP topology failsafe loop with a managed switch or may be wired in a star topology. Typical application would be VAV's.

3. Power for Critical Equipment Controllers

a. Power shall be supplied from two separate panels. One panel is required to be essential or critical but the other panel may be non-essential. An automatic transfer switch or relay shall be used to transfer power between sources. See Division 26 for additional requirements.

b. Power feed shall have surge protection (Known acceptable source: DTK-120HW manufactured by Ditek).

1) Metal Oxide Varistor (MOV)
2) Self-restoring after each surge within ratings.
3) Clamping level: 130 VRMS/ 185V peak
4) Response Time: <5 ns
5) Surger Current: 19,500 amps
6) Energy dissipation: 255 joules
7) Agency Approvals: UL 1449, IEEE C62.41B

c. A local UPS shall be provided for panel to prevent power bump interruptions that occur during emergency generator startup. (known acceptable source: SUA500PDR-S manufactured by APC_ Note: A UPS is not required when one of the power sources is critical power.

1) Nominal Input Voltage: 120V
2) Input Connections: Hardwired Input (3-Wire: H-N-G)
3) Nominal Output Capacity: 500 VA/ 325 W
4) Nominal Output Voltage 120V
5) Output Connections: Hardwired Output (3-Wire; H-N-G)
6) Surge Energy Rating: 540 Joules
7) Filtering: Full time multi-pole noise filtering:
   a) 0.3% surge let-through
   b) Zero clamping response time.

c) Meets UL 1449

8) Certifications: cUl, UL 1778, FCC (Class A), CE (Class A) VDE

9) Runtime (full load): 8.5 minutes

10) Integrated Dry Contact I/O

D. General Installation Practices for Field Devices

1. Well mounted sensors shall include thermal conducting compound within the well to ensure good heat transfer to the sensor.

2. Actuators shall be firmly mounted to give positive movement and linkage shall be adjusted to give smooth continuous movement throughout 100 percent of the stroke.

3. Relay outputs shall include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.

4. Water line mounted sensors shall be removable without shutting down the system in which they are installed.

E. Temperature Sensors:

1. The contractor shall install sensors in accordance with the manufacturer's recommendations.

2. The location of sensors shall be as indicated on approved controls drawings and manufacture's recommendations.

3. The contractor shall mount sensors rigidly and adequately for the environment within which the sensor operates.

4. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing. Conduit shall be filled with safing. The area between sensor and wall shall have a rubber gasket.

5. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.

6. Sensors used in mixing plenums and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.

7. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across the duct. Each bend shall be supported with a capillary clip. Provide 1 foot of sensing element for each square foot of coil area.

8. All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in the thermal wells.

9. Install outdoor air temperature sensors on the north wall when available and as approved by the COR, complete with a sun shield at the designated location. May use chiller outside air temperature sensor but it must be direct wired and not over the network.

F. Differential air pressure and static pressure sensors:

1. The location of pressure sensors shall be as indicated on the mechanical drawings.

2. For supply duct static pressure, pipe the high pressure tap to a duct probe that measures at a 90 degree angle to flow (to measure only the static pressure and not the effects of

velocity). Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor if one is installed or to the plenum if a building static pressure sensor is not installed.

3. For return duct static pressure, pipe the high pressure tap to a duct probe that measures at a 90 degree angle to flow (to measure only the static pressure and not the effects of velocity). Pipe the low-pressure port to a tee in the low-pressure tap tubing of the corresponding building static pressure sensor if one is installed or to the plenum if a building static pressure sensor is not installed.

4. For building static pressure, pipe the low-pressure port of the sensor to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe the high-pressure port to a location behind a thermostat cover.

5. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.

6. All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels and not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without the use of ladders or special equipment to the maximum extent possible.

7. All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shutoff valves installed before the tee.

8. Annular pitot tubes shall be installed so that the total head pressure ports are set-in-line with the pipe axis upstream and the static port facing downstream. The total head pressure ports shall extend diametrically across the entire pipe. Annular pitot tubes shall not be used where the flow is pulsating or where pipe vibration exists.

G. Flow Meters

1. Install flowmeters in accessible locations in piping systems based on manufacturer’s recommendations regarding orientation and straight run requirements.

2. Install flowmeter elements with at least the minimum straight lengths of pipe, upstream and downstream from meter, required to produce the published flowmeter accuracy according to manufacturer's written instructions.

3. This contractor shall be responsible for connecting flowmeter transmitters to flow metering elements as required.

4. After installation, commission all meters according to manufacturer's written instructions.

5. Adjust faces of meters and gages to proper angle for best visibility. Refer to manufacturers written instructions.

6. Flowmeter schedule by application

   a. Flowmeter selection, including flow sensing technology and materials of construction shall be based on accuracy requirements, installation requirements, fluid characteristics and ambient conditions. Flowmeters shall be selected and installed in accordance with manufacturers recommendations. Refer to controls drawings for additional information regarding flow metering applications.

H. Actuators:

1. Damper actuators shall be provided with all mounting hardware and linkages.

2. Mount and link control damper actuators according to manufacturer's instructions.
3. When spring return actuators are used on normally closed dampers, the seals shall be compressed when the dampers have been closed by the actuator.
4. Damper/actuator combinations shall modulate smoothly from fully closed to fully open and return.
5. Electric/Electronic Damper Actuators shall be direct-mounted on the damper shaft or jackshaft unless shown as a linkage installation. They shall be mounted following the actuator manufacturer's recommendations.
6. Electric/Electronic Valve Actuators shall be connected to the valve with adapters approved by the actuator manufacturer. They shall be mounted following the actuator manufacturer's recommendations.
7. All actuator shall have a feedback point. All two position actuators must have two status switches.

I. Air Measuring Devices (AMD):

1. Locate AMD per manufacturer's recommendations.
2. Install AMD per manufacturer's recommendations.

3.4 HARDWARE INSTALLATION

A. Hardware Installation Practices for Wiring

1. All controllers are to be mounted vertically and per the manufacturer's installation documentation.
2. The 120VAC power wiring to each Ethernet or Remote Site controller shall be a dedicated run, with a separate breaker. Each run will include a separate hot, neutral and ground wire. The 120vac entering a DDC panel shall have a surge projection device type DTK-120HW or approve equal. The ground wire will terminate at the breaker panel ground. This circuit will not feed any other circuit or device.
3. A true earth ground must be available in the building. Do not use a corroded or galvanized pipe, or structural steel.
4. Wires are to be attached to the building proper at regular intervals such that wiring does not droop. Wires are not to be affixed to or supported by pipes, conduit, etc.
5. Conduit in finished areas will be concealed in ceiling cavity spaces, plenums, furred spaces and wall construction. Exception; metallic surface raceway may be used in finished areas on masonry walls. All surface raceway in finished areas must be color matched to the existing finish within the limitations of standard manufactured colors.
6. Conduit, in non-finished areas where possible, will be concealed in ceiling cavity spaces, plenums, furred spaces, and wall construction. Exposed conduit will run parallel to or at right angles to the building structure.
7. Wires are to be kept a minimum of three (3) inches from hot water, steam, or condensate piping.
8. Where sensor wires leave the conduit system, they are to be protected by a plastic insert.
9. Wire will not be allowed to run across telephone equipment areas.
10. Provide fire caulking at all rated penetrations per specification section 07 84 13 Penetration Firestopping.

B. Installation Practices for Field Devices

1. Well-mounted sensors will include thermal conducting compound within the well to insure good heat transfer to the sensor.
2. Actuators will be firmly mounted to give positive movement and linkage will be adjusted to give smooth continuous movement throughout 100 percent of the stroke.
3. Relay outputs will include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.
4. Water line mounted sensors shall be removable without shutting down the system in which they are installed.
5. For duct static pressure sensors, the high pressure port shall be connected to a metal static pressure probe inserted into the duct pointing upstream. The low pressure port shall be left open to the plenum area at the point that the high pressure port is tapped into the ductwork.
6. For building static pressure sensors, the high pressure port shall be inserted into the space via a metal tube. Pipe the low pressure port to the outside of the building.

C. Enclosures

1. For all I/O requiring field interface devices, these devices where practical will be mounted in a field interface panel (FIP). The Contractor shall provide an enclosure which protects the device(s) from dust, moisture, conceals integral wiring and moving parts.
2. FIPs shall contain power supplies for sensors, interface relays and contactors, and safety circuits. The 120vac entering a FIP shall have a surge projection device type DTK-120HW or approve equal.
3. The FIP enclosure shall be of steel construction with baked enamel finish; NEMA 1 rated with a hinged door and keyed lock. The enclosure will be sized for twenty percent spare mounting space. All locks will be keyed identically.
4. All wiring to and from the FIP will be to screw type terminals. Analog or communications wiring may use the FIP as a raceway without terminating. The use of wire nuts within the FIP is prohibited.
5. All outside mounted enclosures shall meet the NEMA-4 rating.
6. The wiring within all enclosures shall be run in plastic track. Wiring within controllers shall be wrapped and secured.

D. Identification of Hardware and Wiring

1. The contractor shall label all wiring and cable, including that within factory-fabricated panels, at each end and within 2 inches of the end of the cable with the DDC address or termination number. The labels shall be shrink wrap type and machine printed.
2. The contractor shall label all pneumatic tubing at each end within 2 inches of the end with a descriptive identifier.
3. The contractor shall label or code each point of field terminal strips to show the instrument or item served.
4. The contractor shall label all control panels with minimum ½ inch letters on laminated plastic nameplates.
5. The contractor shall identify all other control components with permanent labels. All plug-in components shall be labeled on both the removable component and the permanently installed base such that it is obvious where the removed component is to be re-installed.

6. The contractor shall label room sensors relating to terminal box or valves with nameplates.

7. Manufacturer's nameplates and UL or CSA labels are to be visible and legible after equipment is installed.

8. All identifiers shall match the as-built documents.

E. Warning Labels:

1. The contractor shall affix permanent warning labels to all equipment that can be automatically started by the DDC system.

a. Labels shall use white lettering, 12 point type or larger, on a red background.

b. The labels shall read: "CAUTION: This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to the OFF position before servicing."

2. The contractor shall affix permanent warning labels to all motor starters and all control panels that are connected to multiple power sources utilizing separate disconnects.

a. Labels shall use white lettering, 12 point type or larger, on a red background.

3. The labels shall read: "CAUTION: This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing."

F. Existing Controls.

1. Existing controls which are to be reused must each be tested and calibrated for proper operation. Existing controls which are to be reused and are found to be defective requiring replacement, will be noted to the COR. The FAA will be provide direction as required.

G. Location

1. The location of sensors is per mechanical and controls drawings.

2. Space humidity or temperature sensors will be mounted away from machinery generating heat, direct light and diffuser air streams.

3. Outdoor air sensors will be mounted on the north building face directly in the outside air. Install these sensors such that the effects of heat radiated from the building or sunlight is minimized.

4. Field enclosures shall be located immediately adjacent to the controller panel(s) to which it is being interfaced.

H. Software Installation

1. The Contractor shall provide all labor necessary to install, initialize, start-up and debug all system software as described in this section. This includes any operating system software or other third party software necessary for successful operation of the system.

3.5 ON-SITE TRAINING

A. The BAS system supplier shall provide both on-site and classroom training to the FAA's representative and maintenance personnel per the following description:

B. On-site training shall consist of a minimum of (40) hours of hands-on instruction geared at the operation and maintenance of the systems. The curriculum shall include

1. System Overview
2. System Software and Operation
3. System access
4. Software features overview
5. Changing setpoints and other attributes
6. Scheduling
7. Editing programmed variables
8. Displaying color graphics
9. Running reports
10. Workstation maintenance
11. Viewing application programming
12. Operational sequences including start-up, shutdown, adjusting and balancing.
13. Equipment maintenance

C. The Contractor shall provide six weeks' notice of the scheduled time for the delivery of the on-site training defined in Part 1 of this specification.

D. The training shall be conducted by an individual that is familiar with the installed system.

E. The extent of the training and the methodology of delivery shall conform to the information submitted in advance.

F. The training program is a formal event with hands on activities by the students. It is not a "Watch Me" event. Competency is the objective.

3.6 CONTROL SYSTEM SWITCH-OVER

A. Demolition of the existing control system will occur after the new temperature control system is in place including new sensors and new field interface devices.

B. Switch-over from the existing control system to the new system will be fully coordinated with the COR. A representative of the FAA will be on site during switch-over.

C. The Contractor shall minimize control system downtime during switch-over. Sufficient installation mechanics will be on site so that the entire switch-over can be accomplished in a reasonable time frame.

3.7 DATABASE CONFIGURATION.

A. The Contractor will provide all labor to configure those portions of the database that are required by the points list and sequence of operation.

3.8 GRAPHIC PAGES

A. Graphic Page Requirements

1. The sequence of control defines the buildings and all of the equipment items to be controlled by the BMS. Graphic pages shall be constructed as described below as applicable (If a central plant is not part of this project, the requirements described below for central plant graphics are moot).
2. The contractor shall develop additional graphic pages to be defined by the owner during the construction period as follows:
    a. Up to five additional pages per building.
    b. Up to twenty additional global pages when a project involves more than one building.

B. Hierarchy

1. The organization of graphic pages shall be from a global level down to a very detailed level through a series of links.
2. Linking shall allow the operator to move down the hierarchy, up the hierarchy and laterally within the hierarchy.

C. Hierarchy Outline

1. Site Plan Page: A visual representation of the site (map). One page or multiple linked pages depending on the size of the site plan.
    a. Link to individual building graphic pages.
    b. Display outdoor weather conditions.
2. Utility Management Page: A summary of data on the utility consumption for the site.
    a. Link up to the site plan.
    b. Display
        1) Utility consumption data.
            a) Demand data.
            b) Voltages, currents and power factors.
            c) Demand control actions currently in effect.
    c. Presenting the utility management data may require more than one graphic page to effectively report the data from multiple meters.
3. Building Graphic Page: Typically a picture of the building. One page per building.
    a. Link to floor plans within the building.
    b. Link to central plant graphics where the plant serves the entire building.
    c. Link to delivery systems if the delivery system serves the entire building
    d. Link up to the site plan.
4. Floor Plan Page: This will be a two dimensional plan of a floor area. A minimum of one page per floor per building is required. Where floor plans are large, multiple linked pages are required. For each control zone the value of the controlled parameters shall be displayed. This will typically be lighting status, temperature and relative humidity if relative humidity is a controlled variable.
    a. Link up to the Building page.

b. Link up to the Site Plan page.

c. Link to any delivery system that serves the floor plan area (air handling unit is typical).

d. Link to time schedules that affect the systems that serve the area

e. Link to a Terminal Unit Summary page where multiple zones on the floor are served by unitary control devices such a VAVs or fan coil units.

f. Individual control zones shall be identified.

g. The location of terminal equipment serving each zone shall be shown.

h. The location of sensors installed in the occupied space shall be shown.

i. Where room numbers are available, they shall be shown.

5. Central Plant Page: A graphical representation of the equipment that makes up the plant such as chillers, pumps, boilers, towers etc. If the plant is small, this graphic will display the values of process variables and commands to end devices. If the plant is complex this graphic will just contain links to equipment graphics. A page for each plant is required.

   a. Link up to the Building page.

   b. Link up to the Site Plan page.

   c. Link to Central Plant Equipment Component page (chiller, pumps, tower, etc.).

   d. The graphic representation of the equipment shall be 3-dimensional.

   e. Display:

      1) Process variables.

      2) Commands to end devices.

      3) Status of end devices.

      4) Alarm points if this is the only central plant graphic.

      5) Plant status (enabled/disabled).

      6) Demand control status.

   f. Link to any time schedules that affect the operation of the plant.

   g. Link to any pre-configured trend charts associated with the performance of the plant.

   h. Link to a Central Plant Configuration Page.

6. Central Plant Equipment Component Page: A graphical representation of an element of equipment such as a chiller, pumps, boiler or tower or some combination of all of these. A page for each primary equipment item per plant is required.

   a. Link up to the Central Plant page.

   b. Link up to the Building page.

   c. Link up to the Site Plan page.

   d. The graphic representation of the equipment shall be 3-dimensional.

   e. Display:

      1) Process variables.

      2) Commands to end devices.

3) Status of end devices.
4) Alarm points.
5) Equipment status (enabled/disabled).
6) Demand control status.

f. Link to any time schedules that affect the operation of the equipment component.

g. Link to any pre-configured trend charts associated with the performance of the equipment component.

h. Link to a Central Plant Configuration Page.

7. Central Plant Configuration Page: On this page the operator is given access to the configuration parameters for the entire plant or a piece of equipment in the plant. Typically, this page presents data in a tabular format. The type of data on this page is not changed frequently, but the operator may wish to view it frequently. One page per plant for small plants and one page per primary equipment item per plant for larger plants are required.

a. Set Points.

b. Tuning Parameters.

c. Calibration Parameters.

d. Timing Parameters.

e. Application parameters.

f. Reset Schedules.

g. Lead Lag Information.

h. Time Schedules.

i. Link up to the Equipment or Central Plant page.

j. Link up to the Building page.

8. Delivery System Page: A graphical representation of an air or water delivery system such as an air handling unit, roof top air handling unit, computer room air conditioning unit. One page for each delivery system.

a. If the Delivery System serves a specific floor area, link up to the Floor Area page.

b. Link up to the Building page.

c. Link up to the Site Plan page.

d. Link to the Central Plant page if the Delivery System is served by a Central Plant.

e. If the Delivery System supplies multiple terminal devices, link to a Terminal Unit Summary page.

f. Link to a Delivery System Configuration page.

g. The graphical representation of the equipment shall be 3-dimensional and represent the true physical characteristics of the installed system.

h. Display:

1) Process variables.

2) Commands to end devices.
3) Status of end devices.
4) Status of different modes (economizer on/off, mechanical cooling enabled/disabled, occupied/unoccupied).
5) Alarm points.

i. Link to any time schedules that affect the system operation.

j. Link to any pre-configured trend charts for the system.

9. Delivery System Configuration Page: On this page the operator is given access to the configuration parameters for the delivery system. Typically, this page presents data in a tabular format. The type of data on this page is not changed frequently, but the operator may wish to view it frequently. One page per delivery system is required.

a. Display:
1) Set Points.
2) Tuning Parameters.
3) Calibration Parameters.
4) Timing Parameters.
5) Application parameters.
6) Reset Schedules.
7) Lead Lag Information
8) Time Schedules.

b. Link up to the Delivery System page.

c. Link up to the Building page.

d. Link up to the Site Plan page.

10. Terminal Equipment Summary Page: On this page the dynamic data and set points that are associated with multiple terminal units are presented in a tabular format. The objective is to present a summary of terminal unit performance for an area of the facility. One page is required for each group of terminal units. In the tabular data, do not use less than 12 pt font size. Multiple linked pages may be used if there are a large number of terminals served by one delivery system.

a. Display in the table:
1) Process variables.
2) Set points for each process.
3) Command to each end device.
4) Status of each end device.
5) Load factors such as terminal load for a VAV terminal unit.

b. Link to the page for each Terminal Unit.

c. Link up to the Delivery System page.

d. Link up to the Floor Plan page.

e. Link up to the Building page.

f. Link up to the Site Plan page.

11. Terminal Unit Page: A graphical representation of a terminal unit such as a VAV terminal or fan coil terminal. One page for each terminal unit.
    a. Link up to the Terminal Summary page.
    b. Link up to the Floor Plan page.
    c. Link up to the Building page.
    d. Link up to the Site Plan page.
    e. The graphic representation of the equipment shall be 3-dimensional and shall represent the actual installed terminal unit (if the VAV does not have a fan, a fan should not be shown, etc.).
    f. Display
        1) Process variables.
        2) Command to end devices.
        3) Status of end devices.
        4) Set points for each process.
        5) Modes (auto, heat, cool, etc.).
        6) Capacity indicators (terminal load, %heat, %cool, etc.).
        7) Reset schedules.
        8) Occupancy commands and status.
        9) Alarm points.

D. For all points on a graphic page that are subject to being under manual or test mode, the display shall indicate when test mode or manual mode has been applied to the point.

3.9 DEFAULT GRAPHIC PAGES

A. It shall be possible to assign a specific graphic page as a “Default System Graphic” for each User Group and/or each User setup within the system.

B. When a User signs onto the system, the “Default System Page” shall be displayed. Using links, the User may then move from page to page within the system.

3.10 AUTOMATIC TIME OUT

A. When a workstation detects no activity for a specific period of time, the system shall automatically logout the connected user.

B. The same User or a different User shall then be required to enter their User Name and Password to re-enter the system.

3.11 TREND DATA PRESENTATION

A. Trend data shall be presentable in a trend log list with the time stamp and value presented in two columns of data.
    1. It shall be possible to copy the data from a trend log list to Microsoft Excel.

B. Trend data shall be presented in trend charts where one or more variables are displayed graphically with the value on the "Y" axis and time on the "X" axis.

1. Each trend chart shall support up to two sets of engineering units for the "Y" axis, one on the left axis and one on the right axis.

2. A single chart may be used to display multiple trend logs as long as the trend logs use one of the two possible engineering unit scales.

3. All trend logs shall be included in a trend chart. The operator shall not be required to create a chart to view the data.

4. The creation process for trend charts shall be native to the system and not require a third party software package.

5. At the operator's discretion, polling based trend data shall be presented in a trend chart format.

3.12 DYNAMIC APPLICATION FLOW CHARTS

A. Graphically programmed applications in the NSC shall have a graphical viewer that allows the application to be presented in real time with current values displayed on the graphical program with periodic updates. This graphical viewer shall present itself via workstation.

B. Graphically programmed applications in programmable process controllers and supervisory logic controllers shall allow the application to be presented in real time with current values displayed on the graphical program with periodic updates. This viewer shall present itself to a directly connected service laptop running the application programming tool.

3.13 USER GROUPS

A. The contractor shall configure four users groups, one for each level of security. The group names shall be representative of the "names" below:

1. Administrators

2. Engineers

3. Operators

4. Viewers

B. Users

1. The contractor shall configure two users in each user group. The names and passwords shall be representative of the "names" below:

a. Administrators Group

1) Admin1 / Admin1

2) Admin2 / Admin2

b. Engineers Group

1) Engr1 / Engr1

2) Engr2 / Engr2

c. Operators Group
   1) Oper1 / Oper1
   2) Oper2 / Oper2

d. Viewers Group
   1) View1 / View1
   2) View2 / View2

2. Administrators shall have full authority over the entire system.

3. Engineers shall have the ability to create, edit, control and view but they shall not be able to add users or set passwords.

4. Operators shall have the ability to control and view only.

5. Viewers shall have the ability to view only.

C. With the exception of the Viewers Group, these users shall not be added to the system until all testing has been completed and the system has been accepted. The contractor shall accept all responsibility for actions that result from the unauthorized issuance of user names and passwords above the level of viewers prior to system acceptance unless specifically instructed to do so in writing by the owner.

3.14 ALARM PROCESSING

A. All alarms required by the sequence of control shall be fully configured for delivery to the operator workstations and the alarm files.

B. A common alarm viewer shall be established to receive alarms from all of the field devices.

C. A separate alarm viewer shall be established on a per building basis to receive just the alarms from that building.

D. It shall be possible to setup unique alarm viewers based on the alarm category (a number from 1 to 1000 assigned to each alarm).

E. The alarm messages shall be descriptive and include as a minimum:

1. System identification

2. Date

3. Time

4. Nature of the alarm such as high value, low value, or fail to start.

F. The system shall be configured to send an alarm message on return to normal.

G. Upon system turnover, all users shall receive all alarms but the system shall have the ability to expose alarm messages to specific users or user groups as desired by the system manager.

3.15 START-UP TESTING

A. The contractor shall furnish all labor and test apparatus required to execute the startup testing plan. Key tasks to be executed and documented in the start-up testing report include:

1. Verification of all primary and secondary voltages.
2. Verification that power wiring for all devices conforms to manufacturer's instructions.
3. Verification that all labeling is in place.
4. Inspection of wiring for loose strands and tight connections.
5. Verification of field bus topology, grounding of shields (if used) and installation of termination devices.
6. Verification that all devices are installed per the submittal.
7. Verification that each I/O device is landed per the submittals and functions per the sequence of control.
    a. Analog sensors shall be properly scaled and a value reported to the OWS.
    b. Binary sensors shall have the specified normal position and the correct state is reported to the OWS.
    c. Analog outputs have the specified normal position and move full stroke when so commanded.
    d. Binary outputs have the specified normal state and respond to energize/de-energize commands.

B. The start-up testing report shall identify the date each task was completed and include the initials of the technician performing the task.

C. The Contractor shall keep the COR informed of the start-up testing schedule. At least one week's notice must be provided so that the COR and/or commissioning agent may observe the execution of the start-up tasks.

3.16 CALIBRATION

A. The Contractor shall ensure that all analog sensors have been calibrated with high quality instrumentation suitable for the sensor being calibrated.

1. The instruments shall display a current (12 month) NIST traceable calibration sticker. Associated instrument calibration certificates shall be made available within 24 hours of a request.
2. The measured value, reported value, and the calculated offset that was entered into the database shall be recorded.
3. The calibration criteria shall be:
    a. Space Temperature: +/- 0.5 degrees F
    b. Air Temperature: +/- 0.5 degrees F
    c. Fluid Temperature: +/- 0.5 degrees F
    d. Air Flow Rate: +/- 5 %

e. Liquid Flow Rate: +/- 5 %

f. Differential Pressure: +/- 3 %

g. Gauge Pressure: +/- 5%

h. Relative Humidity: +/- 3 % relative humidity

i. CO2: +/- 2 %

B. The Contractor shall document all calibration tasks:

1. Name and location of the sensor
2. Measured value
3. Reported value
4. Date of calibration
5. Initials of the technician performing the task
6. The Calibration Report shall include all of the above.

C. The Contractor shall keep the COR informed of the calibration schedule. At least one week's notice must be provided so that the COR and/or commissioning agent may observe the execution of the calibration tasks.

3.17 LOOP TUNING

A. The contractor shall tune all P, PI and PID control loops under typical operating conditions. Example: A chilled water control loop typically operates between 50 and 65 degrees F. The loop shall be tuned when the chilled water is within this typical operating range. This may require off-season tuning.

B. The PID control applications shall provide for stable changes to loop set points (how often and by how much), so that derivative control is not required unless absolutely necessary.

C. The loop tuning criteria shall be a stable control loop where the average error over 15 minutes and 30 samples shall be less than:

1. Space Temperature: +/- 0.75 degrees F
2. Air Temperature: +/- 1.50 degrees F
3. Air Humidity: +/- 5 % relative humidity
4. Chilled Water Temp: +/- 1.00 degrees F
5. Hot Water Temp: +/- 1.00 degrees F
6. Duct Pressure: +/- 0.2 inches w.g.

D. The Contractor shall document all loop tuning tasks.

1. Name and location of the control loop
2. Results of the tuning
   a. Gain in percent per unit of measure

b. Integral time constant in seconds or Integral Gain in percent per unit of measure per second

E. The Contractor shall keep the FAA informed of the tuning schedule. At least one week's notice must be provided so that the COR and/or commissioning agent representative may observe the execution of the tuning tasks.

3.18 PERFORMANCE VERIFICATION TESTING

A. The Contractor shall verify that the performance of the system conforms to the sequence of control.

1. The Contractor shall execute a series of cause and effect tests to ensure that each aspect of the sequence of control is fully implemented.

B. The Contractor shall document:

1. A definition of each functional test
2. The date the test was conducted
3. The initials of the technician performing the test

C. The Contractor shall keep the Owner informed of the tuning schedule. At least one week's notice must be provided so that the Owner or Owner's representation may observe the execution of the functional testing.

D. This work shall be coordinated with the commissioning agent if applicable.

3.19 OPERATOR INTERACTION TESTING

A. The Contractor shall verify that the performance of the system conforms to the drawings and specification for both an operator workstation and a web based operator interface.

1. Graphics navigation
2. Trend data collection and presentation
3. Alarm handling, acknowledgement and routing
4. Time schedule editing
5. User adjustable parameter adjustments
6. Manual control of points and values
7. System backup process

B. The Contractor shall document:

1. A brief description of each task
2. The date the test was conducted
3. The initials of the technician performing the test

C. The Contractor shall keep the FAA informed of the operator interaction testing schedule. At least one week's notice must be provided so that the COR and/or commissioning agents representative may observe the execution of the testing.

3.20 PERSONNEL AND EQUIPMENT FOR TESTING

A. The Contractor shall provide all labor and equipment required to perform:

1. Start-Up Testing
2. Functional Testing
3. Calibration
4. Tuning
5. Operator Interaction Testing

B. The Contractor personnel conducting the testing shall be competent with and knowledgeable of all project specific systems, hardware and software.

3.21 FAILURES AND RE-TESTING

A. The Contractor shall ensure that all tests achieve satisfactory results.

B. Failures of any test shall result in corrective action and re-testing by the Contractor.

3.22 DOCUMENTATION

A. As built software documentation will include the following:

1. Descriptive point lists
2. Application program listing
3. Application programs with comments.
4. Printouts of all reports.
5. Alarm list.
6. Printouts of all graphics
7. Commissioning and System Startup
8. An electronic copy of all databases, configuration files, or any type of files created specifically for each system.

END OF SECTION 23 09 23