REQUEST FOR PROPOSAL

September 5, 2018

Dear Sir or Madam:

The Cartersville School System invites you to submit a proposal on the following items.

Purchase and Installation a Siemens Talon Building Automation System for Cartersville Elementary School

Return your sealed pricing bid clearly marked **on the outside of the envelope or package to:**

Dr. Marc Feuerbach, Superintendent
Cartersville School System
RFP # 0220-0905-103 ENCLOSED
P.O. Box 3310, 15 Nelson Street
Cartersville, Georgia 30120

no later than 2:00 p.m., Wednesday, October 3, 2018.

The Cartersville School Board reserves the right to accept and/or reject any and all bids.

We invite your participation.

Respectfully,

Marc Feuerbach, Ed.D.
Superintendent

Enclosures

INSTRUCTION TO BIDDERS

1. Proposals are due no later than 2:00 PM., Wednesday, October 3, 2018, and shall be opened publicly at that time.

2. **Proposals must be submitted on the forms enclosed**. Bidders may attach other appropriate information to best evaluate the proposal.

3. Proposals must meet the requirements relating to any and all Georgia Department of Education guidelines.

4. There will be a mandatory pre-bid meeting will be held on Tuesday, September 18, 2018 @ 10:00 AM EST. at the Cartersville City Schools Central Office located at 15 Nelson Street, Cartersville Georgia.

5. The Cartersville School Board reserves the right to accept or reject any and all proposals.

6. Work is to begin no earlier than October 10, 2018 and must be completed no later than November 30, 2018.

7. Payment will be made within 30 days of the completion of project.

8. Proposals will be evaluated on price, starting date and completion date.

10. **Contractor must remove existing thermostats and controllers without damage, place in an appropriate container and returned to the Owner.**

11. Contractor must provide a copy of **Certificate of Liability Insurance, E-Verification number, Workers Compensation Insurance and a W-9 form.**

12. Contactor is responsible for the total number thermostats, sensors and controllers required to complete the project and provide a fully operational system based on the requirements of the RFP.

13. Further information regarding the RFP can be obtained by email only:

Ken Paige
Director of Operations
Cartersville City Schools
kpaige@cartersvilleschools.org

Dean Williams
Supervisor of Maintenance
Cartersville City Schools
dwilliams@cartersvilleschools.org

PROPOSAL FORM

Please include this cover sheet as (page 1) of your proposal

Cartersville School System
P.O. Box 3310
15 Nelson Street
Cartersville, Georgia 30120

We have carefully examined and fully understand the Instructions to Bidders and other documents found in the specifications as prepared by you.

We propose to enter into a contract to furnish the materials and deliver services as specified at the price listed below. We also assure you that a company representative will be readily available to assist in reviewing the materials and services.

Total bid proposal price for **Purchase and Installation a Siemens Talon Building Automation System for Cartersville Elementary School**

$ _____

_____
Name of Company

_____
Signature of Company Representative Authorized to Submit this Proposal

_____
Printed Name of Representative

_____
Business Address/ Street, City, State, Zip Code

_____ _____ _____
Phone Number Fax Number Email

Office use only

SPECIFICATIONS

PART 1 - GENERAL

1.1.1.1 SUMMARY

A. This Section includes control equipment and installation for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-furnished controls.

B. See "Sequences of Operation" for requirements that relate to this Section.

1.1.1.2 RELATED DOCUMENTS

A. Drawings and Specification Sections of the Contract, including General and Supplementary Conditions, apply to this Section.

1. Division 01 – General and Special Requirements
2. Division01 – Submittal Requirements
3. Division01 – Materials and Equipment
4. Division23 – Common Work Results for HVAC
5. Section 23 – Variable Frequency Drives
6. Division 23 – Sequences of Operation
7. Division23 – Testing, Adjusting, and Balancing for HVAC
8. Division26 – General Electrical Provisions for Electrical Work
9. Division26 – Common Work Results for Electrical
10. Division26 – Low Voltage Electrical Power Conductors and Cables
11. Division26 – Hangers and Supports for Electrical Systems
12. Division26 – Raceway and Boxes for Electrical Systems
13. Division26 – Identification for Electrical Systems
14. Division 26 – Wiring Devices

1.1.1.3 ABBREVIATIONS

A. AAC: Advanced Application Controller

B. AHU: Air Handling Unit.

C. ALN: Automation Level Network

D. ASC: Application Specific Controller

E. ASHRAE: American Society of Heating Refrigerating and Air-Conditioning Engineers

F. BAS: Building Automation System

G. BC: Building Controller

H. BIBB: BACnet Interoperability Building Blocks

I. BIM: Building Information Modeling

J. BMS: Building Management System.

K. CFM: Cubic Feet per Minute.

L. DCV: Demand Controlled Ventilation

M. DDC: Direct digital controls

N. EIA: Electronics Industries Alliance

O. EMI: Electro-Magnetic Interference

P. EP: Electric-to-Pneumatic

Q. FAS: Fire Alarm System.

R. FLN: Floor Level Network

S. FCU: Fan Coil Unit

T. HMI: Human Machine Interface

U. HVAC: Heating, Ventilating and Air Conditioning.

V. IEEE: Institute of Electrical and Electronic Engineers

W. I/O: Input/Output

X. IP: Internet Protocol

Y. IT: Information Technology

Z. LAN: Local area network.

AA. LCD: Liquid Crystal Display

BB. LED: Light Emitting Diode

CC. MER: Mechanical Equipment Room.

DD. MLN: Management Level Network

EE. MS/TP: Master-slave/token-passing.

FF. NEMA: National Electric Manufacturers' Association

GG. NFPA: National Fire Protection Association

HH. OEM: Operator Equipment Manufacturer

II. PC: Personal Computer

JJ. PICS: Protocol Implementation Conformance Statement

KK. PID: Proportional Integral Derivative.

LL. POT: Portable Operators Terminal.

MM. RAM: Random Access Memory

NN. RFI: Radio Frequency Interference

OO. RTD: Resistance Temperature Device

PP. TAB: Testing and Balancing

QQ. TCP: Transfer Control Protocol

RR. UDP: User Datagram Protocol

SS. UL: Underwriters Laboratories

TT. UPS: Uninterruptable Power Supply

UU. VAV: Variable Air Volume

VV. VFD: Variable Frequency Drive.

WW. WAN: Wide Area Network.

1.1.1.4 DEFINITIONS

A. BACnet: An industry standard data communication protocol for Building Automation and Control Networks. Refer to the latest version of AHSRAE standard 135.

B. Scope Terminology

1. Provide = Furnish equipment, engineer, program and install
2. Furnish = Furnish equipment, engineer and program
3. Mount = securely fasten or pipe
4. Install = mount and wire
5. Wire = wire only

1.1.1.5 WORK INCLUDED

A. The BAS Contractor shall provide a complete and operational system that will perform the sequences of operation as described herein.

B. Furnish a complete distributed direct digital control system in accordance with this specification section. This includes all system controllers, logic controllers, and all input/output devices. Items of work included are as follows:

1. Provide a submittal that meets the requirements below for approval.
2. Coordinate installation schedule with the mechanical contractor and general contractor.
3. Provide installation of all panels and devices unless otherwise stated.
4. Provide power for panels and control devices unless otherwise stated.
5. Provide all low voltage control wiring for the DDC system.
6. Provide miscellaneous control wiring for HVAC and related systems regardless of voltage.
7. Provide engineering and technician labor to program and commission software for each system and operator interface. Submit commissioning reports for approval.
8. Provide testing, demonstration and training as specified below.

C. The installation of the control system shall be performed under the direct supervision of the controls manufacturer with the shop drawings, flow diagrams, bill of materials, component designation, or identification number and sequence of operation all bearing the name of the manufacturer.

1.1.1.6 TECHNICAL PROPOSAL

A. Technical proposals shall be prepared in accordance with these specifications. Three (3) copies of the proposal shall be submitted with the bid. Proposals that are unbound, loose in a file folder, stapled, stapled in a manila file folder, etc., will not be acceptable. The technical proposal shall include the following data/information as a minimum. The order of listing here is not intended to indicate, nor should it be construed to indicate, the relative importance of the data/information:

1. Information on organizational capability to handle this project (management, personnel, manufacturing, single source responsibility, etc.).

2. Information on training program to demonstrate specification compliance.

3. System Configuration as Proposed:

    a. Describe system architecture including a schematic layout with location and type (model number) of all control panels.

    b. Describe system operation, functions and control techniques.

    c. Modularity.

    d. Migration strategies to protect owner's investment in BMS system.

4. Technical data to support the information on the hardware and software proposed for this solution including any integrated systems and/or solutions.

5. Detailed description of all operating, command, application and energy management software provided for this project.

6. A signed certificate stating the Contractor "has read the performance and functional requirements, understands them and his technical proposal will comply with all parts of the specification."

7. Line-by-line specification concordance statement.

8. Other requirements for inclusion in the technical proposal are located throughout this specification.

B. Submit technical proposals with pricing in accordance with Instructions to Bidders.

C. Failure to submit technical proposal containing the information outlined above will result in rejection of bidder's proposal.

1.1.1.7 SUBMITTALS

A. Provide submittals for fast track items that need to be approved and released to meet the schedule of the project. Provide submittals for the following items separately upon request:

1. Valve schedule and product data
2. Damper schedule and product data
3. Mounting and wiring diagrams for factory-installed control components
4. Thermostat locations

B. Provide a complete submittal with all controls system information for approval before construction starts. Include the following:

1. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
2. Wiring Diagrams: Power, signal, and control wiring. Detail the wiring of the control devices and the panels. Show point-to-point wiring from field devices to the control panel. Show point-to-point wiring of hardwired interlocks. Show a ladder diagram or schematic of wiring internal to the panels, including numbered terminals. Clearly designate wiring that is done at a factory, at a panel shop or in the field.
3. Details of control panel faces, including sizes, controls, instruments, and labeling.
4. Schedule of dampers and actuators including size, leakage, and flow characteristics. If dampers are furnished by other, submit a damper actuator schedule coordinating actuator sizes with the damper schedule.
5. Schedule of valves including leakage and flow characteristics.
6. Written description of the Sequence of Operations.
7. Network riser diagram showing wiring types, network protocols, locations of floor penetrations and number of control panels. Label control panels with network addresses and BACnet device instance numbers. Show all routers, switches, hubs and repeaters.
8. Point list for each system controller including both inputs and outputs (I/O), point numbers, controlled device associated with each I/O point, and location of I/O device.
9. Starter and variable frequency drive wiring details of all automatically controlled motors.
10. Reduced size floor plan drawings showing locations of control panels, thermostats and any devices mounted in occupied space.
11. Product Data: Include manufacturer's technical literature for each control device indicated, labeled with setting or adjustable range of control. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated. Submit a write-up of the application software that will be used on the operator workstation including revision level, functionality and software applications required to meet the specifications.

12. Submit BACnet Protocol Implementation Conformance Statements (PICS) for all direct digital controllers, software and other system components that will communicate on the BAS utilizing BACnet.

C. Submit a description of the application software that will be used on the operator workstation including revision level, functionality and software applications required to meet the specifications.

D. Submit blank field checkout and commissioning test reports, customized for each panel or system, which will be filled out by the technician during start-up.

E. Variance letter: Submit a letter detailing each item in the submission that varies from the contract specification or sequence of operation in any way.

F. After the BAS system is approved for construction, submit sample operator workstation graphics for typical systems for approval. Print and submit the graphics that the operator will use to view the systems, change setpoints, modify parameters and issue manual commands. Programming shall not commence until typical graphics are approved.

G. Operation and Maintenance Data: In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:

1. Product data with installation details, maintenance instructions and lists of spare parts for each type of control device.

2. Keyboard illustrations and step-by-step procedures indexed for each operator function.

3. Inspection period, cleaning methods, cleaning materials recommended and calibration tolerances.

4. Calibration records and list of set points.

1.1.1.8 PROJECT RECORD DOCUMENTS

A. Project Record Documents: Submit three (3) copies of record (as-built) documents upon completion of installation. Submittal shall consist of:

1. Project Record Drawings. As-built versions of the submittal shop drawings provided as AutoCAD compatible files in electronic format and as 11 x 17 inch prints.

2. Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements in the Control System Demonstration and Acceptance section of this specification.

3. Operation and Maintenance (O & M) Manual.

a. As-built versions of the submittal product data.

b. Names, addresses, and 24-hour telephone numbers of installing contractors and service representatives for equipment and control systems.

c. Operator's Manual with procedures for operating control systems, logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.

d. Programming manual or set of manuals with description of programming language and of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.

e. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.

f. Documentation of all programs created using custom programming language, including setpoints, tuning parameters, and object database.

g. Graphic files, programs, and database on electronic media.

h. List of recommended spare parts with part numbers and suppliers.

i. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware, including computer equipment and sensors.

j. Complete original original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.

k. Licenses, guarantees, and warranty documents for equipment and systems.

B. Operating manual to serve as training and reference manual for all aspects of day-to-day operation of the system. As a minimum include the following:

1. Sequence of operation for automatic and manual operating modes for all building systems. The sequences shall cross-reference the system point names.

2. Description of manual override operation of all control points in system.

3. BMS system manufacturers complete operating manuals.

C. Provide maintenance manual to serve as training and reference manual for all aspects of day-to-day maintenance and major system repairs. As a minimum include the following:

1. Complete as-built installation drawings for each building system.

2. Overall system electrical power supply schematic indicating source of electrical power for each system component. Indicate all battery backup provisions.

3. Photographs and/or drawings showing installation details and locations of equipment.

4. Routine preventive maintenance procedures, corrective diagnostics troubleshooting procedures, and calibration procedures.

5. Parts list with manufacturer's catalog numbers and ordering information.

6. Lists of ordinary and special tools, operating materials supplies and test equipment recommended for operation and servicing.

7. Manufacturer's operation, set-up, maintenance and catalog literature for each piece of equipment.

8. Maintenance and repair instructions.

9. Recommended spare parts.

D. Provide Programming Manual to serve as training and reference manual for all aspects of system programming. As a minimum include the following:

1. Complete programming manuals, and reference guides.

2. Details of any custom software packages and compilers supplied with system.

3. Information and access required for independent programming of system.

1.1.1.9 QUALITY ASSURANCE

A. Codes

1. Perform all wiring in accordance with Division 26, NEC, local codes and Owner's requirements.

2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

3. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."

4. Comply with ASHRAE 135-2010 BACnet: A Data Communication Protocol for Building Automation and Control Networks.

5. Comply with ASHRAE 90.1-undefined2007undefinedundefined2010undefined[object Object]2013undefined Energy Standard for Buildings Except Low-Rise Residential Buildings.

6. All equipment shall be UL listed and approved and shall meet with all applicable NFPA standards, including UL 916 - PAZX Energy Management Systems,

   a. Provide written approvals and certifications after installation has been completed.

7. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

8. The manufacturer of the building automation system shall provide documentation supporting compliance with ISO-9002 (Model for Quality Assurance in Production, Installation, and Servicing) and ISO-140001 (The application of well-accepted business management principles to the environment). The intent of this specification requirement is to ensure that the products from the manufacturer are delivered through a Quality System and Framework that will assure consistency in the products delivered for this project.

B. Qualifications

1. Installing contractor shall be in the business of installing and servicing DDC controls for mechanical systems, temperature and ventilation control, environmental control, lighting control, access and security, life safety and energy management as their primary business.

2. Installer Qualifications: An experienced installer who is the authorized representative of the automatic control system manufacturer for both installation and maintenance of controls required for this Project.

3. Engineering, drafting, programming, and graphics generation shall be performed by the local branch engineers and technicians directly employed by the Building Automation System Contractor.

4. Supervision, checkout and commissioning of the system shall be by the local branch engineers and technicians directly employed by the Building Automation System Contractor. They shall perform commissioning and complete testing of the BAS system.

C. The BAS contractor shall maintain a service organization consisting of factory trained service personnel and provide a list of ten (10) projects, similar in size and scope to this project, completed within the last five years.

D. Final determination of compliance with these specifications shall rest solely with the Engineers and Owner who will require proof of prior satisfactory performance.

E. For any BAS system and equipment submitted for approval, the BAS contractor shall state what, if any, specific points of system operation differ from these specifications.

F. All portions of the system must be designed, furnished, installed, commissioned and serviced by manufacturer approved, factory trained employees.

G. The system shall have a documented history of compatibility by design for a minimum of 15 years. Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability for any existing control system component including but not limited to building controllers, advanced application controllers, application specific, personal operator workstations and portable operator's terminals, to be connected and directly communicate with any new BAS system equipment without bridges, routers or protocol converters.

1.1.1.10 DELIVERY, STORAGE, AND HANDLING

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

B. Deliver, store, protect, and handle products to site under provisions of the contract Documents. Coordinate all site delivers with Construction project Manager.

C. Protect products from construction operations, dust, and debris, by storing materials inside, protected from weather in a conditioned space.

1.1.1.11 COORDINATION

A. Coordinate IP drops, network connections, user interfaces, firewall, etc with Owner's IT representative.

B. Coordinate location of thermostats, humidistats, panels, and other exposed control components with plans and room details before installation.

C. Coordinate equipment with Division 28 "Fire Alarm" to achieve compatibility with equipment that interfaces with that system.

D. Coordinate power for control units and operator workstation with electrical contractor.

E. Coordinate equipment with provider of starters and drives to achieve compatibility with motor starter control coils and VFD control wiring.

F. Coordinate scheduling with the mechanical contractor and general contractor. Submit a schedule for approval based upon the installation schedule of the mechanical equipment.

G. Coordinate installation of taps, valves, airflow stations, etc. with the mechanical contractor.

H. Products Furnished but Not Installed Under This Section

1. Hydronic and Refrigerant Piping accessories:
    a. Control Valves
    b. Temperature Sensor Wells and Sockets
    c. Pressure Sensor Wells and Sockets
    d. Flow Switches
    e. Flow Meters
    f. Differential Pressure Transmitters
2. Sheet metal accessories
    a. Dampers
    b. Airflow Stations
    c. Terminal Unit Controls

I. Products Installed but Not Furnished Under This Section

1. Refrigeration Equipment:
    a. Refrigerant Leak Detection System
    b. Proof of flow pressure switches
2. Rooftop Air Handling Equipment:
    a. Thermostats
    b. Duct Static Pressure Sensors

J. Products Integrated To but Not Furnished or Installed Under This Section

1.1.1.12 WARRANTY

A. Provide warranty per Division 20 Section "General Mechanical Requirements" and as supplemented in this section.

B. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of 1224 months from completion of system demonstration.

C. Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the vendor. The maximum acceptable response time to provide this service at the site shall be 24 hours.

D. During normal building occupied hours, failure of items that are critical for system operation shall be provided within 4 hours of notification from the Owner's Representative.

E. This warranty shall apply equally to both hardware and software.

PART 2 - PRODUCTS

2.1.1.1 SYSTEM DESCRIPTION

A. The Building Automation System (BAS) contractor shall furnish and install a networked system of HVAC controls. The contractor shall incorporate direct digital control (DDC) for central plant equipment, building ventilation equipment, supplemental heating and cooling equipment, and terminal units.

B. The BAS shall be based on the Niagara Framework (or "Niagara"), a Java-based framework developed by Tridium. Niagara provides an automation infrastructure that integrates diverse systems and devices (regardless of manufacturer, communication standard or software) into a unified platform that can be managed in real time over the Internet using a standard Web browser.

C. The BAS shall be comprised of Network Area Controller or Controllers (NAC) within each facility. The NAC shall connect to the owner's local or wide area network, depending on configuration. Access to the system, either locally in each building, or remotely from a central site or sites, shall be accomplished through standard Web browsers, via the Internet and/or local area network. Each NAC shall communicate to BACnet Building Controllers and other open and legacy protocol systems/devices.

D. Provide networking to new DDC equipment using industry accepted communication standards. System shall utilizeBACnet communication according to ANSI/ASHRAE standard 135-2010 for interoperability with smart equipment, for the main IP communication trunk to the BAS Server and for peer-to-peer communication between DDC panels and devices. The system shall not be limited to only standard protocols, but shall also be able to integrate to a wide variety of third-party devices and applications via drivers and gateways.

E. Provide standalone controls where called for on the drawings or sequences.

F. **The BAS shall be the Siemens TALON System as manufactured by Siemens Building Technologies.**

2.1.1.2 BUILDING AUTOMATION SYSTEM NETWORK

A. All networked control products provided for this project shall be comprised of an industry standard open protocol internetwork. Communication involving control components (i.e. all types of controllers and operator interfaces) shall conform to ASHRAE 135-2010 BACnet standard. Networks and protocols proprietary to one company or distributed by one company are prohibited.

B. Access to system data shall not be restricted by the hardware configuration of the building management system. The hardware configuration of the BMS network shall be totally transparent to the user when accessing data or developing control programs.

1. Software applications, features, and functionality, including administrative configurations, shall not be separated into several network control engines working together.

C. Provide at a minimum 1 operator interface to be designated as the BAS Server with server application software. Additional operator interfaces shall use operator workstation licenses or connect via a thick or thin-client application.

D. BAS Server shall be capable of simultaneous direct connection and communication with BACnet/IP, OPC and TCP/IP corporate level networks without the use of interposing devices.

E. Any break in Ethernet communication from the server to the controllers on the Primary Network shall result in a notification at the server.

F. Any break in Ethernet communication between the server and standard client workstations on the Primary Network shall result in a notification at each workstation.

G. The network architecture shall consist of three levels of networks:

1. The Management Level Network (MLN) shall utilize BACnet/IP over Ethernet along with other standardized protocol, such as web services, html, JAVA, SOAP, XML, etc., to transmit data to non-BAS software applications and databases. The BAS Server and Operator Workstations shall reside on this level of the network architecture.

2. The Automation Level Network (ALN) shall utilizeBACnet/IP over Ethernet. It shall connect BACnet Building Controllers to the BAS Server and Operator Workstations. Controllers for central plant equipment and large infrastructure air handlers shall reside on the ALN backbone BACnet/IP network. Provide network media converters, routers and switches as necessary for a complete network.

3. The Floor Level Network shall utilizeBACnet/IP over Ethernet or BACnet MS/TP over RS-485 toconnect all of the DDC-controlled terminal heating and cooling equipment on a floor or in a system that are controlled with BACnet Advanced Application Controllers or BACnet Application Specific Controllers. FLN devices are networked to a router that connects to the Automaton Level Network backbone.

H. The primary backbone network between the building level controllers, BAS Server and Operator Workstations shall be based upon BACnet/IP. Ethernet Network switches shall be strategically placed through the building to cover several floors or several mechanical rooms that are within 300 ft wiring-feet of each other.

I. Use fiber optic cabling for all Ethernet runs longer than 300 ft.

J. Provide a router for each RS-485 subnetwork to connect them to the base building backbone level network. The router shall connect BACnet MS/TP subnetworks to BACnet over Ethernet. Routers shall be capable of handling all of the BACnet BIBBs that are listed for the controller that reside on the subnetwork.

K. The Building Level Controllers shall be able to support subnetwork protocols that may be needed depending on the type of equipment or application. Subnetworks shall be limited to :

1. BACnet MS/TP
2. Modbus

L. BACnet MSTP Setup rules

1. Addressing for the MSTP devices shall start at 00 and continue sequentially for the number of devices on the subnetwork.
2. No gaps shall be allowed in the addresses.
3. Set the MaxMaster property to the highest address of the connected device.
4. MaxMaster property shall be adjusted when devices are added to the subnetwork.

M. Provide all communication media, connectors, repeaters, bridges, switches, and routers necessary for the internetwork.

N. Controllers and software shall be BTL listed at the time of installation.

O. The system shall meet 1peer-to-peer communication services such that the values in any one BACnet Building Controller or BACnetAdvanced Application Controllercan be read or changed from all other controllers without the need for intermediary devices. The software shall provide transparent transfer of all data, control programs, schedules, trends, and alarms from any one controller through the internetwork to any other controller, regardless of subnetwork routers.

P. Systems that use variations of BACnet using Point-to-Point (PTP) between controllers, gateways, bridges or networks that are not peer-to-peer are not allowed.

Q. Remote Communications: Provide a TCP/IP compatible communication port for connection to the Owner's network for remote communications. Provide coordination with the Owner for addressing and router configuration on both ends of the remote network.

R. The system shall be installed with a 10% spare capacity on each subnetwork for the addition of future controllers.

S. On each floor, wing or major mechanical room provide an Ethernet RJ45 connection that allows connection to the BACnet network. An open port shall always be available and shall not require any part of the network to be disconnected. The location shall be accessible to the base building personnel and not in a location where the tenant can restrict the access.

T. Distributed Control Requirements:

1. The loss of any one DDC controller shall not affect the operation of other HVAC systems, only for the points connected to the DDC controller.

2. The system shall be scalable in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, DDC Controllers, and operator devices.

3. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC Controller shall operate independently by performing its own specified control, alarm management, operator I/O, and data collection. The failure of any single component or network connection shall not interrupt the execution of any control strategy, reporting, alarming and trending function, or any function at any operator interface device.

4. DDC Controllers shall be able to access any data from, or send control commands and alarm reports directly to, any other DDC Controller on the network without dependence upon a central processing device. DDC Controllers shall also be able to send alarms to multiple operator workstations without dependence upon a central or intermediate processing device.

5. Operators shall have the ability to make database changes at the central system server while operator workstations are on-line without disrupting other system operations.

6. The DDC control panel shall be mounted in the same mechanical room as the equipment being controlled, or an adjacent utility room.

7. Multiple systems can be programmed on the same controller as long as they are in the same room. Systems on separate floors shall have separate controllers.

8. VAV boxes subnetworks shall be connected to the AHU controller that feeds those boxes. If multiple subnetworks are needed, then the VAV shall be grouped into subnetworks in an orderly method, such as per floor, per wing, etc.

9. Remote sensors shall be wired to the control panel of the equipment it is controlling, not across the network.

10. Signals to remote motor control centers shall be hard wired to the control panel, not across the network.

11. Terminal units shall each have their own controller. Only exceptions are:

    a. Groups of reheat coils

    b. Groups of exhaust fans

    c. Groups of chilled beams serving same zone or several adjacent zones

2.1.1.3 BUILDING AUTOMATION SYSTEM SERVER HARDWARE

A. **Provide a PC for the BAS Server database. Provide the latest model of the nominal speed, RAM and memory for a commercial office grade PC from a named brand manufacturer. Minimum requirements and accessories shall be:**

1. Processor: Intel Core i7 series or AMD equal

2. **16GB RAM**

3. **1TB Hard disk space, 7200RPM**

4. **Video Card with 2 GB RAM**

5. **At least 2 USB Ports**

6. **NIC Card**

7. **101 key enhanced keyboard, Mouse, power strip**

8. **UPS for 15 minute backup**

B. **Provide a wide screen, active matrix LCD, flat panel type monitor that supports a minimum display resolution of no less than 1920 × 1080 pixels, Energy Star compliant 32-bit color. The display shall have a minimum of 21-inch visible area in diagonal measurement. Separate controls shall be provided for color, contrasts and brightness. The screen shall be non-reflective.**

C. Locate the BAS Server in a clean, secure, dry and temperature controlled environment

D. The server shall reside on the same BACnet/IP protocol network as the System Controllers.

E. Provide software licenses for interfacing to the BAS.

F. Load software, configure and setup for viewing the BAS system.

G. Provide with the PC an operating system, such as Windows 10 64-or

H. Software: Provide the following application software licenses, preloaded on the server for the Owner: MS Office Professional, Internet Explorer, Acrobat Reader, ACAD Viewer, Microsoft IIS server. Set up an icon on the desktop to take the Owner directly to the BAS system login page.

I. Provide a copy of the software (or all software's if there are multiple) used to program and download sequences to controllers.

J. Provide a backup of the all of the programs used in the system for storage by the Owner.

2.1.1.4 BACNET ADVANCED WORKSTATION SOFTWARE

A. The Graphical User Interface (GUI) shall include navigation with logical grouping of the equipment into equipment summary screens such that all the VAV boxes being fed air from a particular AHU can be displayed together for comparison.

B. The GUI shall include Air Handler unit roll up screens showing the min/max and average airflow devices in the family of equipment and provide for a means to quickly reset static discharge set point for more efficient controls.

C. The GUI shall logically group graphics navigation by tenant so that in a multi-tenant building, only the equipment graphics associated with the tenants' space can be easily viewed.

D. The Custom Equipment graphics for VAV boxes shall allow the user to initiate the creation of trend storage and collection of a system point through a simple drag and drop.

E. Each custom VAV equipment graphic shall have the ability to display the detailed sequence of operations controlling the space from within each unique device and/or application.

F. The GUI shall provide a completely interactive user interface and must offer the following features as a minimum:

1. Operating System:

   a. The GUI shall run on Microsoft Windows Operating Systems and/or standard Internet browsers including Internet Explorer, Firefox, and Chrome.

2. The GUI shall employ browser-like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu-pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.

3. Real-Time Displays. The GUI, shall at a minimum, support the following graphical features and functions:

   a. Graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URL's, and links to other graphic screens.

   b. Graphics shall support layering and each graphic object shall be configurable for assignment to a layer. A minimum of six layers shall be supported.

   c. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.

   d. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.

   e. Holidays shall be set by using a graphical calendar without requiring any keyboard entry from the operator.

   f. Commands to start and stop binary objects shall be done by selecting the appropriate object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.

   g. Adjustments to analog objects, such as set points, shall be done by right-clicking the selected object and using a graphical slider to adjust the value. No entry of text shall be required.

4. System Configuration. At a minimum, the GUI shall permit the operator to perform the following tasks, with proper password access:

   a. Create, delete or modify control strategies.

b. Add/delete objects to the system.

c. Tune control loops through the adjustment of control loop parameters.

d. Enable or disable control strategies.

e. Generate hard copy records or control strategies on a printer.

f. Select points to be alarmable and define the alarm state.

g. Select points to be trended over a period of time and initiate the recording of values automatically.

5. On-Line Help. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext. All system documentation and help files shall be in HTML format.

6. Security. Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system administrator shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.

7. System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.

8. Alarm Console:

a. The system will be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm. The use of the Alarm Console can be enabled or disabled by the system administrator.

b. When the Alarm Console is enabled, a separate alarm notification window will supersede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and un-acknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.

G. Web Browser Clients

1. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer™ or Chrome.

2. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the System, shall not be acceptable.

3. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.

4. The Web browser client shall support at a minimum, the following functions:

   a. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.

   b. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.

   c. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.

   d. Storage of the graphical screens shall be in the Network Area Controller (NAC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.

   e. Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.

   f. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:

      1) Modify common application objects, such as schedules, calendars, and set points in a graphical manner.

         a) Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.

         b) Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.

      2) Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.

      3) View logs and charts

      4) View and acknowledge alarms

      5) Setup and execute SQL queries on log and archive information

   g. The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.

h. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

H. System Programming

1. The Graphical User Interface software (GUI) shall provide the ability to perform system programming and graphic display engineering as part of a complete software package. Access to the programming functions and features of the GUI shall be through password access as assigned by the system administrator.

2. A library of control, application, and graphic objects shall be provided to enable the creation of all applications and user interface screens. Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface displays shall not be acceptable.

3. Programming Methods:

a. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.

b. All programming shall be done in real-time. Systems requiring the uploading, editing, and downloading of database objects shall not be allowed.

c. The system shall support object duplication within a customer's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

4. The B-ASC, and Building Controller's sequence of operations must be visible and editable from Niagara AX and via the Siemens LaunchPad Web Services application. All Building Controllers shall be available on the network for command, control and editing through the Niagara AX without the requirement of the BACnet Driver on Niagara AX.

I. BACnet:

1. The BAS server and Operator Workstations shall meet the BACnet device profile of an Advanced Workstation Server (B-AWS) and Operator Workstation (B-OWS) and shall support the following BACnet BIBBs:

a. Data Sharing

1) Data Sharing-Read Property-Initiate, Execute (DS-RP-A,B)

2) Data Sharing-Read Property Multiple-Initiate, Execute (DS-RPM-A,B)

3) Data Sharing-Write Property-Initiate, Execute (DS-WP-A,B)

4) Data Sharing-Write Property Multiple-Initiate (DS-WPM-A)

5) Data Sharing-COV-Initiate (DS-COV-A)

b. Scheduling

1) Scheduling-Initiate (SCHED-A)

c. Trending

1) Trending-Viewing and Modifying Trends-Initiate (T-VMT-A)

2) Trending-Automated Trend Retrieval-Initiate (T-ATR-A)

d. Network Management

1) Network Management-Connection Establishment-Initiate (NM-CE-A)

e. Alarming

1) Alarm and Event-Notification-Initiate (AE-N-A)

2) Alarm and Event-ACK-Initiate (AE-ACK-A)

3) Alarm and Event –Alarm Summary-Initiate (AE-ASUM-A)

4) Alarm and Event –Enrollment Summary-Initiate (AE-ESUM-A)

5) Alarm and Event –Information-Initiate (AE-INFO-A)

f. Device Management

1) Device Management-Dynamic Device Binding- Initiate, Execute (DM-DDB-A, B)

2) Device Management-Dynamic Object Binding- Initiate, Execute (DM-DOB-A,B)

3) Device Management-Device Communication Control- Initiate (DM-DCC-A)

4) Device Management-Private Transfer- Initiate, Execute (DM-PT-A,B)

5) Device Management-Text Message-Execute (DM-TM-B)

6) Device Management-Time Synchronization- Initiate (DM-TS-A)

7) Device Management-UTC Time Synchronization- Initiate (DM-UTC-A)

8) Device Management-Reinitialize Device- Initiate (DM-RD-A)

9) Device Management-Backup and Restore- Initiate (DM-BR-A)

10) Device Management-List Manipulation- Initiate, Execute (DM-LM-A,B)

11) Device Management-Object Creation and Deletion- Initiate (DM-OCD-A)

2. The BAS Server and Workstations shall support the following Data Link Layers:

a. BACnet IP Annex J

b. BACnet IP Annex J Foreign Device

c. ISO 8802-3, Ethernet (Clause 7)

3. The BAS Server and Workstations shall be able to interact with all of the BACnet objects in the controllers. In addition, the software shall be able to support the following objects as they relate to features in the workstation software:

   a. Calendar – Creatable, Deletable

   b. Command – Creatable, Deletable

   c. Event Enrollment – Creatable, Deletable

   d. Notification Class – Creatable, Deletable

   e. Schedule - Creatable, Deletable

4. The BAS Server and Workstations shall support transmitting and receiving segmented messages.

5. The BAS Server and Workstation shall have the capability to be the BACnet/IP Broadcast Management Device (BBMD) and support foreign devices.

2.1.1.5 WEB BASED CONTROLLER SOFTWARE FOR CONFIGURATION, PROGRAMMING AND OPERATORS

A. The purpose of this specification is to allow the Owner/Operator to have the same controller programming capabilities as the Controls Contractor Technician without additional software, tools, or licenses.

   1. The controller programming shall be accessible to any user via a Web Services application over an IP or Internet connection through port 80.

B. The following types of controllers shall have this feature:

   1. All BACnet BC level controllers

   2. Network Engine Controllers

   3. Controllers on equipment or sequences customized for this job

C. Manufacturer:

   1. Siemens Launch Pad™ (compatible with TC controllers)

   2. Controllers from other manufacturers shall meet the capabilities of this specification

D. The controller shall come with the software built-in and delivered with the controller as part of the controller purchase. It shall not require a separate software license to enable the software capability.

1. The software shall be provided as an integral part of DDC Controllers and shall not be dependent upon any higher level computer or another controller for execution.

E. The software application shall be accessible from a PC using Web Services, but shall use all of its own services and data files so as to not be susceptible to Microsoft Windows operating systems based viruses.

F. Access to the controller software shall be username and password protected. User shall be authenticated by the controller.

G. The embedded Web Services shall provide the following functionality to users, based on their access and privilege rights:

1. Point Navigation – Provide a screen that allows users to see all of the points that are active in the system. The points shall include hardwired, software, schedules, trends, alarms and network setup.

   a. The point navigation shall display the point name, descriptor, command priority, alarm status, and current value.

   b. The user shall be able to run and print a pre-configured point log report through a web interface client that shows the point name, descriptor, command priority, alarm status, and current value.

   c. The interface and report shall allow selection filter such that the operator can select or deselect the types of point that are visible.

2. Alarm Display –displays current BAS alarms to which the user has access will be displayed. Users will be able to acknowledge active alarms, erase resolved alarms, and directly link to the Point Commanding feature.

   a. The alarm display must provide a filter that displays all alarms whether acknowledged or not.

   b. The alarm display must provide a filter that displays only alarms that have not yet been acknowledged.

   c. The alarm display must provide a persistent indication whenever there is one or more unacknowledged alarm in any connected field panel.

3. Point details – users will have access to point detail information including operational status, operational priority, physical address, and alarm limits, for point objects to which they have access rights.

4. Point Commanding – users will be able to override and command points they have access to via the Web browser interface.

5. Scheduling – allows operators, depending on their current user privileges, to override schedules selected by date, and to modify the properties of a selected schedule.

a. The scheduler display must be able to represent facility mode schedules in a graphical format.

6. Trend Data Report – allows users to run and print a pre-configured trend data report for historical data reporting, including a representation of the alarm status of the each point for each Trend sample. The report shall allow selection of individual points or wildcard selection of points.

   a. Trend data shall be exportable to a data file, such as .csv or other comparable.

7. Network navigation - Provide a screen that allows users to navigate to the panels and terminal units via the network architecture.

H. The web server shall be able to send SMTP text messages to notify users of alarm status. The owners shall provide a mail server and a connection port. SSL shall not be required.

I. **The operator shall be able to add modify and delete controller database program, including points, schedules, alarms, and trends.**

   1. The operator shall be able to edit the custom program in the field panel that executes the sequences of operations, control loops and logic for the systems controlled.

   2. The operator shall be able to add terminal unit controllers that reside on field panel subnetworks.

J. Internet connections, ISP services, as well as necessary firewalls or proxy servers shall be provided by the Owner as required to support the Web access feature.

K. Coordinate with the Owner/Operator's IT representatives to setup and allow access to controllers via IP connections and Web Services through port 80.

   1. It shall be the responsibility of the Owner/IT to setup and maintain security for user access to the private networks.

   2. Coordinate IP addressing scheme.

2.1.1.6 NETWORK AREA CONTROLLERS (NAC)

A. The Network Area Controller (NAC) 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 NAC. 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

6. Integration of controller data through NiagaraAX drivers installed in the NAC.

7. Network Management functions for all controllers

B. The Network Area Controller must provide the following hardware features as a minimum:

1. One Ethernet Port – 10/100 Mbps

2. One RS-232 port

3. One RS-485 ports

4. Battery Backup

5. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity)

6. The NAC must be capable of operation over a temperature range of 32 to 122°F

7. The NAC must be capable of withstanding storage temperatures of between 0 and 158°F

8. The NAC must be capable of operation over a humidity range of 5 to 95% RH, non-condensing.

C. The NAC shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the NAC shall be an ODBC-compliant database or must provide an ODBC data access mechanism to read and write data stored within it.

D. The NAC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 32 simultaneous users.

E. Provide a "query" feature to allow review of specific alarms by user defined parameters.

F. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.

G. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

H. Network Access

1. Remote Access:

a. For Local Area Network installations, provide access to the LAN from a remote location, via the Internet. The Owner shall provide a connection to the Internet to enable this access via high speed cable modem, asynchronous digital subscriber line (ADSL) modem, ISDN line, T1 Line or via the customer's Intranet to a corporate server providing access to an Internet Service Provider (ISP). Customer agrees to pay monthly access charges for connection and ISP.

2. Event Alarm Notification and actions

a. The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.

b. The NAC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up telephone connection, or wide-area network.

c. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:

   1) To alarm

   2) Return to normal

   3) To fault

d. Provide for the creation of a minimum of eight of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.

e. Provide timed (schedule) routing of alarms by class, object, group, or node.

f. Provide alarm generation from binary object "runtime" and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.

3. Control equipment and network failures shall be treated as alarms and annunciated.

4. Alarms shall be annunciated in any of the following manners as defined by the user:

   a. Screen message text

   b. Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:

      1) Day of week

      2) Time of day

      3) Recipient

   c. Pagers via paging services that initiate a page on receipt of email message

   d. Graphic with flashing alarm object(s)

   e. Printed message, routed directly to a dedicated alarm printer

5. The following shall be recorded by the NAC for each alarm (at a minimum):

   a. Time and date

   b. Location (building, floor, zone, office number, etc.)

   c. Equipment (air handler #, accessway, etc.)

   d. Acknowledge time, date, and user who issued acknowledgement.

   e. Number of occurrences since last acknowledgement.

6. Alarm actions may be initiated by user defined programmable objects created for that purpose.

7. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.

8. A log of all alarms shall be maintained by the NAC and/or a server (if configured in the system) and shall be available for review by the user.

9. Provide a "query" feature to allow review of specific alarms by user defined parameters.

10. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.

11. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

I. Data Collection and Storage

1. The NAC shall have the ability to collect data for any property of any object and store this data for future use.

2. The data collection shall be performed by log objects, resident in the NAC that shall have, at a minimum, the following configurable properties:

   a. Designating the log as interval or deviation.

   b. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.

   c. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.

   d. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.

   e. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.

3. All log data shall be stored in a relational database in the NAC and the data shall be accessed from a server (if the system is so configured) or a standard Web browser.

4. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.

5. All log data shall be available to the user in the following data formats:

   a. HTML

   b. XML

   c. Plain Text

   d. Comma or tab separated values

6. Systems that do not provide log data in HTML and XML formats at a minimum shall not be acceptable.

7. The NAC shall have the ability to archive its log data either locally (to itself), or remotely to a server or other NAC on the network. Provide the ability to configure the following archiving properties, at a minimum:

   a. Archive on time of day

b. Archive on user-defined number of data stores in the log (buffer size)

c. Archive when log has reached its user-defined capacity of data stores

d. Provide ability to clear logs once archived

J. Audit Log

1. Provide and maintain an Audit Log that tracks all activities performed on the NAC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the NAC), to another NAC on the network, or to a server. For each log entry, provide the following data:

a. Time and date

b. User ID

c. Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.

K. DATABASE BACKUP AND STORAGE

1. The NAC shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.

2. Copies of the current database and, at the most recently saved database shall be stored in the NAC. The age of the most recently saved database is dependent on the user-defined database save interval.

3. The NAC database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

2.1.1.7 DIRECT DIGITAL CONTROLLER SOFTWARE

A. Provide a full capability user license to the owner for the operator to be able to see, modify, create, upload, download and save control programs to the DDC controllers.

B. The software program shall be provided as an integral part of DDC Controllers and shall not be dependent upon any higher level computer or another controller for execution.

C. The software application shall be accessible from a PC using the Windows environment, but shall use all of its own services and data files so as to not be susceptible to Microsoft Windows operating systems based viruses.

D. The software shall be provided with an interactive HELP function to assist operators with syntax, abbreviations, commands and saving programs.

E. Point naming and communication format:

1. All points, panels, and programs shall be identified by a 30-character name. All points shall also be identified by a 16-character point descriptor. The same names shall be displayed at both Building Controller and the Operator Interface.

2. All digital points shall have a consistent, user-defined, two-state status indication with 8 characters minimum (e.g., Summer, Enabled, Disabled, Abnormal).

3. The Building Controller Software shall be capable of BACnet communications. The BACnet Building Controller (B-BC) shall have demonstrated interoperability during at least one BTL Interoperability Workshop, have demonstrated compliance to BTL through BTL listing and shall substantially conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135-2004, Annex L.

F. System Security

1. User access shall be secured using individual security passwords and user names.

2. Passwords shall restrict the user to the objects, applications, and system functions as assigned by the system manager.

3. Building Controllers shall be able to assign a minimum of 50 passwords access and control priorities to each point individually. The logon password (at any Operator Interface or portable operator terminal) shall enable the operator to monitor, adjust and control only the points that the operator is authorized for. All other points shall not be displayed at the Operator Interface or portable terminal. Passwords and priorities for every point shall be fully programmable and adjustable.

4. User Log On/Log Off attempts shall be recorded.

5. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user-definable.

6. Use of workstation resident security as the only means of access control is not an acceptable alternative to resident system security in the DDC controller software.

G. User Defined Control Applications: The applications software shall program DDC routines to meet the sequences of operations.

1. Building Controllers shall have the ability to perform energy management routines including but not limited to time of day scheduling, calendar-based scheduling, holiday scheduling, temporary schedule overrides, start stop time optimization, automatic daylight savings time switch over, night setback control, enthalpy switch over, peak demand limiting, temperature-compensated duty cycling, heating/cooling interlock, supply temperature reset, priority load shedding, and power failure restart.

2. The Building Controllers shall have the ability to perform the following pre tested control algorithms:

   a. Two position with differential control and time delays

   b. Floating control

   c. Proportional control

   d. Proportional plus integral control

   e. Proportional, integral, plus derivative control

   f. Automatic tuning of control loops

   g. Start Stop Time Optimization

3. Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.

4. Each controller shall support plain language text comment lines in the operating program to allow for quick troubleshooting, documentation, and historical summaries of program development.

H. Peer-to-peer access to other DDC controllers

1. It shall be possible to use any actual or virtual point data or status, any system calculated data, a result from any process, or any user-defined constant in any controller in the system.

2. Any process shall be able to issue commands to points in any and all other controllers in the system.

3. Processes shall be able to generate operator messages and advisories to other operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of an advanced annunciation feature, such as:

   a. Generate a report

   b. Annunciate an alarm

   c. Issue a text message or email

I. Alarm Management

1. Alarm management shall be provided within the controller software to monitor and direct alarm information to operator devices.

2. Each Building Controller shall perform distributed, independent alarm analysis, minimize network traffic and prevent alarms from being lost. At no time shall the Building Controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device or communications with other panels on the network.

3. Conditional alarming shall allow generation of alarms based upon user defined multiple criteria.

4. An Alarm "shelving" feature shall be provided to disable alarms during testing. (Pull the Plug, etc.).

5. Binary Alarms. Each binary alarm object shall be set to alarm based on the operator-specified state. Provide the capability to automatically and manually disable alarming.

6. Analog Alarms. Each analog alarm object shall have both high and low alarm limits. Alarming must be able to be automatically and manually disabled.

7. All alarm shall include the point's user-defined language description and the time and date of occurrence.

8. Alarm reports and messages shall be routed to user-defined list of operator workstations, or other devices based on time and other conditions. An alarm shall be able to start programs, print reports, be logged in the event log, generate custom messages, and display graphics.

9. The user shall be able to add a 200-character alarm message to each alarm point to more fully describe the alarm condition or direct operator response. Each Building Controller shall be capable of storing a library of at least 50 alarm messages. Each message may be assigned to any number of points in the Controller.

10. Operator-selected alarms shall be capable of initiating a trigger to an advanced annunciation, such as text, email, etc.

11. An alarm history log shall report the start of the alarm condition, acknowledgement by a user and return of the alarm to normal condition.

J. Scheduling:

1. Provide a comprehensive menu driven program to automatically start and stop designated multiple objects or events in the system according to a stored time.

2. Schedules shall reside in the building controller and shall not rely on external processing or network.

3. It shall be possible to define a group of objects as a custom event (i.e., meeting, athletic activity, etc.). Events can then be scheduled to operate all necessary equipment automatically.

4. For points assigned to one common load group, it shall be possible to assign variable time delays between each successive start and/or stop within that group.

5. The operator shall be able to define the following information:

   a. Time, day

   b. Commands such as on, off, auto, etc.

   c. Time delays between successive commands.

   d. There shall be provisions for manual overriding of each schedule by an authorized operator.

6. It shall be possible to schedule calendar-based events up to one year in advance based on the following:

   a. Weekly Schedule. Provide separate schedules for each day of the week. Each of these schedules should include the capability for start, stop, optimal start, optimal stop, and night economizer. When a group of objects are scheduled together as an Event, provide the capability to adjust the start and stop times for each member.

   b. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by the standard schedule for that day of the week.

K. Peak Demand Limiting (PDL):

1. The Peak Demand Limiting (PDL) program shall limit the consumption of electricity to prevent electrical peak demand charges.

2. PDL shall continuously track the amount of electricity being consumed, by monitoring one or more electrical kilowatt-hour/demand meters. These meters may measure the electrical consumption (kWh), electrical demand (kW), or both.

3. PDL shall sample the meter data to continuously forecast the demand likely to be used during successive time intervals.

4. If the PDL forecasted demand indicates that electricity usage is likely to exceed a user preset maximum allowable level, then PDL shall automatically shed electrical loads.

5. Once the demand peak has passed, loads that have been shed shall be restored and returned to normal control.

L. Temperature-compensated duty cycling

1. User defined conditions shall be able to initiate a Duty Cycle Control Program.

2. The Duty Cycle Control Program (DCCP) shall be configured to periodically stop and start loads according to various patterns.

3. The loads shall be cycled such that there is a net reduction in both the electrical demands and the energy consumed.

M. Automatic Daylight Savings Time Switchover. The system shall provide automatic time adjustment for switching to/from Daylight Savings Time.

N. Night setback control. The system shall provide the ability to automatically adjust setpoints for night control.

O. Enthalpy switchover (economizer). The Building Controller Software (BCS) shall control the position of the air handler relief, return, and outside air dampers. If the outside air dry bulb temperature falls below changeover setpoint the BCS will modulate the dampers to provide 100 percent outside air. The user will be able to quickly change over to an economizer system based on dry bulb temperature and will be able to override the economizer cycle and return to minimum outside air operation at any time.

P. Control Loop Algorithm

1. Provide a PID (proportional-integral-derivative) closed-loop control algorithm with direct or reverse action and anti-windup. The algorithm shall calculate a time-varying analog value that is used to position an output or stage a series of outputs. The controlled variable, setpoint, and weighting parameters shall be accessible from the operator workstation.

Q. Adaptive Loop Tuning

1. Building Controllers shall also provide high resolution sampling capability for verification of DDC control loop performance. Documented evidence of tuned control loop performance shall be provided on a monthly, seasonal, quarterly, annual period.

2. For PID control loops, operator-initiated automatic and manual loop tuning algorithms shall be provided for all operator-selected PID control loops. Evidence of tuned control loop performance shall be provided via graphical plots or trended data logs for all loops.

a. In automatic mode, the controller shall perform a step response test with a minimum one-second resolution, evaluate the trend data, calculate the new PID gains and input these values into the selected LOOP statement.

b. Loop tuning shall be capable of being initiated either locally at the Building Controller, from a network workstation or remotely using dial-in modems. For all loop tuning functions, access shall be limited to authorized personnel through password protection.

R. Logic programming: Provide a software routine that can build ladder logic to control using many conditional statements.

1. The logic programming syntax shall be able to combine ladder logic with other software features, such as combining status, scheduling, PDL and alarm conditions into one conditional decision.

2. Logic programming shall be able to reference conditions in any other controller in the system.

S. Staggered Start:

1. This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment (or groups of equipment) is started, along with the time delay between starts, shall be user definable in an application and shall not require written scripts or ladder logic.

2. Upon the resumption of power, each Building Controller shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling and turn equipment on or off as necessary to resume normal operations.

T. Totalization Features:

1. Run-Time Totalization. Building Controllers shall automatically accumulate and store run-time hours for all digital input and output points. A high runtime alarm shall be assigned, if required, by the operator.

2. Consumption totalization. Building Controllers shall automatically sample, calculate and store consumption totals on a daily, weekly or monthly basis for all analog and digital pulse input type points.

3. Event totalization. Building Controllers shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly or monthly basis for all points. The event totalization feature shall be able to store the records associated with events before reset.

U. Data Collection:

1. A variety of historical data collection utilities shall be provided to manually or automatically sample, store, and display system data for all points.

2. Building Controllers shall store point history data for selected analog and digital inputs and outputs:

3. Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each Building Controllers point group.

4. Two methods of collection shall be allowed: either by up to four pre-defined time intervals or upon a pre-defined change of value. Sample intervals of 1 minute to 7 days shall be provided.

5. Each Building Controller shall have a dedicated RAM-based buffer for trend data and shall be capable of storing a minimum of 10,000 data samples.

6. Trend data shall be stored at the Building Controllers and uploaded to the workstation when retrieval is desired. Uploads shall occur based upon either user-defined interval, manual command or when the trend buffers are full. All trend data shall be available for use in third-party personal computer applications.

2.1.1.8 BACNET BUILDING CONTROLLERS

A. Provide all necessary hardware for a complete operating system as required. The Building Controller shall be able to operate as a standalone panel and shall not be dependent upon any higher level computer or another controller for operation.

B. Basis of design is Siemens TC Modular and TC Compact Controllers.

C. This controller shall have the BTL listing and meet the BACnet device profile of a Building Controller (B-BC) and shall support the following BACnet BIBBs:

1. Data Sharing

   a. Data Sharing-Read Property-Initiate, Execute (DS-RP-A,B)

   b. Data Sharing-Read Property Multiple- Initiate, Execute (DS-RPM-A,B)

   c. Data Sharing-Write Property- Initiate, Execute (DS-WP-A,B)

   d. Data Sharing-Write Property Multiple- Execute (DS-WPM-B)

   e. Data Sharing-COV- Initiate, Execute (DS-COV-A,B)

   f. Data Sharing-COV-Unsolicited- Initiate, Execute (DS-COVU-A,B)

2. Scheduling

   a. Scheduling-Internal- Execute (SCHED-I-B)

   b. Scheduling-External- Execute (SCHED-E-B)

3. Trending

   a. Trending-Viewing and Modifying Trends - Initiate (T-VMT-A)

   b. Trending-Viewing and Modifying Trends Internal- Execute (T-VMT-I-B)

   c. Trending-Viewing and Modifying Trends-External- Execute (T-VMT-E-B)

   d. Trending-Automated Trend Retrieval- Execute (T-ATR-B)

4. Network Management

    a. Network Management-Connection Establishment- Initiate (NM-CE-A)

5. Alarming

    a. Alarm and Event-Notification- Initiate (AE-N-A)

    b. Alarm and Event-Notification Internal- Execute (AE-N-E-B)

    c. Alarm and Event-Notification External- Execute (AE-N-E-B)

    d. Alarm and Event-ACK- Initiate, Execute (AE-ACK-A,B)

    e. Alarm and Event –Alarm Summary- Execute (AE-ASUM-B)

    f. Alarm and Event –Enrollment Summary- Execute (AE-ESUM-A,B)

    g. Alarm and Event –Information- Initiate, Execute (AE-ESUM-A,B)

6. Device Management

    a. Device Management-Dynamic Device Binding- Initiate, Execute (DM-DDB-A,B)

    b. Device Management-Dynamic Object Binding- Initiate, Execute (DM-DOB-A,B)

    c. Device Management-Device Communication Control- Execute (DM-DCC-B)

    d. Device Management-Private Transfer- Initiate, Execute (DM-PT-A,B)

    e. Device Management-Text Message- Initiate, Execute (DM-TM-A,B)

    f. Device Management-Time Synchronization- Execute (DM-TS-B)

    g. Device Management-Reinitialize Device- Execute (DM-RD-B)

    h. Device Management-Backup and Restore- Execute (DM-RD-B)

    i. Device Management-List Manipulation- Execute (DM-RD-B)

    j. Device Management-Object Creation and Deletion- Execute (DM-OCD-B)

7. The Building Level Controller shall support the following Data Link Layers:

    a. BACnet IP Annex J

    b. BACnet IP Annex J Foreign Device

    c. MS/TP Master (Claus 9)

8. The Building Level Controller shall be able to interact with all of the BACnet objects in the controllers. In addition, the software shall be able to support the following objects as they relate to features in the workstation software:

    a. Calendar – Creatable, Deletable

    b. Command – Creatable, Deletable

    c. Event Enrollment – Creatable, Deletable

    d. Notification Class – Creatable, Deletable

e. Schedule - Creatable, Deletable

9. The Building Level Controller shall support transmitting and receiving segmented messages.

10. The Building Level Controller shall have the capability to be the BACnet/IP Broadcast Management Device (BBMD) and support foreign devices.

11. The Building Level Controller shall have the capability to act as a BACnet router between MS/TP subnetworks and BACnet/IP.

D. This level of controller shall be used for the following types of systems:

1. Chiller plant systems

2. Heating plant systems

3. Cooling Towers

4. Pumping systems

5. VAV air handlers

6. Air handlers over 15,000 cfm

7. Systems with over 24 input/output points

8. Rooftop systems

E. Computing power and memory minimum:

1. A 32-bit, stand-alone, multi-tasking, multi-user, real-time 100MHz digital control microprocessor module.

2. Inputs shall be 16-bit minimum analog-to-digital resolution

3. Outputs shall be 10-bit minimum digital-to-analog resolution

4. Memory module (24 Megabyte, minimum) to accommodate all Primary Control Panel software requirements, including but not limited to, its own operating system and databases (see Controllers Software section), including control processes, energy management applications, alarm management applications, historical/trend data for points specified, maintenance support applications, custom processes, operator I/O, dial-up communications.

5. Real time clock and battery

6. Data collection/ Data Trend module sized for 10,000 data samples.

7. Flash Memory Firmware: Each Building Level Control Panel shall support firmware upgrades without the need to replace hardware.

F. Onboard or Modular hardware and connections:

1. Primary Network communication module, if needed for primary network communications.

2. Secondary Network communication module, if needed for secondary network communications.

3. RJ45 port 10/100Mbaud

4. RS485 ports for subnetworks and point expansion

5. Man to Machine Interface port (MMI)

6. USB Port

G. Input and Output Points Hardware

1. Input/output point modules as required including spare capacity.

2. Input/output point modules shall have removable terminal blocks.

3. Monitoring of the status of all hand-off-auto switches.

4. Monitoring of all industry standard types of analog and digital inputs and outputs, without the addition of equipment to the primary control panel.

5. Local status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Each primary control panel shall perform diagnostics on all inputs and outputs and a failure of any input or output shall be indicated both locally and at the operator workstation.

6. Graduated intensity LEDs or analog indication of value for each analog output.

H. Code compliance

1. Approvals and standards: UL916; CE; FCC

2. Provide UL864-UUKL where called for in the sequences of operations.

I. Accessories:

1. Appropriate NEMA rated metal enclosure.

2. Power supplies as required for all associated modules, sensors, actuators, etc.

J. The operator shall have the ability to manually override automatic or centrally executed commands at the primary control panels via local, point discrete, on-board hand/off/auto operator override switches. If on board switches are not available, provide separate control panels with HOA switches. Mount panel adjacent to primary control panel. Provide hand/off/auto switch for each digital output, including spares.

K. Each Building Level Control Panel shall continuously perform self-diagnostics on all hardware modules and network communications. The System Level Control Panel shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication with any system.

L. Panel setup, point definitions and sequencing diagrams shall be backed up on EEPROM memory.

M. Power loss. In the event of the loss of power, there shall be an orderly shutdown of all Building Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 30 days.

N. Building Level control panels shall provide at least two serial data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals. Primary control panels shall allow temporary use of portable devices without interrupting the normal communications, operation of permanently connected modems, printers or terminals.

O. Building Level Controllers shall have the capability to serve as a gateway between Modus subnetworks and BACnet objects. Provide software, drives and programming.

P. Isolation shall be provided at all primary control panel terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standards 587-1980.

Q. Spare Capacity: Provide enough inputs and outputs to handle the equipment shown to be "future" on drawings and 10% more of each point type. Provide all hardware modules, software modules, processors, power supplies, communication controllers, etc. required to ensure adding a point to the spare point location only requires the addition of the appropriate sensor/actuator and field wiring/tubing.

R. Environment.

1. Controller hardware shall be suitable for the anticipated ambient conditions.
2. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at 0°C to 49°C (32°F to 120°F).
3. Controllers used in conditioned space shall be mounted in dust-proof enclosures and shall be rated for operation at 0°C to 49°C (32°F to 120°F).
4. Controller hardware shall be optionally suitable for rooftop environments.

S. Immunity to power and noise.

1. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.
2. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
3. Isolation shall be provided at all primary network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:
    a. RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6) at 3V.
    b. Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact.
    c. Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500V signal, 1 kV power.
    d. Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max).

4. Isolation shall be provided at all Building Controller's AC input terminals to suppress induced voltage transients consistent with:

    a. IEEE Standard 587 1980

    b. UL 864 Supply Line Transients

    c. Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)

2.1.1.9 BACNET ADVANCED APPLICATION CONTROLLERS

A. Provide all necessary hardware for a complete operating system as required. The Advanced Application level control panel shall be able to operate as a standalone panel and shall not be dependent upon any higher level computer or another controller for operation.

B. Basis of design is Unitary Equipment Controller (TCxx-UCM).

C. The Advanced Application Controller Software shall be capable of BACnet communications. The BACnet Advanced Application Controller (B-AAC) shall have demonstrated compliance to BTL through BTL listing and shall substantially conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135-2004 or ANSI/ASHRAE 135-2008. Supported BIBBS shall include:

1. Data Sharing

    a. Data Sharing-Read Property-Initiate, Execute (DS-RP-A,B)

    b. Data Sharing-Read Property Multiple- Initiate, Execute (DS-RPM-A,B)

    c. Data Sharing-Write Property- Initiate, Execute (DS-WP-A,B)

    d. Data Sharing-Write Property Multiple- Execute (DS-WPM-B)

    e. Data Sharing-COV- Initiate, Execute (DS-COV-A,B)

2. Scheduling

    a. Scheduling-Internal- Execute (SCHED-I-B)

3. Trending

    a. Trending-Viewing and Modifying Trends Internal- Execute (T-VMT-I-B)

    b. Trending-Automated Trend Retrieval- Execute (T-ATR-B)

4. Network Management

    a. Network Management-Connection Establishment- Initiate (NM-CE-A)

5. Alarming

    a. Alarm and Event-Notification Internal- Execute (AE-N-I-B)

    b. Alarm and Event-ACK- Initiate, Execute (AE-ACK-A,B)

    c. Alarm and Event –Enrollment Summary- Execute (AE-ESUM-B)

d. Alarm and Event –Information- Execute (AE-INFO-B)

6. Device Management

a. Device Management-Dynamic Device Binding- Initiate, Execute (DM-DDB-A,B)

b. Device Management-Dynamic Object Binding- Initiate, Execute (DM-DOB-A,B)

c. Device Management-Device Communication Control- Execute (DM-DCC-B)

d. Device Management-Time Synchronization- Execute (DM-TS-B)

e. Device Management-Reinitialize Device- Execute (DM-RD-B)

f. Device Management-Backup and Restore- Execute (DM-BR-B)

g. Device Management-List Manipulation- Execute (DM-LM-B)

h. Device Management-Object Creation and Deletion- Execute (DM-OCD-B)

7. The Advanced Application Controller shall be able to interact with all of the BACnet objects in the controllers. In addition, the software shall be able to support the following objects as they relate to features in the workstation software:

a. Calendar – Creatable, Deletable

b. Command – Creatable, Deletable

c. Event Enrollment – Creatable, Deletable

d. Notification Class – Creatable, Deletable

e. Schedule - Creatable, Deletable

8. The Advanced Application Controller shall support transmitting and receiving segmented messages.

D. Communication:

1. BAS Network: The Advanced Application Controller shall support the following Data Link Layers:

a. MS/TP Master

2. Serial Communication: Temporary use of portable devices shall not interrupt the BAS communication, nor the normal operation of permanently connected printers or terminals.

a. Provide at least one EIA-232C serial data communication port for operation of operator I/O devices such as industry standard printers, operator terminals, and portable laptop operator's terminals.

b. A USB port shall alternatively be available to support local HMI tools connection.

E. Software

1. The software programs specified in this section shall be provided as an integral part of Advanced Application Controllers and shall not be dependent upon any higher level computer or another controller for execution.

2. Advanced Application Controllers shall have the ability to perform energy management routines including but not limited to

    a. scheduling, calendar-based scheduling, holiday scheduling, temporary schedule overrides

    b. automatic daylight savings time switch over

    c. night setback control

    d. economizer switch over using enthalpy, dry bulb or a combination

    e. peak demand limiting,

    f. temperature-compensated duty cycling

    g. heating/cooling interlock

    h. supply temperature reset

    i. priority load shedding

    j. power failure restart

3. The software shall have a routine for automatic tuning of control loops

4. System Security in the Field Panel

    a. User access shall be secured using individual security passwords and user names.

    b. Passwords shall restrict the user to the objects, applications, and system functions as assigned by the system manager.

    c. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user-definable.

    d. Use of workstation resident security as the only means of access control is not an acceptable alternative to resident system security in the field panel.

5. User Defined Control Applications:

    a. Controllers shall be fully-programmable. Controllers shall execute custom, job-specific sequences to automatically perform calculations and special control routines. Factory installed or pre-configured sequences shall only be allowed if they exactly match the sequence specified herein.

    b. Programs shall combine control logic, control loop algorithms, and energy management routines

    c. Each controller shall support plain language text comment lines in the operating program to allow for quick troubleshooting, documentation, and historical summaries of program development.

    d. Controller shall provide a HELP function key, providing enhanced context sensitive on-line help with task oriented information from the user manual.

F. Adaptive Loop Control.

1. Each AAC controller shall come standard with an Adaptive Control Loop Algorithm

a. Tuning parameter shall automatically adjust for non-linear applications

2. Model-Free Adaptive (MFA) algorithm

   a. The algorithm shall not require modeling of the non-linear system in order to maintain control at all points of the non-linear load.

   b. The controlled variable, setpoint, and weighting parameters shall be user-selectable.

3. Output shall be analog or shall stage a series of outputs.

4. Adaptive Control shall take the place of Proportional, Proportional + Integral, and PID type algorithms for non-linear applications. Adaptive Control routines shall :

   a. Improve response time

   b. Improve System efficiency

   c. Improve Stability

   d. Result in Consistent outputs

   e. Reduce cycling and repositioning

   f. Reduce wear and tear on actuators

5. Adaptive control shall auto-adjust to compensate for

   a. mode changes

   b. load changes

   c. seasonal changes

   d. Heating and cooling changeover

   e. Heating or cooling capacity changes on the primary side

   f. Flow changes on the primary or secondary side

   g. Airflow changes across coil

   h. Flow across a heat exchanger

6. Adaptive control shall auto-adjust to compensate for

   a. Non-linear coils and heat exchangers

   b. Hot water and chilled water reset routines

   c. Water flow reset routines

   d. Duct Static reset routines

7. Auto-Tune PID loops are not acceptable substitutions.

8. If Adaptive Loop Control is not available, then the BAS contractor shall provide re-tuning of the control loops for coils and heat exchangers for each of the following conditions:

a. Low heating supply water, high heating supply water

b. Low load on steam coil, high load on steam coil

c. Chilled water coil, non dehumidification and condensing

d. Chilled water coil, low airflow, high airflow, economizer

e. Dual temperature systems tune for heating and cooling modes

f. Each of 4 seasons

G. This level of controller shall be used for the following types of systems:

1. Systems with custom sequences that meet all of the criteria below:
2. No primary pumping systems
3. Secondary Pumping systems that are remote from Central Plants
4. Air handlers up to 15,000 cfm
5. Systems up to 20 input/output points
6. Room control sequences that cannot be achieved with an application specific controller
7. BAS Network or Architecture or Sequences do not require the system to be on an IP network
8. No systems that require integration to meters, VFDs or other smart equipment
9. Integration to smart thermostats is allowed

H. Input/Outputs

1. Inputs shall be 16-bit minimum digital resolution
2. Outputs shall be 10-bit minimum digital resolution
3. The following I/O port types shall be available on the controller

a. Universal Input (software configurable):

1) Digital Input choices:

a) Pulse Accumulator

b) Contact Closure Sensing

c) Dry Contact/Potential Free inputs only

d) Digital Input (10 ms settling time)

e) Counter inputs up to 20 Hz, minimum pulse duration 20 ms (open or closed)

2) Analog Input Choices:

a) 0-10 Vdc

b) 4-20 mA

c) 1K Ni RTD @ 32°F (Siemens, JCI, DIN Ni 1K)

d) 1K Pt RTD (375 or 385 alpha) @ 32°F

e) 10K NTC Type 2 or Type 3 Thermistor

f) 100K NTC Type 2 Thermistor

b. Universal Input or Output (software configurable):

1) All of the above input types

2) Analog Output Types:

a) 0 to 10 Vdc @ 1 mA max

c. Super Universal Input or Output (software configurable):

1) All of the above input types

2) All of the above output types

3) Super digital output type:

a) 0 to 24 Vdc, 22 mA max. (for controlling pilot relay)

4) Super Analog Output Choices:

a) 0 to 20 mA @ 650 Ω max.

4. Provide software configurable I/O ports such that a programmer make a port either an input or an output

I. Each System Level Control Panel shall, at a minimum, be provided with:

1. Appropriate NEMA rated metal enclosure.

2. A 32-bit,multi-tasking, real-time 100 MHz digital control microprocessor with plug-in, enclosed processors.

3. Each Advanced Application Controller shall have sufficient memory, a minimum of 24 megabyte, to support its own operating system and databases, including control processes, energy management applications, alarm management applications, historical/trend data for points specified, maintenance support applications, custom processes, and operator I/O.

4. Real time clock and battery

5. Data collection/ Data Trend module sized for 10,000 data samples.

6. Power supplies as required for all associated modules, sensors, actuators, etc.

7. Monitoring of all industry standard types of analog and digital inputs and outputs, without the addition of equipment to the primary control panel.

8. Local status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device.

9. Each control panel shall perform diagnostics on all inputs and outputs and a failure of any input or output shall be indicated both locally and at the operator workstation.

10. Graduated intensity LEDs or analog indication of value for each analog output.

J. Power loss. In the event of the loss of power, there shall be an orderly shutdown of all controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for the operating system software and firmware.

1. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.

2. Brownout protection and power recovery circuitry protect the controller board from power fluctuations.

3. Battery backup shall be provided to support the real-time clock for 10 years

4. The program and database information stored SDRAM memory shall be battery backed for a minimum of 30 days and up to 60 days. This eliminates the need for time consuming program and database re-entry in the event of an extended power failure.

K. Database Restore: Each AAC controller shall automatically save the latest programmed database. The controller shall be able to automatically restore a lost or corrupt database without involvement from the operator.

L. Each System Level Control Panel shall continuously perform self-diagnostics on all hardware modules and network communications. The System Level Control Panel shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication with any system.

M. Each Control Panel shall support firmware upgrades without the need to replace hardware.

N. System Level control panels shall provide at least two RS-232C serial data communication ports for operation of operator I/O devices such as operator terminals, and additional memory. Control panels shall allow temporary use of portable operator interface devices without interrupting the normal communications.

O. Immunity to noise.

1. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).

2. Isolation shall be provided at all primary network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:

a. RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6) at 3V.

b. Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact.

c. Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500V signal, 1 kV power.

d. Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max).

3. Isolation shall be provided at all Advanced Application Controller's AC input terminals to suppress induced voltage transients consistent with:

a. IEEE Standard 587 1980

b. Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)

P. Agency Compliance

1. UL UL916 PAZX (all models)

2. UL916 PAZX7 (all models)

3. FCC Compliance CFR47 Part 15, Subpart B, Class B

Q. Spare Capacity: Provide enough inputs and outputs to handle the equipment shown to be "future" on drawings and 10% more of each point type. Provide all hardware modules, software modules, processors, power supplies, communication controllers, etc. required to ensure adding a point to the spare point location only requires the addition of the appropriate sensor/actuator and field wiring/tubing.

2.1.1.10 BACNET APPLICATION SPECIFIC CONTROLLERS (DXR)

A. Each Application Specific Controller shall operate as a stand-alone controller capable of performing its user selectable control routines independently of any other controller in the system. Each Application Specific Controller shall provide standard applications and programmability to provide both reliability and flexibility. Each application specific controller shall be a microprocessor-based, multi-tasking, digital control processor.

B. Basis of design is the programmable Siemens DXR controller.

C. Configurable control applications. Each Application Specific Controller model must have a set of pre-loaded, selectable and field-adjustable control applications appropriate for the secondary HVAC equipment that the controller model is intended to control. Specific applications must be configurable to meet the user's control strategy requirements, allowing for additional system flexibility.

D. Programmability: Application Specific Controllers shall be programmable. Program language shall be graphical.

E. The Application Specific Controller shall include all point inputs and outputs necessary to perform the specified HVAC control sequences. The controller shall accept input and provide output signals that comply with industry standards. Controllers utilizing proprietary control output signals shall not be acceptable. Controllers shall provide outputs utilized either for two-state, modulating floating, or proportional control, allowing for additional system flexibility.

1. Analog inputs shall be software configurable to accept sensors using 0-10v (such as RH or CO2 sensors), NTC3k, NTC10k, NTC100k, Ni1000, PT1K 385, and resistance sensors of 1000Ω, 2500 Ω, 10K Ω, and 100k Ω . 24vDC power to drive active sensors shall be an option available from the controller.

2. Digital input

3. Analog Outputs shall support 0-10v HVAC control signals.

4. Digital outputs shall be AC 24V high-side switching triacs, able to switch loads of 250 mA / 6 VA per output.

5. Every installed Application Specific Controller shall be prepared for the addition of occupancy, CO2 and humidity sensors

6. Additional sensors and output modules for occupancy, lighting and shade control within the same space as the HVAC control shall be connected as needed via a sub-network connection on each Application Specific Controller

7. The Application Specific Controller shall be compatible with a Siemens Room Unit which combines a display with CO2, temperature and humidity sensing in 1 wall device.

8. The Application Specific Controller shall be compatible with a Siemens Room Unit which combines a display with temperature sensing and configurable switches for lighting, shade and scene control in 1 wall device.

F. Application Specific Controller communication

1. Communication over floor level network shall be BACnet over MS/TP or BACnet IP over Ethernet.

2. A maximum of 96 controllers may be configured on individual BACnet MS/TP networks.

3. Each controller that uses BACnet IP shall provide at least two Ethernet ports allowing the controllers to be wired in a daisy-chain configuration of up to at least 20 controllers per chain, utilizing standard Ethernet cables of up to 300ft in length between each controller.

G. The Application Specific Controller shall have the BTL listing and meet the BACnet device profile of an Application Specific Controller (B-ASC) as specified in ANSI/ASHRAE 135-2012. The controller shall support the following BACnet BIBBs:

1. Data Sharing

   a. DS-RP-A: Data Sharing – Read Property-A

   b. DS-RP-B: Data Sharing – Read Property-B

   c. DS-RPM-A: Data Sharing – Read Property Multiple-A

   d. DS-RPM-B: Data Sharing – Read Property Multiple-B

   e. DS-WP-A: Data Sharing – Write Property-A

   f. DS-WP-B: Data Sharing – Write Property-B

   g. DS-WPM-A: Data Sharing – Write Property Multiple-A

   h. DS-WPM-B: Data Sharing – Write Property Multiple-B

   i. DS-COV-A: Data Sharing – Change of Value -A

   j. DS-COV-B: Data Sharing – Change of Value -B

   k. DS-COVP-A: Data Sharing – Change of Value Property -A

l. DS-COVP-B: Data Sharing – Change of Value Property –B

2. Alarm and Event

a. AE-N-I-B: Alarm and Event – Notification Internal-B

b. AE-ACK-B: Alarm and Event – ACK-B

c. AE-ASUM-B: Alarm and Event – Alarm Summary-B

d. AE-ESUM-B: Alarm and Event – Enrollment Summary-B

e. AE-INFO-B: Alarm and Event – Information-B

f. AE-EL-I-B: Alarm and Event – Event Log Internal-B

3. Trending

a. T-VMT-I-B: Trending – Viewing and Modifying Internal-B

b. T-ATR-B: Trending – Automated Trend Retrieval-B

4. Device Management

a. DM-DDB-A: Device Management – Dynamic Device Binding-A

b. DM-DDB-B: Device Management – Dynamic Device Binding-B

c. DM-DOB-B: Device Management – Dynamic Object Binding-B

d. DM-DCC-B : Device Management – Device Communication Control-B

e. DM-TS-B: Device Management – Time Synchronization-B

f. DM-UTC-B: Device Management – UTC Time Synchronization-B

g. DM-RD-B: Device Management – Reinitialize Device-B

h. DM-BR-B: Device Management – Backup and Restore-B

i. DM-R-B:Device Management – Restart-B

j. DM-LM-B : Device Management – List Manipulation-B

The Application Specific Controller shall support the following Data Link Layers:

k. BACnet MS/TP Master (Clause 9)

l. BACnet IP, Foreign Device

H. The Application Specific Controller shall provide for control of each piece of equipment, including, but not limited to the following:

1. Variable Air volume (VAV)

2. Constant Air volume (CAV)

3. Hot water and electric reheat Coils (RH)

4. Fan Coil Units (FCU)

5. Fan Powered Boxes (FPB)
6. Unit Conditioners
7. Unit Ventilators
8. Baseboard radiator
9. Chilled/heated ceiling panels
10. DX cooling and chilled water coils

I. Applications for VAV terminals:

1. The following VAV terminal box equipment configurations must be supported with pre-loaded, pre-tested applications that can be selected and configured during commissioning:
    a. VAV w/cool air only
    b. VAV w/hot or cool air, automatic switchover
    c. VAV w/ HW reheat
    d. VAV w/ CHW
    e. VAV w/ HW reheat and CHW
    f. VAV w/ Electric reheat
    g. VAV w/ Series fan and HW reheat
    h. VAV w/ Series fan and Electric reheat
    i. VAV w/ Parallel fan and HW reheat
    j. VAV w/ Parallel fan and Electric reheat
2. All VAV applications must support the following options (where appropriate):
    a. Demand Control Ventilation using CO2 measurement
    b. Minimum ventilation control and flow set points configurable for each application operating mode
    c. Separate minimum and maximum flow set points for heating, cooling and ventilation
    d. Supply temperature cascade control
    e. Configuration for Constant Volume control
    f. Chilled/heated ceiling
    g. 2-pipe HW/CHW coil valve control
    h. Variable speed fan control (fan-power applications only)
    i. Multi-speed fan control (fan-power applications only)

j. Auxiliary/Base-board/Radiator heating, valve, two position or modulating and electric.

k. Analog or 3-point floating control valve/damper actuation, including 6-way heating/cooling valve via standard BACnet Analog Output objects.

l. Fault Detection for automatic change to pressure dependent control.

m. Built in air balancing support.

n. User initiated rapid ventilation to assist in purging the space for a configurable time with a separate flow set point

o. Occupancy sensor

J. Applications for Fan Coil terminals:

1. The following Fan Coil terminal box equipment configurations must be supported with pre-loaded, pre-tested applications that can be selected and configured during commissioning.

2. Heating sources

a. 2-pipe HW coil

b. 2-pipe HW/CHW coil, automatic switchover

c. Electric reheat

3. Cooling sources

a. 2-pipe CHW coil

b. DX Cooling

4. All Fan Coil applications must support the following options (where appropriate):

a. VAV pressure dependant control of a damper (no flow sensor)

b. Heating/cooling control with no fan

c. Chilled/heated Ceiling

d. Single or multi-speed or variable speed fan control

e. Auxiliary/Base-board heating, valve modulating or two position and electric

f. Analog or 3-point floating control valve actuation, including 6-way heating/cooling valve via standard BACnet Analog Output objects.

g. Occupancy sensor

K. Applications for Unit Ventilator terminals:

1. The following Unit Ventilator terminal box equipment configurations must be supported with pre-loaded, pre-tested applications that can be selected and configured during commissioning.

a. Heating and/or Cooling with Outdoor air damper control

2. All Unit Ventilator applications must support the following options (where appropriate):

   a. DX or CHW cooling

   b. Electric or HW heating

   c. 2-pipe HW/CHW coil, automatic switchover

   d. Discharge temperature control

   e. Demand Control Ventilation for each application operating mode

   f. Single or multi-speed or Variable speed fan control

   g. Auxiliary/Base-board heating,, valve modulating or two position and electric

   h. Analog control or floating control valve/damper actuation, including 6-way heating/cooling valve via standard BACnet Analog Output objects.

   i. Cooling via economizer control of outside air damper.

   j. Occupancy sensor

L. Provide centralized control functions for secondary HVAC control, Lighting, and Shading

1. Functions for coordinating control across a grouping of rooms, a floor area, entire floor, façade, mechanical or electrical supply chains, or different combinations thereof shall be provided.

2. Support commanding of all group members to a common position or state.

3. Support consolidation of common information from group members for calculation or optimization purposes

4. Central functions shall reside in an Application Specific Controller dedicated to the central control functions specified herein.

5. Members of the groups used by the central functions specified herein shall be assigned and be changeable through standard BACnet services.

M. Central functions for Secondary HVAC

Utilize the HVAC control status and conditions in a large number of Application Specific Controllers in order to support optimization of primary HVAC plants.

1. Central Supply Air function collects air demand data from rooms (Application Specific Controller flow control loops) to support demand-based run/stop decisions for air handler. Rooms indicate need for primary heating, cooling and ventilation.

2. Central Supply Air function collects data from rooms (Application Specific Controller flow loops) to minimize duct pressure. Application Specific Controllers provide multiple signals to support duct pressure reset, including damper command, damper saturation signal and air flow deviation signal. All are available for collection by Central Air application.

3. Central Supply Air function collects data from rooms (Application Specific Controller control loops) to support dynamically optimizing the primary supply air temperature. Data available from the Application Specific Controller includes cooling demand and demand in the room for reheat.

4. Central Supply Air function collects data from rooms (Application Specific Controller control loops) to support dynamically optimizing the outside air intake. Data available from the Application Specific Controller includes ventilation demand and CO2 levels.

N. Coordination between Application Specific Controllers. In situations where more than one controller is serving a common space, it must be possible through configuration only (not reprogramming) to subordinate one or more Application Specific Controllers to another Application Specific Controller allowing multiple controllers to coordinate HVAC control in a large space.

O. Application Operating Modes - All of the following operating modes shall be supported, with configurable operation of each controlled device during each mode.

1. Comfort, Standby (Pre-comfort), Economy, and Building Protection modes

a. Comfort: Space is occupied

b. Standby: Space has been or will be unoccupied for a short time

c. Economy: Space has been or will be unoccupied for a longer time

d. Building Protection: Space has been or will be unoccupied for a more than a day

2. Configurable set points and limits for each mode.

a. The operating mode can be changed by system schedule or command or by conditions in the space such as by presence detection.

b. All controlled devices shall respond to changes in operating mode in a configurable way such as set point resets after a configurable time to optimize energy consumption.

P. Room Units / HMIs shall provide an intuitive user alert to indicate energy-efficient operation or when there is unnecessary energy consumption, and provide occupants with a one-touch release to return to efficient, comfortable control. Energy efficient operation shall be determined by configurable and programmable algorithms provided by the Application Specific Controller and shall include (but not be limited to) the following conditions:

1. Temperature set point is set outside customer-specified limits

2. Fan Speed is overridden to a higher speed than is required for automated temperature control

The energy efficiency status for each Application Specific Controller and space shall also be available as BACnet object at the BMS for operating and monitoring.

Q. Scene control. The Application Specific Controller shall provide a set of configurable and field-adjustable presets of HVAC, lighting and shading levels that can be activated by pressing assigned buttons on the Room Unit / HMI.

R. Application Specific Controller Configuration and Commissioning Tool

1. Provide industry standard, commercially available laptop to host the Application Specific Controller Configuration and Commissioning Tool. The tool shall plug directly into all controllers as described below:

2. Functionality of the Configuration and Commissioning Tool connected to any Application Specific Controller shall include:

   a. Provide connection capability at either the controller, a related room unit, through a BACnet router or through a Siemens Field Panel controller to access controller information.

      1) When connected via a related room unit to a controller, the tool shall be able to access information of the controller the room unit is connected to and all controllers connected to the same MS/TP or IP network.

      2) Connection of the Tool to a controller shall not interrupt nor interfere with normal network operation in any way, prevent alarms from being transmitted or preclude centrally-initiated commands and system modification.

      3) Tool access to controller shall be password-controlled. Password protection shall be configurable for each operator based on function, points (designating areas of the facility), and edit/view capability.

   b. Provide device discovery, configuration and setup for addressing and network management of multiple devices from one connection point (location) in parallel.

   c. Select, view, command, change, and enable/disable features and functionality of the control application.

   d. Load pre-designed templates of configuration settings and allow copying of templates to other controllers in order to speed the commissioning process.

   e. Provide status, setup, balancing and control reports to support commissioning and troubleshooting activities.

   f. Backup and restore of application configurations

   g. Air flow balancing.

      1) For every air flow sensing channel in the Application Specific Controller control application, the Tool shall offer an interface and menu specifically designed to support the Test, Adjust, and Balance functions. Through the balancing menu, the controller enables the following operations:

         a) Select the operating point for the test from a list of named operating points, including maximum and minimum cooling, maximum and minimum ventilation and maximum and minimum heating.

         b) Accept the balancer's flow measurement as a manually entered value.

         c) Automatically calculate and display the revised flow calibration factor.

         d) Apply the new calibration factor on command.

      2) The Application Specific Controller shall maintain a BACnet object reflecting the TAB state of the controller as: Initial, Balancing, Balanced. The Application Specific Controller records data representing the TAB

process, and stores for later retrieval. The controller delivers the data when called for producing reports. Stored data includes:

a) Air balancer's air flow measurement.

b) Controller's air flow measurement after correction.

c) Named test point (max cooling, etc.).

d) Initial calibration factor.

e) Applied selected calibration factor

h. The tool should allow configuring, loading and balancing multiple controllers from one connection point (location) in parallel

i. The Ethernet / IP Application Specific Controller models shall provide web pages for troubleshooting and operation and monitoring which can be accessed via a standard web browser

S. Each Application Specific Controller shall, at a minimum, be provided with:

1. Appropriate NEMA rated enclosure

2. Power supplies as required for all associated modules, sensors, actuators, etc.

3. Each controller measuring air volume shall include a differential pressure transducer

4. Approvals and standards: UL916 PAZX; CUL; FCC

T. Each Application Specific Controller shall continuously perform self-diagnostics on all hardware and secondary network communications. The Application Specific Controller shall provide both local and remote annunciation of any detected component failures or repeated failure to establish communication to the system.

U. Power Supply. The Application Specific controller shall be powered from a 24 VAC source and shall function normally under an operating range of -15% / +20%.

V. All controller configuration settings and programs shall be stored in non-volatile memory. The controllers shall be able to return to full normal operation without user intervention after a power failure of unlimited duration.

W. Environment. The controllers shall function normally under ambient conditions of 23 to 122°F (-5 to 50°C) and 5% to 95% RH (non-condensing). Provide each controller with a suitable cover or enclosure to protect the circuit board assembly.

2.1.1.11 INTEGRATION GATEWAYS

A. The Building Automation System shall establish a seamless interconnection with other building, electrical and/or mechanical subsystems as well as other manufacturers control systems. List of systems may be specified in the sequences, on the drawings or in the specifications. These systems shall be controlled, monitored and graphically operated with the same software used for all other control modules.

B. System Information. All system information specified in the I/O Point Summary and related documents shall be available to the BAS server.

C. This contactor shall include labor and material for communicating and displaying at the BAS Interfaces points from packaged equipment and building subsystems that are specified to be BACnet and are required in the sequence of operations.

D. Hardware:

1. The integration software driver shall reside on a Building Controller or on a dedicated DDC gateway device designed to provide seamless, two-way translation between two or more standard or non-standard protocols.

2. Provide Data Link\Physical Layer communication ports as necessary to match the communication available from the 3rd part equipment manufacturer. Configurations including EIA-232, EIA-485, and Ethernet.

3. In addition to BACnet, the protocol gateway shall also support other protocols including Modbus, J-Bus and other protocols as specified herein for electrical/mechanical subsystems.

4. The gateway shall have at least two communication ports. One shall be for communication between native BACnet controllers residing on the controller network. The other port(s) shall have the ability to be configured for different protocols.

E. The protocol gateway shall provide full custom programmability of the data flowing between the networks using the same software used for the Building Controllers as specified herein. The system shall have the ability to create custom building control strategies using global data between networks.

2.1.1.12 CONTROL PANELS

A. Controllers in mechanical rooms shall be mounted in NEMA 1 enclosures.

B. Controllers in areas where moisture is a concern shall be mounted in NEMA 12 enclosures.

C. Controllers installed outdoors shall be mounted in NEMA 4X enclosures. Provide heaters where freezing temperatures are normally experienced.

D. Mount on walls at an approved location or provide a free standing rack.

E. Panels shall be constructed of 16 gauge, furniture-quality steel, or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with ANSI 61 gray polyester-powder painted finish, UL listed. Provide common keying for all panels.

F. Provide power supplies for control voltage power.

G. Dedicate 1 power supply to the DDC controller. Other devices shall be on a separate power supply, unless the power for the control device is derived from the controller terminations.

H. Power supplies for controllers shall be a transformer with a fuse or circuit breaker. Power supplies for other devices can be plain transformers.

I. All power supplies for 24V low voltage wiring shall be class 2 rated and less than 100VA. If low voltage devices require more amps, then provide multiple power supplies. If a single device requires more amps, then provide a dedicated power supply in a separate enclosure and run a separate, non-class 2 conduit to the device.

J. Surge transient protection shall be incorporated in design of system to protect electrical components in all DDC Controllers and operator's workstations.

K. All devices in a panel shall be permanently mounted, including network switches, modems, media converters, etc.

L. Provide a pocket to hold documentation.

2.1.1.13 UNINTERRUPTIBLE POWER SUPPLY

A. Provide an UPS for each of the following:

1. BAS Server

B. Each UPS shall power the device for a minimum of 30 minutes, in the case of power interruption.

C. The UPS shall be DIN rail mounted within the associated control panel and consist of a battery power source, charger, AC output inverter system and automatic load transfer circuits for a full automatic operation. The UPS shall be an on-line type. When normal AC power returns, the UPS shall transfer the load to the rectifier output. At this time, the charger shall turn on to its 'high' charge rate until the batteries are charged approximately 80% of their rated capacity and then automatically shall switch to its maintenance 'sensing' position to keep the batteries in their best full-charge condition. Battery recharge time shall not be more than 3 hours.

D. Each UPS shall be provided, as a minimum, with pilot lights for the following conditions: "Incoming AC Power is Available", "UPS Ready Mode" and "UPS in Standby Mode". The UPS shall have the capability to hot-swap batteries without interrupting the supply of power to its users.

E. The batteries shall be of the totally enclosed nickel-cadmium type or equal. Batteries that can leak gas shall not be acceptable. There shall not be any damages should the emergency outage of line power exceed the maximum operation time of the UPS. Automatic shutdown shall occur when the UPS' maximum duty cycle is exceeded.

F. Provide APC, Liebert, or pre-approved equal.

2.1.1.14 SENSORS

A. General

1. Provide mounting hardware for all devices, including actuator linkages, wells, installation kits for insertion devices, wall boxes and fudge plates, brackets, etc.

2. If a special tool is required to mount a device, provide that tool.

3. Sensors shall be mounted in proper location of return airflow, not in direct flow of supply air.

B. Terminal Unit Space Thermostats

1. Each controller performing space temperature control shall be provided with a matching room temperature sensor.

   a. Plain Space Temperature Sensors – Wired: Where called for in the sequences or on the drawings, provide sensors with plain covers.

   b. The sensing element for the space temperature sensor shall be thermistor type providing the following.

      1) Element Accuracy: + /- 1.0°F

      2) Operating Range: 55 to 95°F

      3) Set Point Adjustment Range: 55 to 95°F

      4) Calibration Adjustments: None required

      5) Installation: Up to 100 ft. from controller

      6) Auxiliary Communications Port: as required

      7) Local LCD Temperature Display: as required

      8) Setpoint Adjustment Dial as required

      9) Occupancy Override Switch as required

   c. Auxiliary Communication Port. Each room temperature sensor shall include a terminal jack integral to the sensor assembly. The terminal jack shall be used to connect a portable operator's terminal to control and monitor all hardware and software points associated with the controller. RS-232 communications port shall allow the operator to query and modify operating parameters of the local room terminal unit from the portable operator's terminal.

2. Digital Display temperature sensor specifications – Wired:

   a. As called for in the sequences of operations or on the drawings, provide temperature sensors with digital displays.

   b. The sensing element for the space temperature sensor must be IC-based and provide the following.

      1) Digitally communicating with the Application Specific Controller.

      2) Mountable to and fully covering a 2 x 4 electrical junction box without the need for an adapter wall plate.

      3) IC Element Accuracy: +/- 0.9°F

      4) Operating Range: 55 to 95°F

      5) Setpoint Adjustment Range: User limiting, selectable range between 55 and 95°F

6) Display of temperature setpoint with numerical temperature values

7) Display of temperature setpoint graphically, with a visual Hotter/Colder setpoint indication

8) Calibration: Single point, field adjustable at the space sensor to +/- 5°F

9) Installation: Up to 100 ft. from controller

10) Auxiliary Communications Port: included

11) Local OLED Temperature Display: included

12) Display of Temperature to one decimal place

13) Temperature Setpoint Adjustment included

14) Occupancy Override Function included

c. Auxiliary Communication Port. Each room temperature sensor shall include a terminal jack integral to the sensor assembly. The terminal jack shall be used to connect a portable operator's terminal to control and monitor all hardware and software points associated with the controller. RS-232 communications port shall allow the operator to query and modify operating parameters of the local room terminal unit from the portable operator's terminal.

3. Provide the following options as they are called for in the sequences or on the drawings:

a. Setpoint Adjustment. The setpoint adjustment function shall allow for modification of the temperature by the building operators. Setpoint adjustment may be locked out, overridden, or limited as to time or temperature through software by an authorized operator at any central workstation, Building Controller, room sensor two-line display, or via the portable operator's terminal.

b. Override Switch. An override button shall initiate override of the night setback mode to normal (day) operation when activated by the occupant and enabled by building operators. The override shall be limited to two (2) hours (adjustable.) The override function may be locked out, overridden, or limited through software by an authorized operator at the operator interface, Building Controller, room sensor two-line display or via the portable operator's terminal.

c. Space Combination Temperature and Humidity Sensors. Each controller performing space temperature control shall be provided with a matching room temperature sensor, which also includes the ability to measure humidity for either monitoring or control purposes. The combination temperature and humidity sensors shall have the same appearance as the space temperature sensors. Humidity elements shall measure relative humidity with a +/- 2% accuracy over the range of 10 to 90% relative humidity. Humidity element shall be an IC (integrated circuit) sensing element. Humidity sensing elements shall be removable and field replaceable if needed.

C. Temperature Sensors

1. All temperature sensors shall meet the following specifications:

a. Accuracy: Plus or minus 0.2 percent at calibration point.

b. Wire: Twisted, shielded-pair cable.

c. Vibration and corrosion resistant

2. Space temperature sensors shall meet the following specifications:

a. 10k ohm type 2 thermisters

3. Insertion Elements in Ducts shall meet the following specifications:

a. Single point 10k ohm thermister

b. Use where not affected by temperature stratification

c. The sensor shall reach more that 1/3 the distance from the duct wall

d. Junction box for wire splices

4. Averaging Elements in Ducts shall meet the following specifications:

a. 72 inches (183 cm) long

b. Flexible

c. Use where prone to temperature stratification, in front of coils, or where ducts are larger than 9 sq. ft.

d. Junction box for wire splices

5. Insertion Elements for Liquids shall meet the following specifications:

a. Platinum RTD with 4-20mA transmitter

b. Threaded mounting with matching well

c. Brass well with minimum insertion length of 2-1/2 inches for pipes up to 4" diameter

d. Brass well with insertion length of 6 inches for pipes up to 10" diameter

e. Junction box for wire splices

6. Outside-Air Sensors Platinum RTD with 4-20mA transmitter:

a. Watertight enclosure, shielded from direct sunlight

b. Circulation fan

c. Watertight conduit fitting

D. Where called for in the sequences of operations, provide the following feature on space sensors and thermostats:

1. Security Sensors: Stainless-steel cover plate with insulated back and security screws

2. Space sensors with setpoint adjust: Plain white plastic cover with slide potentiometer to signal a setpoint adjustment to the DDC

3. Space Sensors with LCD display:

a. Operator buttons for adjusting setpoints, setting fans speeds and overriding unit to on/off

b. Graphical LCD icons for signaling heating/cooling mode, fans speed, schedule mode, actual temperature and current setpoint

E. Humidity Sensors shall meet the following specifications:

1. Bulk polymer sensor element

2. Accuracy: 2 percent full range with linear output

3. Room Sensors: With locking cover matching room thermostats, span of 0 to 100 percent relative humidity

4. Duct and Outside-Air Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity

F. Air Static Pressure Transmitter shall meet the following specifications:

1. Non-directional sensor with suitable range for expected input, and temperature compensated.

2. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.

3. Output: 4 to 20 mA.

4. Building Static-Pressure Range: 0 to 0.25 inches wg.

5. Duct Static-Pressure Range: 0 to 5 inches wg.

G. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; proportional output 4 to 20 mA.

H. Equipment operation sensors as follows:

1. Status Inputs for Fans: Differential-pressure switch with adjustable range of 0 to 5 inches wg.

2. Status Inputs for Pumps: Differential-pressure switch piped across pump with adjustable pressure-differential range of 8 to 60 psig.

3. Status Inputs for direct drive electric motors: Current-sensing relay with current transformers, adjustable and sized for 175 percent of rated motor current.

4. Status inputs for belt drive electric motors: Current sensing transmitter with linear 4-20mA output

I. Electronic Valve/Damper Position indication: Visual scale indicating percent of travel and 0 to 10 V dc, feedback signal.

J. Water-Flow Switches: Pressure-flow switches of bellows-actuated mercury or snap-acting type, with appropriate scale range and differential adjustment, with stainless-steel or bronze paddle. For chilled-water applications, provide vapor proof type.

K. Air Differential Pressure Switches: Diaphragm type air differential pressure switches with die cast aluminum housing, adjustable setpoint, minimum 5 amp switch rating at 120VAC, SPDT switches, and the switch pressure range shall be suited for the application. Provide Dwyer or equal. These switches shall be utilized for filter status.

L. Leak detectors: Provide spot leak detectors that can be secured to the floor or secured to a drain pan. The detection shall used a microchip controlled energized probes. The detector shall operate on 24Vor less. Provide a way to adjust the height of the leak probes. The SPDT contacts shall be inside a watertight enclosure.

2.1.1.15 ELECTRO-MECHANICAL THERMOSTATS

A. Fire-Protection Thermostats: UL listed with fixed or adjustable settings to operate at not less than 75 deg F above normal maximum operating temperature, with the following:

1. Reset: Automatic with control circuit arranged to require manual reset at central control panel, with pilot light and reset switch on panel labeled to indicate operation.

B. Electric Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point. Setpoint shall be adjustable.

1. Bulb Length: Minimum 20 feet.

2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

C. Electric space thermostats: Provide a charged element type stat with snap acting SPDT switch. The switch shall be rated for 16A or 1HP at 120V.

D. Aquastat: Provide a charged element type stat with snap acting SPDT switch. The switch shall be rated for 16A or 1HP at 120V.

2.1.1.16 AUTOMATIC CONTROL VALVES

A. General:

1. All automatic control valves shall be fully proportioning, unless specified otherwise. The valves shall be quiet in operation and fail-safe in either normally open or normally closed position in the event of control air failure. All valves shall be capable of operating at varying rates of speed to correspond to the exact dictates of the controllers and variable load requirements. The valves shall be capable of operating in sequence with other valves and/or dampers when required by the sequence of operation. All control valves shall be sized by the control vendor and shall be guaranteed to accommodate the flow rates as scheduled. All control valves shall be suitable for the pressure conditions and shall close against the differential pressures involved. Body pressure rating and connection type construction shall conform to fitting and valve schedules. Control valve operators shall be sized to close against a differential pressure equal to the design pump heads plus 10 percent.

2. Cold water, hot water and steam valves, throttling type, and bypass valves shall have equal percentage flow characteristics.

3. Unless otherwise specified, control valves 2 inches and smaller shall have cast iron or bronze bodies with screwed NPT connections.

4. Valves between 2-1/2 inch and 4 inch shall have cast iron bodies with flanged connections.

5. All automatic control valves installed exposed to the elements shall be provided with electric actuators with operating characteristics and accessories as described in herein. Coordinate with electrical contractor for power availability and point of connection.

6. All automatic control valves controlled by the BAS shall be furnished by the controls contractor unless noted otherwise in these documents.

7. All automatic control valves shall be installed by the mechanical trade.

8. The controls contractor shall provide wiring as follows:

   a. All line voltage power for electric valve actuators shall be wired by the controls contractor from the nearest available power panel. Coordinate with electrical trade.

   b. All wiring between the central control system (ATC/BMS) and the valve actuator shall be wired by the controls contractor.

   c. All wiring between the valve actuator and their associated thermostats, pressure switches, control devices, etc. shall be wired by the controls contractor.

   d. All wiring shall comply with code requirements. Segregate high and low voltage wiring & circuits and segregate the FAS and controls (BMS) terminals.

B. Characterized Ball Valves

1. All control valves shall be sized by the control vendor. All control valve bodies shall be suitable for the static and dynamic pressures of the system. Control valve operators shall be sized to close against a differential pressure equal to the design pump head plus 10 percent.

2. Body pressure rating and connection type construction shall conform to fitting and valve schedules.

   a. Design body pressure shall be determined by the adding the static pressure due to the height of the system plus the compression tank charge plus the maximum head of the system pump at cut off. Provide 10% design factor.

3. The valve seat differential pressure rating shall exceed the pump dynamic head design pressure.

4. All automatic control valves controlled by the BAS shall be furnished by the controls contractor unless otherwise noted in these documents.

5. All automatic control valves shall be installed by the mechanical trade.

6. The controls contractor shall provide wiring as follows:

   a. All line voltage power for electric valve actuators shall be wired by the controls contractor from the nearest available power panel. Coordinate with electrical trade.

b. All low voltage wiring between the controller and the valve actuator shall be wired by the controls contractor.

c. All wiring between safeties and the valve actuator shall be wired by the controls contractor.

d. All wiring shall comply with code requirements. Segregate high and low voltage wiring and circuits and segregate the Fire Alarm (FACS) and BAS controls wiring.

C. Manufacturer

1. Siemens 599 series valves bodies, SSD, SAX, SQV Actuators, Series 230, 231, 232, 233, 238, 239, 371, and 373 assemblies

D. Threaded Valves, line size ½" to 2"

1. Controlled Media Specific Items

a. The control valve shall be suitable for chilled water to a minimum of 35°F (2°C) and hot water to a maximum temperature of 250°F (121°C). 3-way 1-1/2 inch and 2 inch valves shall be suitable for chilled water to a minimum of 35°F (2°C) and hot water to a maximum temperature of 230°F (110°C).

b. The control valve shall be suitable for up to 50% ethylene or propylene glycol solutions, chilled glycol/water solutions to a minimum of 35°F (2°C) and hot glycol/water solutions to a maximum temperature of 250°F (121°C). 3-way 1-1/2 inch and 2 inch valves shall be suitable for up to 50% ethylene or propylene glycol solutions, chilled glycol/water solutions to a minimum of 35°F (2°C) and hot glycol/water solutions to a maximum temperature of 230°F (110°C).

2. General Construction Materials/Applicable Standards

a. Control valve bodies shall be constructed of forged brass according to ASTM B283 (C37700, CuZn39Pb2 or equivalent), and shall meet requirements of ANSI 250 and 600WOG pressure classes.

b. Inlets and outlets shall be clearly marked on the valve bodies.

c. Valve ball shall consist of nickel-plated brass, chrome-plated brass or stainless steel.

d. End connections shall be NPT internally threaded according to ANSI B1.20.1.

e. The control valve flow rate (Cv) shall meet the requirements of ANSI/ISA S75.02.

f. The control valve shall have an equal percentage flow characteristic, according to ANSI/ISA S75.11. A single glass filled PTFE V port insert shall provide both the ball seal and shall establish the flow coefficient of the valve. The V port insert shall be retained by the valve body itself, not requiring additional retaining components. Flow coefficient adapters requiring a retainer clip, or installed after final assembly of the valve or as inserts in the ball shall not be allowed.

g. 2-way valves and the A-AB path on 3-way valves shall meet the requirements of ANSI Class IV (0.01% of rated Cv) seat leakage, or better, according to ANSI/FCI 70.2, at the specified close-off pressure. Bypass path (B-AB) on 3-way valves

shall meet the requirements of ANSI Class III (0.1% of rated Cv) seat leakage, or better, according to ANSI/FCI 70.2.

h. Chilled and Hot water valve shall have a blow-out proof stem with two EPDM (peroxide cured) O-rings. External stem retainers will not be allowed.

i. Valve stem shall be made of brass or stainless steel.

j. Valve shall have the ability to be manually operated in the event of a power failure.

E. Actuators - Electric

1. The valves shall be provided with an actuator by the same manufacturer, factory installed.

2. All actuators shall have visual position indication.

3. No external programming device shall be required.

4. Actuator shall be electric motor driving, microprocessor signal controlled.

5. Modulating valves shall be positive positioning, responding to a 0-10VDC, 2-10VDC or 4-20mA signal. Floating modulating signals are acceptable for modulation on terminal units and radiation units. There shall be a visual valve position indicator.

6. Power: All actuators shall be 24VAC power and less than 100VA draw. Power shall be via Class 2 wiring. Actuators requiring more than 100VA shall have a dedicated conduit for power wiring, not mixed with the signal wiring.

7. Fail Safe: Valves actuators shall position the valve in a fail-safe position when the power supply is disrupted or the signal goes to 0. Fail-safe according to the following guidelines unless otherwise stated in the sequence of operations

   a. Power fail safe shall be via spring loaded mechanical means

   b. Any AHU hot water exposed to ventilation air shall fail open

   c. AHU Chilled water coils exposed to ventilation air in possible freezing conditions shall be fail open

   d. AHU Chilled water coils that are drained in winter months or are in climate zones without freezing conditions shall be fail-in-place

   e. Terminal unit valves shall fail-in-place

8. Fail in Safe valves on primary equipment such as chilled water systems, hot water systems and condenser water systems shall have a means to manually open the valve when power is not available, such as a hand wheel or a geared crank with a clutch.

9. The actuator shall be designed with a current limiting motor protection. A release button (clutch) or handle on the actuator shall be provided to allow for manual override (except when actuator is spring return type).

10. Actuator shall provide minimum torque required for proper valve close-off. The close-off differential pressure rating of the valve shall exceed the highest possible head pressure available at the pump plus 10%, and still be rated for a Class IV leakage.

11. The actuator shall have the capability of adding auxiliary switches or feedback potentiometer if specified.

12. All automatic control valves installed in locations exposed to the elements shall be provided with weather resistant housings and heaters for climates that reach below freezing.

13. Actuators shall be UL and CSA listed.

F. Hot Water / Condenser Water / Control Valves

1. Single-seated.

2. Fully proportioning with modulating plug or V-port inner valves.

3. Body pressure rating and connection type construction shall conform to fitting and valve schedules. The ANSI rating of the valve shall match the ANSI rating of the piping in which the valve is installed. Minimum ANSI rating shall be ANSI 125.

4. Stainless steel stems and trim.

5. Spring loaded Teflon packing

6. Quiet in operation.

7. Fail-safe in either normally open or normally closed position in the event of power failure.

8. Capable of operating in sequence with other valves and/or dampers when required by the sequence of operation.

9. Capable of operating at varying rates of speed to correspond to the exact dictates of the controller and variable load requirements.

G. Differential Pressure Control Valves :

1. Provide for all water systems where modulating water flow conditions are required to prevent excessive pump pressure build-up. Provide a valve for each closed loop water system. Valve to be globe type. Provide valves 2" and smaller with screwed end bodies and provide valves 2-1/2" and larger with flanged ends.

H. Steam Valves:

1. Steam control valves shall be of linear flow characteristics for modulating service.

2. Sizing Criteria:

a. 15 psig or less; pressure drop 80% of inlet psig.

b. 16 to 50 psig; pressure drop 50% of inlet psig.

c. Over 50 psig; pressure drop as scheduled on plans.

d. Steam valves shall fail normally open or closed, as scheduled on plans, or as follows:

1) Heating coils in air handlers: normally open.

2) Steam to hot water heat exchanger: normally closed.

3) Other applications: as required by sequences of operation.

2.1.1.17 ELECTRONIC ACTUATOR SPECIFICATION

A. ELECTRONIC VALVE ACTUATORS

1. Actuator shall be fully modulating, floating (tri-state), two position, and/or spring return as indicated in the control sequences. Specified fail safe actuators shall require mechanical spring return.

2. Modulating valves shall be positive positioning, responding to a 2-10VDC or 4-20mA signal. There shall be a visual valve position indicator.

3. The actuator shall have the capability of adding auxiliary switches or feedback potentiometer if specified.

4. Actuator shall provide minimum torque required for proper valve close-off. The actuator shall be designed with a current limiting motor protection. A release button (clutch) or handle on the actuator shall be provided to allow for manual override (except when actuator is spring return type).

5. Actuators shall be UL listed.

B. ELECTRONIC DAMPER ACTUATORS

1. Actuator shall be direct coupled (over the shaft), enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The actuator-to-shaft clamp shall use a "V" bolt and "V" shaped, toothed cradle to attach to the damper shaft for maximum holding strength. Single bolt or set screw type fasteners are not acceptable.

2. Actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator. End switches to deactivate the actuator at the end of rotation or magnetic clutch are not acceptable.

3. For power-failure/safety applications, a mechanical, spring return mechanism shall be used.

4. Actuators with spring return mechanisms shall be capable of either clockwise or counterclockwise spring return operation by simply changing the mounting orientation.

5. Proportional actuators shall accept a 2-10VDC, 4-20mA signal, or be of the 2 point floating type and provide a 2-10VDC actuator position feedback signal.

6. All actuators shall have an external manual gear release (clutch) or manual crank to aid in installation and for allowing manual positioning when the actuator is not powered.

7. All actuators shall have an external direction of rotation switch to aid in installation and to allow proper control response.

8. Actuators shall be provided with a factory-mounted 3-foot electrical cable and conduit fitting to provide easy hook-up to an electrical junction box.

9. Actuators shall be listed under Underwriters Laboratories Standard 873 and Canadian Standards Association. They must be manufactured under ISO 9001.

PART 3 - EXECUTION

3.1.1.1 EXAMINATION

A. The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the architect/engineer for resolution before rough-in work is started.

B. The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started.

C. The contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate—or if any discrepancies occur between the plans and the contractor's work and the plans and the work of others—the contractor shall report these discrepancies to the engineer and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others.

3.1.1.2 INSTALLATION

A. Provide all relays, switches, sources of emergency and UPS battery back-up electricity and all other auxiliaries, accessories and connections necessary to make a complete operable system in accordance with the sequences specified. All field wiring shall be by this contractor.

B. Install controls so that adjustments and calibrations can be readily made. Controls are to be installed by the control equipment manufacturer.

C. Mount surface-mounted control devices on brackets to clear the final finished surface on insulation.

D. Install equipment level and plumb.

E. Install control valves horizontally with the power unit up.

F. Unless otherwise noted, install wall mounted thermostats and humidistat 60" above the floor measured to the center line of the instrument, or as otherwise directed by the Architect.

G. Install averaging elements in ducts and plenums in horizontal crossing or zigzag pattern.

H. Install outdoor sensors in perforated tube and sunshield.

I. Install damper motors on outside of duct in protected areas, not in locations exposed to outdoor temperatures.

J. Install labels and nameplates on each control panel listing the name of the panel referenced in the graphics and a list of equipment numbers served by that panel.

K. Furnish hydronic instrument wells, valves, and other accessories to the mechanical contractor for installation.

L. Furnish automatic dampers to mechanical contractor for installation.

3.1.1.3 GRAPHIC DISPLAY GENERATION

A. All workstation(s) shall be provided with color graphics. All workstation(s) software shall include a graphical viewing and control environment and definition and construction of dynamic color graphic displays.

B. Provide a main default screen showing the basic layout of the building. Each color graphic screen shall have transfer links to allow the building operator to transfer between system associated screens (both forward and backward), as well as a transfer link back to the main default screen.

C. Basic CAD floor plans with layers for walls, windows, low pressure ductwork only, supply diffusers and room numbers shall be provided for all CV, VAV, and FPVAV terminal units. Floor plans shall show the location of each space temperature sensor with a dashed line to the associated terminal unit. Display in real time the difference between the space temperature and the current setpoint.

1. Display the

   a. cooling %,

   b. heating % (if applicable)

   c. current CFM of each terminal unit.

2. Provide a transfer link for each terminal unit to allow the operator to access the flow graphic for each individual terminal unit. Use a different color to shade the background area for each part of a floor plan graphic served by a different air handling unit.

D. Thermal floor plan graphics:

1. Show heating and cooling zones throughout the building in a range of colors (minimum 5) that provide a visual display of temperatures relative to their respective setpoints. The colors shall be updated dynamically as zones' comfort conditions change. Locations of space sensors shall also be shown for each zone. Floor plan humidity's shall be represented similarly to zone temperatures. Setpoint adjustment and color band displays shall be provided as a tool for user adjustment.

2. These full screen plans shall be accessible by rolling over the floor on the building elevation rendering. This will provide the viewer a quick and accurate overview of which zones are at setpoint, near setpoint, or need attention.

3. The viewer may then click on any zone to be brought to the terminal unit that is related to that zone. Rolling over any zone will bring up the zone description and temperature in a pop-up flag. Flags are used to keep the zone information legible regardless of how small the zone is depicted on the plan

4. All floor plans shall be vector based to allow for zooming in and out of floor plans without pixelization.

5. If zone lighting controls are tied into the BAS, then produce the same floor viewing and control for lights.

6. If a Web-based graphical interface is specified, then the floor plan graphics shall be accessible through the Web Browser Interfaces.

E. All control set points shall be easily adjustable from the system's color graphic screen by operators with the proper access level. Each controlled point on the BAS operator workstation color graphic screens shall have the set point indicated along with the actual controlled variable reading (preferred set point on top and actual reading on bottom). All points shall indicate the associated engineering unit. All analog outputs points shall indicate engineering units such as "%-open" or "%-closed" as required by the application. All normally-closed or normally-open points shall indicate the normal position (such as "N.C." or "N.O." next to the controlled device).

F. Provide system color graphics for each HVAC system and for each electrical, plumbing and/or piping system that is monitored and/or controlled by the BMS. Provide scaled floor plans indicating equipment location, service, and system data as required.

G. Provide color graphic floor plan displays and system schematics for each piece of mechanical equipment, including but not limited to air handling units, chilled water systems and hot water systems to optimize system performance analysis and speed alarm recognition.

H. The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection or text-based commands.

I. Dynamic temperature values, humidity values, flow values and status indication shall be shown in their actual respective locations and shall automatically update to represent current conditions without operator intervention.

J. The windowing environment of the PC operator workstation(s) shall allow the user to simultaneously view several graphics at a time to analyze total building operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.

1. Provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g., fans, cooling coils, filters, dampers, etc.), complete mechanical systems (e.g., constant volume-terminal reheat, VAV, etc.) and electrical symbols.

2. Graphical displays can be created to represent any logical grouping of system points or calculated data based upon building function, mechanical system, building layout or any other logical grouping of points which aids the operator in the analysis of the facility.

K. Provide an automatically updated, dynamic display of the site-specific BMS architecture indicating the status of primary and secondary controllers, PC workstation(s)and networks.

L. Provide a separate dynamic display page of each HVAC (AHU, AC, chiller, cooling tower, fuel oil, etc.), electrical, and/or plumbing system connected to the BMS.

M. Provide a separate dynamic display page of each piece of terminal equipment (VAV box, fan coil unit, etc.) connected to the BMS.

N. Provide an additional (10) separate dynamic, graphic display pages at each workstation as required by the operating staff to further assist in daily system operations.

O. Graphics shall incorporate all system integration points communicated via hardware or software gateways and/or interfaces. Origin of information shall be transparent to the operator and shall be controlled, displayed, trended, etc. as if the points were hardwired to the BMS.

P. Each graphic shall have a "BACK" button and a "HOME" or "MAIN" button located in the same location on all graphics.

Q. The operator shall be able to clearly distinguish the difference between the following types of points on a graphic either by color, shape, icon or text lable:

1. Real-time sensor reading
2. Setpoint
3. Manually set vs. program set Setpoint
4. Real-time output reading
5. Manually Overridden or commanded output vs program set output
6. Status feedback from a piece of equipment vs the output command

R. When the operator selects a graphic from a menu or a hyperlink, the system shall also make the following adjustments for the operator:

1. Highlight the system name on the system tree
2. Highlight the controller name on the network tree
3. Make appear links to additional information associated with the data on the graphic, such as:
    a. Adjustable modes of operation
    b. Setpoints
    c. Alarm statuses
    d. Trend logs

4. Make appear links to additional information associated with the system on the graphic, such as:

    a. Controls as-built schematics and wiring diagrams

    b. As-built Sequence of Operation

    c. Mechanical drawings

    d. Electrical drawings

S. For control loops that have a 4-point setpoint reset schedule, the operator shall have access to adjust the 4 points in the graphics. Provide a separate graphic with the 4 adjustable data points and a line graph with labels vertices showing the scale of the reset ramp. Display the current calculated output setpoint.

T. Integration graphics shall be representative of personnel standing in front of equipment. The graphics for equipment specified in the Building Systems Integration paragraph shall be representative of the manufacturers' local display panel and each shall be completely operable from the computer workstation.

3.1.1.4 ELECTRICAL WIRING SCOPE

A. This contractor shall be responsible for power that is not shown on the electrical drawings, to controls furnished by this contractor. If power circuits are shown on the electrical drawings, this contractor shall continue the power run to the control device. If power circuits are not shown, this contractor shall coordinate with the electrical contractor to provide breakers at distribution panels for power to controls. This contractor is then responsible for power from the distribution panel.

    1. Coordinate panel locations. If enclosures for panels are shown on the electrical drawings, furnish the enclosures according to the electrician's installation schedule.

B. This contractor shall not be responsible for power to control panels and control devices that are furnished by others, unless it is part of the control interlock wiring.

C. Refer to Coordination section for what devices this contractor is responsible to mount and which are turned over to others to mount.

D. This contractor shall be responsible for wiring of any control device that is furnished as part of this section of specification.

E. Interlock wiring shall be run in separate conduits from BAS associated wiring.

F. Provide network wiring for equipment that is called to be integrated to the BAS.

3.1.1.5 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. All low voltage control wiring shall be class 2. Control wiring that is not class 2 shall be run in separate conduits from class 2 wiring.

B. Floor level network wiring between terminal units can be combined with thermostat and other low voltage wiring in the same conduit. All other network wiring shall be in dedicated conduits.

C. Install raceways, boxes, and cabinets according to Division 26 Section "Raceways and Boxes."

D. Install building wire and cable according to Division 26 Section "Conductors and Cables."

E. Installation shall meet the following requirements:

1. Conceal cable and conduit, except in mechanical rooms and areas where other conduit and piping are exposed.

2. Install exposed cable in raceway or conduit.

3. Install concealed cable using plenum rated cable.

4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.

5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.

6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.

7. All wiring in lab areas shall be in conduit.

8. All unsupported risers shall be rigid steel conduit. Supported risers shall be EMT.

F. Rigid conduit shall be steel, hot dip galvanized, threaded with couplings, ¾ inch minimum size, manufactured in accordance with ANSI C-80-1. Electrical metallic tubing (EMT) with compression fittings or intermediate metallic conduit (IMC) may be used as conduit or raceway where permitted by the NEC.

G. Concealed control conduit and wiring shall be provided in all spaces except in the Mechanical Equipment Rooms and in unfinished spaces. Install in parallel banks with all changes in directions made at 90 degree angles.

H. Install conduit adjacent to machine to allow service and maintenance.

I. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

J. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

K. Ground equipment.

3.1.1.6 COMMUNICATION WIRING

A. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.

B. Do not install communication wiring in raceway and enclosures containing Class 1 wiring.

C. Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.

D. Contractor shall verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.

E. Cable bundling:

1. RS485 cabling run open air in accessible areas can be bundled with other class 2 low voltage cabling.
2. RS485 cabling run between terminal units in conduits above ceilings or under floors or in inaccessible areas can be bundled with other class 2 low voltage cabling.
3. RS485 cabling run between floors shall be in a communication only conduit.
4. RS485 conduit run long distances between utility rooms or between buildings shall be in a communication only conduit.
5. Ethernet cabling shall be in a communication only conduit.
6. Ethernet and RS485 can be run together.
7. Fiber optics can be run with Ethernet and RS485 cabling as long as the conduit is bent to fiber optic standards and junction boxes are sized for fiber optic use.

F. RS485 Cabling

1. RS485 cabling shall be used for BACnet MS/TP networks.
2. RS485 shall use low capacitance, 20-24 gauge, twisted shielded pair.
3. The shields shall be tied together at each device.
4. The shield shall be grounded at one end only and capped at the other end.
5. Provide end of line (EOL) termination devices at each end of the RS485 network or subnetwork run, to match the impedance of the cable, 100 to 120ohm.

G. Ethernet Cabling

1. Ethernet shall not be run with any Class 1 or low voltage Class 2 wiring.
2. CAT6, unshielded twisted pair (UTP) cable shall be used for BAS Ethernet.
3. Solid wire shall be used for long runs, between mechanical rooms and between floors. Stranded cable can be used for patch cables and between panels in the same mechanical room up to 50 feet away.
4. When the BAS Ethernet connects to an Owner's network switch, document the port number on the BAS As-builts.

H. Fiber-Optic Cabling

1. Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post-installation residual cable tension shall be within cable manufacturer's specifications.

2. All cabling and associated components shall be installed in accordance with manufacturers' instructions. Minimum cable and unjacketed fiber bend radii, as specified by cable manufacturer, shall be maintained.

3. All terminations shall to be made into a patch panel, designed for such use. Free air terminations with patch panels are prohibited.

I. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lighting arrestor shall be installed according to the manufacturer's instructions.

J. All runs of communication wiring shall be unspliced length when that length is commercially available.

K. All communication wiring shall be labeled to indicate origination and destination data.

L. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

3.1.1.7 IDENTIFICATION

A. Permanent warning labels shall be affixed to all equipment that can be automatically started by the DDC system.

1. Labels shall use white lettering (12-point type or larger) on a red background.

2. Warning labels shall read as follows: C A U T I O N This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.

B. Permanent warning labels shall be affixed to all motor starters and all control panels that are connected to multiple power sources utilizing separate disconnects.

1. Labels shall use white lettering (12-point type or larger) on a red background.

2. Warning labels shall read as follows: C A U T I O N This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.

C. Control Equipment and Device labeling:

1. Labels and tags shall match the unique identifiers shown on the as-built drawings.

2. All Enclosures shall be labeled to match the as-built drawing by either control panel name or the names of the DDC controllers inside.

3. All sensors and actuators not in occupied areas shall be tagged.

4. Airflow measurement arrays shall be tagged to show flow rate range for signal output range, duct size, and pitot tube AFMS flow coefficient.

5. Duct static pressure taps shall be tagged at the location of the pressure tap.

6. Each device inside enclosures shall be tagged.

7. Terminal equipment need only have a tag for the unique terminal number, not for each device. Match the unique number on:

   a. First, the design drawings, or

   b. Second, the control as-builts, or

   c. Third, the DDC addressing scheme

8. Tags on the terminal units shall be displayed on the Operator Workstation Graphics.

D. Tags shall be mechanically printed on permanent adhesivebacked labeling strips, 12 point height minimum.

E. Manufacturers' nameplates and UL or CSA labels are to be visible and legible after equipment is installed.

F. Identification of Wires

1. Tag each wire with a common identifier on each end of the wire, such as in the control panel and at the device termination.

2. Tag each network wire with a common identifier on each end.

3. Tag each 120V power source with the panel and breaker number it is fed by.

G. Identification of Conduits:

1. Identify the low voltage conduit runs as BAS conduit, power feeds not included.

2. Identify each electric box, junction box, utility box and wiring tray with a blue paint mark or blue permanent adhesive sticker.

3. For conduit runs that run more than 8 ft between junction boxes in 1 room, place a blue identifier at least every 8 feet.

4. Place a blue identifier on each side of where a conduit passed through a wall or other inaccessible path.

5. Identify all BAS communication conduits the same as above.

3.1.1.8 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment, and retest.

3. Calibration test controllers by disconnecting input sensors and stimulating operation with compatible signal generator.

B. Engage a factory-authorized service representative to perform startup service.

C. Replace damaged or malfunctioning controls and equipment.

1. Start, test, and adjust control systems.

2. Demonstrate compliance with requirements, including calibration and testing, and control sequences.

3. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.

3.1.1.9 SYSTEM CHECKOUT AND STARTUP

A. Inspect each termination in the MER control panels and devices to make sure all wires are connected according to the wiring diagrams and all termination are tight.

B. After the controls devices and panels are installed and power is available to the controls, perform a static checkout of all the points, including the following:

1. Inspect the setup and reading on each temperature sensor against a thermometer to verify its accuracy.

2. Inspect the setup and reading on each humidity sensor against a hygrometer to verify its accuracy.

3. Inspect the reading on each CO2 sensor using a calibration kit to verify the sensor range accuracy matches the DDC setup.

4. Inspect the reading of each status switch to verify the DDC reads the open and close correctly.

5. Command each relay to open and close to verify its operation.

6. Command each 2-position damper actuator to open and close to verify operation.

7. Command each 2-position valve to open and close to verify operation.

8. Ramp each modulating actuator to 0%, 25%, 50%, 75% and 100% to verify its operation.

9. Ramp each modulating output signal, such as a VFD speed, to verify its operation.

10. Test each safety device with a real life simulation, for instance check freezestats with ice water, water detectors with water, etc.

C. Document that each point was verified and operating correctly. Correct each failed point before proceeding to the dynamic startup.

D. Verify that each DDC controller communicates on its respective network correctly.

E. After all of the points are verified, and power is available to the mechanical system, coordinate a startup of each system with the mechanical contractor. Include the following tests:

1. Start systems from DDC.

2. Verify that each setpoint can be met by the system.

3. Change setpoints and verify system response.

4. Change sensor readings to verify system response.

5. Test safety shutdowns.

6. Verify time delays.

7. Verify mode changes.

8. Adjust filter switches and current switches for proper reactions.

9. Adjust proportional bands and integration times to stabilize control loops.

F. Perform all program changes and debugging of the system for a fully operational system.

G. Verify that all graphics at the operator workstations correspond to the systems as installed. Verify that the points on the screens appear and react properly. Verify that all adjustable setpoints and manual commands operate from the operator workstations.

H. After the sequence of operation is verified, setup the trends that are listed in the sequence of operations for logging and archiving for the commissioning procedure.

3.1.1.10 SYSTEM COMMISSIONING, DEMONSTRATION AND TURNOVER

A. The BAS Contractor shall prepare and submit for approval a complete acceptance test procedure including submittal data relevant to point index, functions, sequence, inter-locks, and associated parameters, and other pertinent information for the operating system. Prior to acceptance of the BAS by the Owner and Engineer, the BAS contractor shall completely test the BAS using the approved test procedure.

B. After the BAS contractor has completed the tests and certified the BAS is 100% complete, the Engineer shall be requested, in writing, to approve the satisfactory operation of the system, sub-systems and accessories. The BAS contractor shall submit Maintenance and Operating manuals at this time for approval. An acceptance test in the presence of the Engineer and Owner's representative shall be performed. The Owner will then shake down the system for a fixed period of time (30 days).

C. The BAS contractor shall fix punch list items within 30 days of acceptance.

D. When the system performance is deemed satisfactory in whole or in part by these observers, the system parts will be accepted for beneficial use and placed under warranty.

3.1.1.11 OPTIONAL SERVICE CONTRACT

A. The System Contractor shall, within sixty days after installation of the system begins, present a three (3) year maintenance contract for the Owner's signature. The price is to be indicated for each year with all payment terms and conditions. The contract should state that the Owner has the option to accept or reject the second or third year contract price, given that notice of cancellation should be in writing and given not less than thirty (30) days prior to the anniversary date of the agreement.

B. The contract should state that the Owner has the option to reject the First Year Service, accepting only the System Contractor's obligation as specified herein the warranty section. System Contractor shall provide a clear comparison of warranty coverage versus First Year Service.

C. First, Second, and Third Year Service shall include the following provisions:

1. On-Line Service - Diagnostic and troubleshooting services shall be provided via remote communications capabilities. Response time to Owner requests for this type of corrective maintenance shall be within two (2) hours.

2. Software Maintenance and Consultation - The System Contractor shall review the need for software modifications to the existing database semi-annually, and implement modifications. Backup of the database shall be made semi-annually and retained by the System Contractor.

3. Software Maintenance - Software revisions shall be provided as they become available.

4. Emergency Service - The System Contractor shall provide emergency service, between scheduled preventive maintenance calls, including overtime, necessary to keep equipment and components in proper operation. When a site visit is required to complete troubleshooting procedures, the System Contractor shall be on-site within 24 hours.

5. The System Contractor shall guarantee future availability of continuous, twenty-four hour, seven days a week service for the systems through available maintenance contracts.

6. Service shall be performed by factory trained and employed service representatives of the System Manufacturer.

7. Provide a basic service contract from the manufacturer of the central workstation computer, providing uniform service and parts availability.

8. Provide a basic service contract from the manufacturer of peripherals.

9. Preventive Maintenance shall be performed in accordance with a program of standardized maintenance routines applied to the Owner's equipment. Each schedule shall list the equipment name, location, and appropriate preventive maintenance functions to be performed during that inspection.

10. The System Contractor shall perform regular and systematic preventive maintenance during normal working hours six (6) times per year on approximately the schedule described below. Maintenance routines shall consist of:

    a. Checking performance of equipment and components.

    b. Diagnostic test, examination, cleaning, lubrication, adjustment and calibration of equipment and their components. Such components shall include but are not limited to: Central Processing Unit, disk memory, color graphic CRT, printer, direct digital control units, printed circuit boards, and associated sensors and controllers, including all electric and electronic devices on the systems.

D. The service contract shall be renewable at the Owner's option and shall include provision for increased charges due to the expansion of the system changes, in service coverage and/or inflation.

3.1.1.12 TRAINING

A. During System commissioning and at such time as acceptable performance of the Building Automation System hardware and software has been established, the BAS contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction during normal working hours shall be performed by a competent building automation contractor representative familiar with the Building Automation System's software, hardware and accessories.

B. At a time mutually agreed upon, during System commissioning as stated above, the BAS contractor shall give 16-hours32-hours of onsite training on the operation of all BAS equipment. Describe its intended use with respect to the programmed functions specified. Operator orientation of the automation system shall include, but not be limited to:

1. Explanation of drawings and operator's maintenance manuals.
2. Walk-through of the job to locate all control components.
3. Operator workstation and peripherals.
4. DDC Controller and ASC operation/sequence.
5. Operator control functions including scheduling, alarming, and trending.
6. Explanation of adjustment, calibration and replacement procedures.

C. Additional 8-hours of training shall be given after the 30-day shakedown period.

D. Since the Owner may require personnel to have more comprehensive understanding of the hardware and software, additional training must be available from the Contractor. If the Owner requires such training, it will be contracted at a later date. Provide description of available local and factory customer training. Provide costs associated with performing training at an off-site classroom facility and detail what is included in the manufacturer's standard pricing such as transportation, meals, etc.