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ADDENDUM
NO. 3

</div>

August 12, 2024

Kalamazoo Public Schools – Winchell Elementary School Classroom Addition
2316 Winchell Avenue
Kalamazoo, MI 49008

TO: ALL BIDDERS OF RECORD

This Addendum forms a part of and modifies the Bidding Requirements, Contract Forms, Contract Conditions, the Specifications and the Drawings dated May 17, 2024, by TowerPinkster. Acknowledge receipt of the Addendum in the space provided on the Bid Form. Failure to do so may subject the Bidder to disqualification.

This Addendum consists of Pages ADD 3-1 through 3-2, and TowerPinkster Addendum No. 3 dated August 9, 2024, consisting of 43 pages.

A.   SPECIFICATION SECTION 00 00 10 TITLE PAGE
   1. Revise Bids Received to Wednesday, August 21, 2024, 2:00 PM.

B.   SPECIFICATION SECTION 00 20 00 NOTICE TO BIDDERS

   1. Revise Bids Received to Wednesday, August 21, 2024, 2:00 PM.
   2. Bid Opening. Bids will be publicly opened and read aloud on Wednesday, August 21, 2024, shortly after the 2:00 PM Bid receipt deadline, in The Community Education Center in Room 130, 600 West Vine Street, Kalamazoo, MI 49008.

C. SPECIFICATION SECTION 01 12 00 – MULTIPLE CONTRACT SUMMARY

   1. Paragraph 3.03 Bid Categories

   A. BID CATEGORY NO. 01 – SITEWORK

      1. Add the following Clarifications:

      Clarification No. 1
      Bid Category No. 01 - Sitework shall be responsible to provide all excavation, subgrade placement, and compaction for all concrete work. Including but not limited to establishing the building pad, footings and foundations, and sidewalks to the required elevation. Bid Category No. 02 – Concrete, shall be responsible for and provide minor adjustments to grade prior to slab on grade and concrete paving placement.

   B. BID CATEGORY NO. 07 - MECHANICAL

      1. Add the following Clarifications:

      Clarification No. 1
      Bid Category No. 07 - Mechanical must use ControlNET or Havel as their subcontractor for the mechanical control work.

D. SPECIFICATION SECTION 00 83 00 MICHIGAN SCHEDULE OF PROJECT CONSTRUCTION WAGES
1. Remove section 00 83 00 in its entirety, this is not a prevailing wage project.

E. Refer to the Updated attached Request For Information summary, Pre-Bid RFI No. 01 through 11 are included.

ADDENDUM NO. 3

DATE OF ISSUANCE:	**August 9, 2024**
PROJECT:	**KPS – Winchell Elementary Classroom Addition**
OWNER:	**Kalamazoo Public Schools**
ARCHITECT'S PROJECT NO.:	**23607**
ORIGINAL BID ISSUE DATE:	**May 17, 2024**

SCOPE OF WORK

This Addendum includes changes to, or clarifications of, the original Bidding Documents and any previously issued addenda, and shall be included in the Bid. All of these Addendum items form a part of the Contract Documents. The Bidder shall acknowledge receipt of this Addendum in the appropriate space provided on the Bid Form. Failure to do so may result in disqualification of the Bid.

DOCUMENTS INCLUDED IN THIS ADDENDUM

This Addendum includes **1** pages of text and the following documents:

- Bidding Documents: **0**
- Contract Conditions: **0**
- Specification Sections: **23 0900**
- Drawings: **NA**

CHANGES TO SPECIFICATIONS

ADD-3 Item No. S-1 – Revised Spec Section 23 0900 INSTRUMENTATION AND CONTROL

Revised sub-sections 2.1 & 2.2 to include ControlNet LLC and Havel Brothers as the only two approved installers. Also Removed LEED from section 1.15 Project Commissioning.

CHANGES TO DRAWINGS

None

END OF ADDENDUM.

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SECTION 23 0900 – INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1   SUMMARY

A.   Work shall include furnishing all labor, materials, equipment, and service necessary for a complete and operating Building Management System (BMS), utilizing direct digital controls. The BMS shall be capable of total integration of the facility infrastructure systems with user access to all system data either locally over a secure Intranet within the building or by remote access by a standard Web Browser over the Internet. This shall include HVAC control, electrical, gas and water metering, energy management, alarm monitoring, security and personnel access control, fire-life safety system monitoring, and all trending, reporting and maintenance management functions related to normal building operations all as indicated.

B.   Work shall include furnishing all labor, materials, equipment, and service necessary for a complete and operating Building Management System (BMS), utilizing direct digital controls. The BMS shall be capable of total integration of the facility infrastructure systems with user access to all system data either locally over a secure Intranet within the building or by remote access by a standard Web Browser over the Internet. This shall include HVAC control, electrical, gas and water metering, energy management, alarm monitoring, security and personnel access control, fire-life safety system monitoring, and all trending, reporting and maintenance management functions related to normal building operations all as indicated.

     1.   New Work shall communicate with and be integrated into Owner's existing district wide DDC control system.
     2.   All labor, material, equipment and software not specifically referred to herein or on the plans, required to meet the functional intent of this specification, shall be provided without additional cost to the Owner.

C.   Work shall include but not limited to providing controls and instrumentation in accordance with equipment sequence of operations and their point lists. Point lists shall be a guide to the points required for control system. Final points required shall be determined by sequence of operation requirements.

D.   Work required in this section shall include providing all control components, control wiring, and services required for the connection and operation of the Air Handling Units including related variable frequency drives and air terminal units as indicated on drawings, and as specified in Sections 23 3600, 23 7313, 23 7316, 26 2923, and Section 23 0993.

E.   Work required in this section shall include providing all control components, control wiring, and services required for the connection and operation of the exhaust fans as indicated on drawings, and as specified in Section 23 3423 and Section 23 0993.

F.   Work required in this section shall include providing all control components, control wiring, and services required for the connection and operation of the hydronic heating and cooling system and equipment as indicated on drawings and as specified in Sections 23 2123, 23 5216, 23 6423, 23 6426, 26 2923, and Section 23 0993.

G.   Work required in this section shall include providing all control components, control wiring, and services required for the connection and monitoring of the natural gas and electrical services as indicated on drawings and as specified in Sections 23 0900 and Section 23 0993.

H.   Work required in this section shall include providing all control components, control wiring, and services required for the connection of the remaining equipment as indicated on drawings, as specified in various Division 23 sections, and as specified in Section 23 0993.

I.   Work required in this section shall include complying with requirements of Sections <**Insert Cx Section Numbers Here**>and other sections referenced in <**Insert Cx Section Number Here**>for commissioning requirements.

J.   Work required in this section shall include the complete Building Management System (BMS) including all controllers Interoperable LonWorks Controllers (ILC), Interoperable BACnet Controllers (IBC), control devices, control panels, controller programming, controller programming software, controller input/output wiring, power wiring, interlock and safety wiring, graphical user interface, Graphical User Interface (GUI), Graphical Development Tool (GDT), Network Area Controller(s) (NAC), server software, controller software and programming of the NAC and server, development of all graphical screens, setup of schedules, logs and alarms, global server software control applications, system integration and coordination of the NAC and server software to the Wide Area Network.

K.   Ethernet LAN wiring, and Ethernet routing devices if applicable. The BMS shall provide a single point Ethernet connection utilizing OBIX TCP/IP to the Owner's WAN.

L.   Work required in this section shall include providing all electrical work required for this section. The system shall include all interconnecting wiring and conduit as required for a fully operational system as specified. Wiring shall be installed as per local codes or Division 26 whichever is more stringent.

   1.   Power supply wiring and conduit from power source to power connection on DDC controls and DDC control panels.

      a.   Line voltage wiring shall utilize methods and materials complying with the requirements of the Electrical Specifications, local building code, and NEC.

   2.   Control wiring and conduit between field-installed controls, indicating devices, and control panels.

      a.   Low voltage wiring shall use methods and materials complying with the requirements of the Electrical Specifications, local building code and NEC. Plenum rated cable is acceptable where concealed and accessible.

M.   Division 26 shall be responsible for the for Lighting Control Panels (LCP), Power Distribution Control Panels (PDCP), metering devices, control devices, control panels, controller programming, controller programming software, controller input/output wiring, power wiring, interlock and safety wiring, graphical user interface, controller programming software, controller network wiring, , Ethernet LAN wiring, and Ethernet routing devices if applicable.

1.2   RELATED SECTIONS

A.   The following Sections contain requirements that relate to this Section:

   1.   Division 01 Section "Alternates" for requirements of alternates that relate to this Section.
      a.   Alternate No. 1 pertains to the alternate building addition.
      b.   Alternate No. 4 pertains to an alternate to provide a Trane Tracer Summit controls system equivalent to this specification section.

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       c.   Alternate No. 7 pertains to the monitoring of the natural gas and electrical services.

    2.   Division 23 Section "Common Work Results for HVAC."
    3.   Division 23 Section "Meters and Gages for HVAC Piping" for measuring equipment that relates to this Section.
    4.   Division 23 Section "Sequence of Operations for HVAC Controls" for requirements that relate to this Section.

1.3   WORK BY OTHERS

A.   Setting in place of control valves, flow meters, water pressure and differential taps, flow switches, thermal wells, control dampers, airflow stations, and access doors.

B.   Duct smoke detectors provide under Division 28.

C.   Division 26 shall be responsible for the for Lighting Control Panels (LCP), Power Distribution Control Panels (PDCP), metering devices, control devices, control panels, controller programming, controller programming software, controller input/output wiring, power wiring, interlock and safety wiring, graphical user interface, controller programming software, controller network wiring, , Ethernet LAN wiring, and Ethernet routing devices if applicable.

1.4   ACTION SUBMITTALS

A.   Refer to Division 1 for submittal administrative requirements and procedures.

B.   Submittal shall consist of:

    1.   System architecture showing all digital devices, computers and network configuration.
    2.   Equipment lists of all proposed devices and equipment including data sheets of all products. Provide a PIC statement for each BACnet device and interoperability certification for each LonMark field device provided.
    3.   Valve, damper, and well and tap schedules showing size, configuration, capacity and location of all equipment.
    4.   Data entry forms for initial parameters. Contractor shall provide English listing of all analog points with columnar blanks for high and low warning limits and high and low alarm limits, and a listing of all systems with columnar blanks for beginning and end of occupancy periods; and samples of proposed text for points and messages (for at least two systems of at least 15 points total) including sample 480 character alarm message. All text shall be approved prior to data entry.
    5.   Schematic device wiring and piping interconnection diagrams including panel and device power and sources.
    6.   Software design data including flowchart of a typical DDC program showing interrelationship between inputs, PID functions, all other functions, outputs, etc.
    7.   A complete written Sequence of Operation in suppliers own terminology.

1.5   CLOSEOUT SUBMITTALS

A.   Maintenance data for control systems equipment to include in the operation and maintenance manual specified in Division 1. Include the following:

1. Maintenance instructions and spare parts lists for each type of control device.
2. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
3. Calibration records and list of set points.

B. Project Record Documents: Upon completion of the work, provide a complete set of 'as-built' drawings and application software on USB drive media or compact disk. Drawings shall be provided as AutoCAD™ or Visio™ compatible files. Three copies of the 'as-built' drawings shall be provided in addition to the documents on USB drive media or compact disk.

1.6 CODES AND APPROVALS

A. The complete BMS installation shall be in strict compliance to the national, state and local mechanical and electrical codes and the electrical section of these specifications. All devices shall be UL or FM listed and labeled for the specific use, application and environment to which they are applied.

B. The system shall comply with NFPA 90A Air Conditioning and 90B Warm Air Heating, Air conditioning.

C. System shall be designed and manufactured to ISO 9001 quality standard, and all electronic equipment shall conform to the requirements of FCC regulation Part 15, Section 15 governing radio frequency electromagnetic interference and be so labeled.

1.7 WARRANTY

A. All components, system software, and parts supplied by the BMS contractor shall be guaranteed against defects in materials and workmanship for one year from acceptance date. The BMS contractor at no charge shall furnish labor to repair, reprogram, or replace components during the warranty period. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software disks. The Contractor shall respond to the Owners request for warranty service within 48 hours during normal business hours.

B. Warranty Access

1. The Owner shall grant to the controls installer reasonable access to the BMS during the warranty period.

1.8 BMS CONTRACTOR QUALIFICATIONS

A. The owner and their representatives have conducted a thorough examination, review and qualification process. Bidders or manufacturers other than those meeting the criteria set forth will not be considered qualified acceptable bidders.

B. The BMS contractor shall have a local office within a 75 mile(120 Km)radius of the job site, staffed with "Niagara AX Certified" factory trained engineers fully capable of providing instruction, routine maintenance and 24-hour emergency service on all system components. The BMS contractor shall have a three year experience record in the design and installation of computerized building systems similar in scope and performance to that specified herein, and shall be prepared to provide evidence of this history as condition of acceptance and approval during Submittal.

C.   The BMS contractor shall have a local office within a**[50 mile(80 Km)][75 mile(120 Km)]**radius of the job site, staffed with "Niagara AX Certified" factory trained engineers fully capable of providing instruction, routine maintenance and 24-hour emergency service on all system components. The BMS contractor shall have a three year experience record in the design and installation of computerized building systems similar in scope and performance to that specified herein, and shall be prepared to provide evidence of this history as condition of acceptance and approval during Submittal.

1.   The successful bidder shall have a minimum of five "Niagara AX Certified" engineers under direct employ of the bidding office. Niagara AX Certified engineers will have successfully completed the Tridium factory authorized software programming class taught by an accredited Niagara AX Certified instructor. Copies of actual certificates may be requested and must be supplied within 24 hours of the request.

2.   The successful bidder shall have a minimum of**[three][five]** "Niagara AX Certified" engineers under direct employ of the bidding office. Niagara AX Certified engineers will have successfully completed the Tridium factory authorized software programming class taught by an accredited Niagara AX Certified instructor. Copies of actual certificates may be requested and must be supplied within 24 hours of the request.

1.9   INTEGRATION QUALITY ASSURANCE

A.   The successful bidder shall demonstrate successful implementation of multiple and various system integrations, including complete functional testing and commissioning of those described herein. Integrations shall be fully accessible from a non-proprietary web browser and should include the following (any others not shown may be listed). The successful bidder shall demonstrate successful implementation of multiple and various system integrations. Integrations shall be fully accessible from a non-proprietary web browser and should include, but not limited to the following:

1.   Lighting
   a.   BACnet
   b.   LonWorks

2.   Access Control
   a.   XML

3.   Power
   a.   Meters
   b.   Substations
   c.   Automatic Transfer Switches (ATS)
   d.   Static Transfer Switches (STS)

4.   Back-up Power
   a.   Generators
   b.   Uninterrupted Power Supplies

5.   Microsoft Outlook
   a.   Exchange Server

6.   User Name and Password Synchronization
   a.   Active Directory

7. Computer Room Air Conditioning;
    a. Liebert Units

8. Other CRAC units
9. Experience integrating to the following proprietary control systems
    a. Johnson Controls
    b. Honeywell
    c. Siemens

1.10   SOFTWARE LICENSE AGREEMENT

A. Software licensing for the Network Area Controller (NAC) and server software shall give the Owner the capability to control their system and determine which contractors can bid and engineer their system.

B. It shall be possible to insure the Owner can prevent unauthorized partners from accessing the system for engineering changes.

C. Software licensing shall have the freedom to individually manage authorized parties and independent parties.

D. The software licensing shall have no restrictions on which brand of NAC, server software or System Programming tools can interact with the system. Station Compatibility IN and Station Compatibility OUT must = ALL and Tool Compatibility must = ALL.

    1. All NiagaraAX or Niagara 4 software licenses shall have the following NiCS set to ALL: "accept.station.in=*"; "accept.station.out=*"; "accept.wb.in=*"; "accept.wb.out=*". All open NIC statements shall follow Niagara Open NIC specifications.

E. All JACE hardware licenses and certificates shall be stored on local MicroSD memory card employing encrypted "safe boot" technology.

F. All JACE (SNC) and Station PASS PHRASES and PASSWORDS will be provided to the Owner or their representative at 90% completion or prior to retention being paid.

G. To ensure quality, only JACE/WEBs 8000 hardware products will be used.

H. SYSTEM NETWORK CONTROLLER (SNC) JACE8000

    1. The SNC shall be provided with a 5 Year Software Maintenance license. Labor to implement is to be included.

I. WEB BROWSER GRAPHICAL INTERFACE

    1. Mobile Web Browser Navigation through Smart Phones and Tablets: In order to assure comprehensive mobile navigation with all major browsers, navigation shall be done through the use of a touch-friendly dynamic navigation bar. Right-click commands are not compatible with most mobile/touch devices, so all equipment commands shall utilize touch-compatible buttons. The contents of the dynamic navigation bar shall be customized to match the specific requirements of each building, while retaining the same general categories for consistency and ease of use.

J.   The Owner shall accept the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software.

1.11   ADDED POINT AND MEMORY CAPACITY

A.   The BMS software/firmware provided shall have the capacity for an unlimited number of NACs. Systems requiring future upgrades to accomplish this are not acceptable; capacity shall be provided at the time of bid.

B.   Total system point capacity shall have the capacity for an unlimited number of future points. Systems requiring future upgrades to accomplish this are not acceptable; capacity shall be provided at the time of bid.

C.   Supervising software shall allow unlimited expansion. Supervising software that is limited to the number of network area controllers is not acceptable

1.12   BMS TESTING AND ADJUSTING

A.   Control Contractor shall be responsible for adjusting and readjusting the control systems as required to obtain the desired control sequencing and intent of the specifications. Refer to Section 15990 and requirement that system balance be accomplished twice.

B.   If proper sequencing or system functions cannot be achieved with the factory provided controls, as specified and installed by the equipment manufacturer, and additional controls are required, the required additional controls shall be added at the expense of the factory controls provider.

C.   If proper sequencing or system functions cannot be achieved with the **[controls]**as specified and installed and additional controls are required, the required additional controls shall be added at the expense of the controls provider.

1.13   DELIVERY, STORAGE, AND PROTECTION

A.   Store equipment and materials inside and protected from weather.

B.   Factory-Mounted Components: Arrange for shipping control devices to terminal unit manufacturer for factory mounting on equipment,

1.14   COORDINATION

A.   Coordinate location of exposed control sensors with plans and room details before installation.

B.   Coordinate equipment with Division 28 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system.

C.   Coordinate equipment with Division 26 Section "Motor-Control Centers" to achieve compatibility with motor starters and annunciation devices.

D.   Pre-Installation Conference: Attend a temperature controls conference with the project engineer to develop a mutual understanding of the sequencing, components, and details required for the project.

1.   Engineer may invite other controls related stakeholders to this conference.
2.   Provide a minimum of 7 days' advance notice of scheduled meeting time and location.

1.15   PROJECT COMMISSIONING

A.   **Project has an independent commissioning authority (CxA). Contractors for this project shall meet CxA requirements and shall coordinate with and participate in commissioning activities.**

PART 2 - PRODUCTS

2.1   INSTALLERS

A.   **Subject to compliance with requirements, provide installation, products and services by one of the following:**

1.   **ControlNet LLC.**
2.   **Havel Brothers.**

2.2   GENERAL

A.   **The Building Management System (BMS) shall be comprised of a network of interoperable, stand-alone digital controllers, Network Area Controllers, server software server, graphical user interface software, Web Browser Clients, portable operator terminals, printers, network devices and other devices as specified herein.**

B.   **Provide the capability to open all control valves in each individual system at one time (I.E. zone, riser) to facilitate water balancing.**

2.3   OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES

A.   The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate SNMP, LonWorks, BACnet IP, BACnet MSTP, Modbus TCP/IP or Modbus RTU communication protocols in one open, interoperable system.

B.   The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry standards including ANSI / ASHRAE™ Standard 135, BACnet and LonMark to assure interoperability between all system components is required. For each LonWorks device that does not have LonMark certification, the device supplier must provide an XIF file for the device. For each BACnet device, the device supplier must provide a PICS document showing the installed device's compliance level. Minimum compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet. For each Modbus device supplier must provide a Registry of data points available on the system.

C.   All components and controllers supplied under this contract shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data shall not be acceptable.

D.   The supplied system must incorporate the ability to access all data using standard web browsers without requiring proprietary operator interface and configuration programs.   An Open DataBase Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a supplier-installed server for all database access. Systems requiring proprietary database and user interface programs shall not be acceptable.

E.   The installed system shall provide secure password access to all features, functions and data contained in the overall BMS. Secure Socket Layer (SSL) encryption shall be an available option for remote access.

F.   The installed system must be totally scalable to allow for future expansion with the addition of controllers and/or input/output devices. It shall not be necessary to remove equipment supplied under this contract to expand the system.

G.   The failure of any single component or network shall not interrupt the control functions of non-affected devices. A single network failure shall only affect shared communications or shared data; individual application controllers and network controllers shall continue normal operation minus only the data from a remote device from the affected network. Automatic default values for all network transported data shall be provided to allow continued operation until the network is restored.

H.   A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network.   Systems employing a "flat" single tiered architecture shall not be acceptable.

   1.   Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.
   2.   Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

2.4   COMPUTER HARDWARE (PERSONAL COMPUTER)

A.   The personal computer shall be a newly manufactured IBM compatible computer. It shall include, as a minimum, a CD-ROM drive, a Zip drive, 2-parallel ports, 2-asynchronous serial ports and 2-USB ports. A minimum 17", flat screen color monitor, mouse, and keyboard shall also be included.

B.   The personal computer shall be an Intel Pentium based computer (minimum processing speed of 400 MHz with 256 MB RAM and a 10-gigabyte minimum hard drive). It shall include a 32X CD-ROM drive, 3.5 " floppy drive, a 100 MB Zip drive, 2-parallel ports, 2-asynchronous serial ports and 2-USB ports. A minimum 17", 28-dot pitch SVGA color monitor with a minimum 80 Hz refresh rate shall also be included.

C.   A newly manufactured laser type system printer shall be provided.

D.   A system printer shall be provided. Printer shall be laser type with a minimum 600 x 600-dpi resolution and rated for 8-PPM print speed minimum.

2.5PORTABLE OPERATOR'S TERMINAL (LAPTOP COMPUTER)

A.The Portable Operator's Terminal shall be a newly manufactured IBM compatible computer. It shall include, as a minimum, a CD-ROM drive and appropriate connectors and cables for communication connection to the NAC, Ethernet, and BACnet networks.

B.The Portable Operator's Terminal shall consist of an Intel Pentium based laptop computer (minimum processing speed of 200 MHz with 128 MB RAM and a 2-gigabyte minimum hard drive). It shall include a CD-ROM drive, a 3.5" floppy drive and appropriate connectors and cables for communication connection to the NAC, Ethernet, LonWorks or BACnet networks.

2.6NETWORK AREA CONTROLLER (NAC)

A.The following requirements apply to product selection:

1.Manufacturers:

a.Subject to compliance with requirements, provide products by one of the manufacturers specified.

1)Tridium Vykon AX, Honeywell ComfortPoint, or Honeywell WEBSs AX.

B.The controls Installer shall supply one or more Network Area Controllers (NAC) as part of this contract. Number of area controllers required is dependent on the type and quantity of devices.

C.The Network Area Controller (NAC) shall provide the interface between the ILC, IBC and the Network server software, and provide global supervisory control functions over the control devices connected to the BMS. 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 LonWorks controller data, Modbus controller data and BACnet controller data
7.Network Management functions for all LonWorks based devices

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

1.Two Isolated Ethernet Ports – 10/100 Mbps
2.One RS-232 port
3.One RS-485 port
4.One LonWorks Interface Port – 78KB FTT-10A
5.Battery Backup
6.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 10 gigabyte storage capacity)
7.The NAC must be capable of operation over a temperature range of 32 to 130 deg F
8.The NAC must be capable of withstanding storage temperatures of between 32 to 158 deg F
9.The NAC must be capable of operation over a humidity range of 5 to 95% RH, non-condensing

E.   The NAC shall support standard Web browser access via the Intranet/Internet.   It shall support an unlimited number of clients.

F.   Event Alarm Notification and actions

1.   The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
2.   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.
3.   Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:

   a.   To alarm
   b.   Return to normal
   c.   To fault

4.   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.
5.   Provide timed (schedule) routing of alarms by class, object, group, or node.
6.   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.
7.   Control equipment and network failures shall be treated as alarms and annunciated.
8.   Alarms shall be annunciated in any of the following manners as defined by the user:

   a.   Screen message text
   b.   Email and text message via cell phone of the complete alarm message to multiple recipients. Provide the ability to route and send alarms based on:

      1)   Day of week
      2)   Time of day
      3)   Recipient

9.   Pagers via paging services that initiate a page on receipt of email message
10.   Graphic with flashing alarm object(s)
11.   Printed message, routed directly to a dedicated alarm printer
12.   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 #, access way, etc.)
   d.   Acknowledge time, date, and user who issued acknowledgement.
   e.   Number of occurrences since last acknowledgement.

13.   Alarm actions may be initiated by user defined programmable objects created for that purpose.
14.   Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.
15.   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.
16.   Provide a "query" feature to allow review of specific alarms by user defined parameters.

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17. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.
18. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

G. Data Collection and Storage

1. The NAC shall have the ability to collect data for 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:
3. Designating the log as interval or deviation.
4. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
5. 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.
6. 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.
7. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
8. All log data shall be stored in a relational database and the data shall be accessed from a standard Web Browser.
9. All log data, when accessed from the Network server software (NS), shall be capable of being manipulated using standard SQL statements.
10. 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

11. Systems that do not provide log data in HTML and XML formats at a minimum shall not be acceptable.
12. The NAC shall have the ability to archive its log data to Network server software 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 it's user-defined capacity of data stores
    d. Provide ability to clear logs once archived

H. Audit Logs

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 the log based on time to the Network server software. For each log entry, provide the following data:

    a. Time and date
    b. User ID
    c. Change or activity: i.e., Change set-point, add or delete objects, commands, etc.

I. Database Back-Up 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 on the Network server software. 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.

2.7   INTEROPERABLE LON CONTROLLER (ILC)

A. Controls shall be microprocessor based Interoperable LonMark™ or LonWorks Controllers (ILC). Where possible, all Interoperable LonWorks Controllers shall bear the applicable LonMark™ interoperability logo on each product delivered.

B. HVAC control shall be accomplished using LonMark™ based devices where the application has a LonMark profile defined. Where LonMark devices are not available for a particular application, devices based on LonWorks shall be acceptable. Publicly available specifications for the Applications Programming Interface (API) must be provided to Owner for each LonWorks / LonMark controller defining the programming or setup of each device. The controls Installer shall provide all programming, documentation and programming tools necessary to set up and configure the supplied devices per the specified sequences of operation.

C. The controls Installer shall run the LonWorks network trunk to the nearest Network Area Controller (NAC). Coordinate locations of the NAC with the LonMark devices to ensure that maximum network wiring distances, as specified by the LonWorks wiring guidelines, are not exceeded. A maximum of 126 devices may occupy any one LonWorks trunk and must be installed using the appropriate trunk termination device. All LonWorks and LonMark devices must be supplied using FTT-10A LonWorks communications transceivers.

D. The Network Area Controller (NAC), will provide all scheduling, alarming, trending, and network management for the LonMark / LonWorks based devices.

E. The ILCs shall communicate with the NAC at a baud rate of not less than 78.8K baud. The ILC shall provide LED indication of communication and controller performance to the technician, without cover removal.

F. All ILCs shall be fully application programmable and shall at all times maintain their LONMARK certification, if so certified. Controllers offering application selection only (non-programmable), require a 10% spare point capacity to be provided for all applications. All control sequences within or programmed into the ILC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.

G. The controls Installer shall provide documentation for each device, with the following information at a minimum:

1. Network Variable Inputs (nvi's); name and type
2. Network Variable Outputs (nvo's); name and type
3. Network configuration parameters (nci, nco); name and type

H.   It is the responsibility of the controls Installer to ensure that the proper Network Variable Inputs and Outputs (nvi and nvo) are provided in each ILC, as required by the point charts.

I.   The controls Installer of any programmable ILC shall provide one copy of the manufacturer's programming tool, with documentation, to the Owner.

2.8   INTEROPERABLE BACnet CONTROLLER (IBC)

A.   Controls shall be microprocessor based Interoperable BACnet Controllers (IBC) in accordance with the ANSI/ASHRAE Standard 135-1995. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals. The system supplier must provide a PICS document showing the installed systems compliance level to the ANSI/ASHRAE Standard 135-1995, to Owner.

B.   The IBCs shall communicate with the NAC via an Ethernet connection at a baud rate of not less than 10 Mbps or via the RS485 connection at a baud rate of not less than 38 kbps.

C.   The IBC Sensor shall connect directly to the IBC and shall not utilize any of the I/O points of the controller. The IBC Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive.   The IBC Sensor shall provide a communications jack for connection to the BACnet communication trunk to which the IBC controller is connected. The IBC Sensor, the connected controller, and all other devices on the BACnet bus shall be accessible by the POT.

D.   All IBCs shall be fully application programmable and shall at all times maintain their BACnet Level 3 compliance. Controllers offering application selection only (non-programmable), require a 10% spare point capacity to be provided for all applications. All control sequences within or programmed into the IBC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.

E.   The controls Installer shall provide documentation for each device, with the following information at a minimum:

      1.   BACnet Device; MAC address, name, type and instance number
      2.   BACnet Objects; name, type and instance number

F.   Ensure that the proper BACnet objects are provided in each IBC, as required by the point charts.

2.9   NETWORKS

A.   The Local Area Network (LAN) shall be a 100 Megabits/sec Ethernet network supporting TCP/IP, BACnet IP, Modbus, Java, XML, and HTTP for maximum flexibility for integration of building data with enterprise information systems

B.   Local area network minimum physical and media access requirements:

      1.   Ethernet; IEEE standard 802.3
      2.   Cable; 10 Base-T, UTP-8 wire, category 5E or 6
      3.   Minimum throughput; 10 Mbps, with ability to increase to 100 Mbps

2.10   NETWORK ACCESS

A.   Owners WAN / LAN Access: Controls Installer must adhere to Owner's policy and requirements to obtain Owner's WAN access.

2.11   GRAPHICAL USER INTERFACE (GUI)

A.   The graphical component of the BMS is of critical importance and should consider the following descriptions and graphic representations to be the minimum acceptable. Enhanced graphics shall include detailed 2-dimensional building site and floor plan graphics, 3-dimentional equipment graphics with fan, damper and valve animations providing operators an aid to comprehending complex system operation. Every graphic page shall contain a tabular and cascading menu navigational structure, established in an HTML frame based format to allow immediate "one-click" access to other building systems without the need to back up through the navigational tree.

B.   Navigation is done through the use of an HTML-based menu bar. The contents of the menu bar shall be customized to match the specific requirements of each building, while retaining the same general categories for consistency and familiarity.

1.   The menu bar shall employ cascading menus. With this navigation concept, the operator shall not be more than two mouse button operations from any view. Some examples of the operator screens follow.

2.   A navigational toolbar at the top of each BMS page will be provided and have the following links/functions:

a.   Home: A link that takes the user to a main entry point of navigation at a building or district level.

b.   Chart Builder: A tool that allows charts to be made comparing historical data. It allows custom-built chart data to be exported as an Excel or PDF file.

c.   Alarm Console: A table that shows all points that are in an alarm state. It allows users to silence or acknowledge alarms.

d.   Schedules: A page that shows equipment schedule periods. It allows users to change occupancy times with a weekly or calendar scheduler.

e.   Information: A page with links to pertinent documents, including a User's Guide.

f.   Weather: A page that shows current local weather conditions in a seven-day forecast.

g.   Alarm History: A log of previous alarms that features sorting and time range filters.

h.   Audit Log: A log of users who have accessed the BMS. It records changes made by users and features sorting and time range filters.

i.   Override Summary: A table of all equipment with a manual override status.

j.   User Configuration: A page that allows users to change log-in and profile information. Users with administrative rights may add or delete users to the BMS.

k.   Floor Plans: Links to floor plan sections are shown as graphic outline keys or descriptive tabs.

l.   Main Systems Tabs: Links to major systems and equipment such Hydronic Systems or Air Handlers are listed in descriptive tabs.

3.   Displays shall provide real-time information with visual display of alarm condition by change of color and/or flashing text/color background.

4.   Displays can be viewed from a non-proprietary, commercial Web Browser.

5.   Points that have been defined as data-writes, either as a digital (on/off) or analog (change value) point type, will be setup such that an operator, by right-clicking the data object or graphic, will be able to command a digital value, or modify an analog value. Operators shall view equipment status from the menu. Menu items shall include headings for major equipment categories such as Air Handling Units, Boiler, Chillers, Zone Control, Lighting, etc. Cascading menus from each major category, shall allow the operator to select a particular piece of equipment; i.e. AHU-1 or Chiller.

6.   A maximum of 40 points will be provided in a single status display screen. Points that have been defined as data-writes, either as a digital (on/off) or analog (change value) point type, shall be setup such that an operator, by right-clicking the data object or graphic, shall be able to command a digital value, or modify an analog value.

C.   All Graphics and schedules will reside at the supervisory software level and not at the NAC level to allow for "one password" access to all NACs on the system and global scheduling and trending.

2.12   CUSTOM GRAPHICS - REQUIRED

A.   Home Page

1.   The building site overview shall provide a "mouse over" function to highlight the floor plan area to be accessed as a navigational aid. Room numbers and/or names will be included at the owner's request. Critical data points, i.e. Outdoor Air Temperature, Outdoor Air Relative Humidity, Hot Water Supply Temperature, Chilled Water Supply Temperature or National Weather Service data will be continuously visible, in real time, within the HTML frame on all screens. Additional points may be added or deleted at the owner's request without cost.

B.   Floor Plans

1.   Detailed floor plans shall be created with a vector drawing program accurately depicting the actual building layout to include all rooms, walls, and hallways. All space sensors shall be accurately placed in their actual locations and tagged with their real time space temperature and equipment each is associated with, i.e. 72.5°F/RTU-1, 74.2°/AHU-1, 73.4°/TU-1. Floor plans too large to be practically shown with data points will provide a "mouse over" function to highlight the floor plan area to be accessed. Room numbers and/or names will be included at the owner's request.

C.   Mechanical Systems

1.   Detailed graphics for each mechanical system will include; AHUs, RTUs, CW Piping and Pumps, HW Piping and Pumps, TUs, and EFs as a minimum. Mechanical systems will include on-screen access to their respective set-points, trend logs and schedule. All time schedules will be setup as directed by the owner prior to final job turnover.

2.   Detailed graphics for each mechanical system will include; AHUs, RTUs, HXs, CW Piping and Pumps, HW Piping and Pumps, HPs, TUs, and EFs as a minimum. Mechanical systems will include on-screen access to their respective set-points, trend logs and schedule. All time schedules will be setup as directed by the owner prior to final job turnover.

3.   Dynamic trends of <u>all</u> data points shall be set up (specification will be followed as to actual number of trend points possible) prior to final job turnover. Each trend will be available directly on screen for quick trend access.

4.   Data points will be shown for all relevant inputs and outputs and be positioned near the actual device. Analog and digital parameters will be able to be modified directly from the equipment screen.

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D.   Terminal Units

        1.   Terminal units such as cabinet heaters, unit heaters, VAV boxes will depict the actual configuration of the equipment controlled. Actual equipment configurations from manufacturers web sites and/or photos of installed equipment shall be used to ensure graphic depictions are as "near actual" as possible.

        2.   Terminal units such as heat pumps, fan coil units, unit ventilators, reheat coils, booster coils and VAV boxes will depict the actual configuration of the equipment controlled. Actual equipment configurations from manufacturers web sites and/or photos of installed equipment shall be used to ensure graphic depictions are as "near actual" as possible.

E.   Schedules

        1.   Graphical schedules shall allow the operator to adjust time of day schedules by dragging the On Event slider. An unlimited number of On/Off events shall be allowed for each schedule and schedules can be linked into a Master/Slave scheduling scheme. Schedules shall allow the user to add/edit/delete holiday and special event schedules. Schedules shall be included for each major piece of equipment.

F.   Logging

        1.   Logs shall be provided for all points defined as requiring collection and archiving of their real-time values. Log data will be provided in HTML, XML, comma- and tab-separated value, and plain-text formats.

        2.   Setup parameters for each log include; log intervals, number of collection samples, log collection times and archive times, delta logging with change value selection, etc.

        3.   For every log, the data shall be viewable in both tabular and chart formats.

        4.   Logs shall be archived to the server software daily at a user specified time of day. Archive data shall be available from the creation time of the log until the last archive time.

        5.   For every log, the data can be viewed in both tabular and chart formats.

        6.   Logs and archives will be accessible from a Web Browser (Internet Explorer 5.0 or greater).

        7.   Analog Logs: Value Collected every 15 minutes for a log total of 2 days.

        8.   Each of the following of point types shall be continuously logged. The user shall have the ability to select up to 3 points to be displayed on a single trending graph.

               a.   All Temperatures
               b.   All Temperature setpoints
               c.   All Damper Positions
               d.   All Valve Positions
               e.   All VFD %
               f.   All Airflows
               g.   All Occupancy statuses
               h.   All Enthalpies
               i.   All Humidity's
               j.   All CO_2s

2.13   WEB BROWSER CLIENTS

A.   The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer™ or Netscape Navigator™. Systems requiring additional software (to enable a

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standard Web browser) to be resident on the client machine, or manufacturer-specific browsers shall not be acceptable.

B.   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 BMS, shall not be acceptable.

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

1.   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.
2.   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.
3.   Storage of the graphical screens shall be in the NAC or server software, without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
4.   Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.
5.   Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:

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

          1)   Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
          2)   Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.

     b.   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.
     c.   View logs and charts
     d.   View and acknowledge alarms
     e.   Setup and execute SQL queries on log and archive information

6.   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.
7.   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.

2.14   SERVER SOFTWARE FUNCTIONS AND HARDWARE

A.   The server software shall be provided. The server software shall support all TCP/IP connected to the control system router.

B.   The Network server software shall provide the following functions, at a minimum:

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1. Global Data Access: The server software shall provide complete access to distributed data defined anywhere in the system.

2. Distributed Control: The server software shall provide the ability to execute global control strategies based on control and data objects in any control system in the network, local or remote.

3. The server software shall include a master clock service for its subsystems and provide time synchronization for all control systems.

4. The server software shall accept time synchronization messages from trusted precision Atomic Clock Internet sites and update its master clock based on this data.

5. The server software shall provide scheduling for all control systems and their underlying field control devices.

6. The server software shall provide demand limiting that operates across all control systems. The server software must be capable of multiple demand programs for sites with multiple meters and or multiple sources of energy. Each demand program shall be capable of supporting separate demand shed lists for effective demand control.

7. The server software shall implement the BACnet Command Prioritization scheme (16 levels) for safe and effective contention resolution of all commands issued to control systems. Systems not employing this prioritization shall not be accepted.

8. Each control system supported by the server software shall have the ability to archive its log data, alarm data and database to the Network server software, automatically. Archiving options shall be user-defined including archive time and archive frequency.

9. The server software shall provide central alarm management for all control systems supported by the server software. Alarm management shall include:

    a. Routing of alarms to display, printer, email and pagers
    b. View and acknowledge alarms
    c. Query alarm logs based on user-defined parameters

10. The server software shall provide central management of log data for all control systems supported by the server software. Log data shall include process logs, runtime and event counter logs, audit logs and error logs. Log data management shall include:

    a. Viewing and printing log data
    b. Exporting log data to other software applications
    c. Query log data based on user-defined parameters

C. Server software Hardware Requirements: supplied by

1. The system integrator will be responsible for loading and testing the software on the PC.
2. The system integrator will coordinate with the owner for testing and authorization.

2.15 SYSTEM PROGRAMMING

A. The Graphical Development Tool (GDT) shall provide the ability to perform system programming and graphic display engineering as part of a complete software package. The programming toolset will be provided to the owner as part of this project. The programming software shall be the same programming toolset as used by the contractor's engineers when programming this project. Access to the programming functions and features of the GDT shall be through password access as assigned by the system administrator.

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B. The GDT shall be available in two versions; a thick-client version licensed to the computing platform on which it is installed and a thin-client version, capable of providing the complete set of engineering functions through a standard Web Browser. Programming and development tools not capable of providing all engineering and application development functions with a standard Web Browser are not acceptable.

C. 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. All graphics must be created with a vector 3-D imaging software package, i.e., Dream Weaver, Illustrator, Cool 3-D or other commercially available graphics package.

D. Programming Methods

1. Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user's application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link; i.e., internal, external, hardware, etc.

2. Configuration of each object will be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.

3. 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.

4. All programming shall be done in real-time. Systems requiring the uploading on the owner's IT network, and downloading of database objects shall not be allowed.

5. 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.

2.16   OBJECT LIBRARIES

A. A standard library of objects shall be included for development and setup of application logic, user interface displays, system services, and communication networks.

B. The objects in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.

C. In addition to the standard libraries specified here, the supplier of the system shall maintain an on-line accessible (over the Internet) library, available to all registered users to provide new or updated objects and applications as they are developed.

D.   All control objects shall conform to the control objects specified in the BACnet specification.

E.   The library shall include applications or objects for the following functions, at a minimum:

1.   Scheduling Object. The schedule must conform to the schedule object as defined in the BACnet specification, providing 7-day plus holiday & temporary scheduling features and a minimum of 10 on/off events per day. Data entry to be by graphical sliders to speed creation and selection of on-off events.

2.   Calendar Object. . The calendar must conform to the calendar object as defined in the BACnet specification, providing 12-month calendar features to allow for holiday or special event data entry. Data entry to be by graphical "point-and-click" selection. This object must be "linkable" to any or all scheduling objects for effective event control.

3.   Duty Cycling Object. Provide a universal duty cycle object to allow repetitive on/off time control of equipment as an energy conserving measure. Any number of these objects may be created to control equipment at varying intervals

4.   Temperature Override Object. Provide a temperature override object that is capable of overriding equipment turned off by other energy saving programs (scheduling, duty cycling etc.) to maintain occupant comfort or for equipment freeze protection.

5.   Start-Stop Time Optimization Object. Provide a start-stop time optimization object to provide the capability of starting equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled un-occupancy time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start / stop time object properties based on the previous day's performance.

6.   Demand Limiting Object. Provide a comprehensive demand-limiting object that is capable of controlling demand for any selected energy utility (electric, oil, and gas). The object shall provide the capability of monitoring a demand value and predicting (by use of a sliding window prediction algorithm) the demand at the end of the user defined interval period (1-60 minutes). This object shall also accommodate a utility meter time sync pulse for fixed interval demand control. Upon a prediction that will exceed the user defined demand limit (supply a minimum of 6 per day), the demand limiting object shall issue shed commands to either turn off user specified loads or modify equipment set points to effect the desired energy reduction. If the list of sheddable equipment is not enough to reduce the demand to below the set point, a message shall be displayed on the users screen (as an alarm) instructing the user to take manual actions to maintain the desired demand. The shed lists are specified by the user and shall be selectable to be shed in either a fixed or rotating order to control which equipment is shed the most often. Upon suitable reductions in demand, the demand-limiting object shall restore the equipment that was shed in the reverse order in which it was shed. Each sheddable object shall have a minimum and maximum shed time property to effect both equipment protection and occupant comfort.

F.   The library shall include control objects for the following functions. All control objects shall conform to the objects as specified in the BACnet specification.

1.   Analog Input Object - Minimum requirement is to comply with the BACnet standard for data sharing. Allow high, low and failure limits to be assigned for alarming. Also, provide a time delay filter property to prevent nuisance alarms caused by temporary excursions above or below the user defined alarm limits.

2.   Analog Output Object - Minimum requirement is to comply with the BACnet standard for data sharing.

3.   Binary Input Object - Minimum requirement is to comply with the BACnet standard for data sharing. The user must be able to specify either input condition for alarming. This object must also include

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the capability to record equipment run-time by counting the amount of time the hardware input is in an "on" condition. The user must be able to specify either input condition as the "on" condition.

4. Binary Output Object - Minimum requirement is to comply with the BACnet standard for data sharing. Properties to enable minimum on and off times for equipment protection as well as interstart delay must be provided. The BACnet Command Prioritization priority scheme shall be incorporated to allow multiple control applications to execute commands on this object with the highest priority command being invoked. Provide sixteen levels of priority as a minimum. Systems not employing the BACnet method of contention resolution shall not be acceptable.

5. PID Control Loop Object - Minimum requirement is to comply with the BACnet standard for data sharing. Each individual property must be adjustable as well as to be disabled to allow proportional control only, or proportional with integral control, as well as proportional, integral and derivative control.

6. Comparison Object - Allow a minimum of two analog objects to be compared to select either the highest, lowest, or equality between the two linked inputs. Also, allow limits to be applied to the output value for alarm generation.

7. Math Object - Allow a minimum of four analog objects to be tested for the minimum or maximum, or the sum, difference, or average of linked objects. Also, allow limits to be applied to the output value for alarm generation.

8. Custom Programming Objects - Provide a blank object template for the creation of new custom objects to meet specific user application requirements. This object must provide a simple BASIC-like programming language that is used to define object behavior. Provide a library of functions including math and logic functions, string manipulation, and e-mail as a minimum. Also, provide a comprehensive on-line debug tool to allow complete testing of the new object. Allow new objects to be stored in the library for re-use.

9. Interlock Object - Provide an interlock object that provides a means of coordination of objects within a piece of equipment such as an Air Handler or other similar types of equipment. An example is to link the return fan to the supply fan such that when the supply fan is started, the return fan object is also started automatically without the user having to issue separate commands or to link each object to a schedule object. In addition, the control loops, damper objects, and alarm monitoring (such as return air, supply air, and mixed air temperature objects) will be inhibited from alarming during a user-defined period after startup to allow for stabilization. When the air handler is stopped, the interlocked return fan is also stopped, the outside air damper is closed, and other related objects within the air handler unit are inhibited from alarming thereby eliminating nuisance alarms during the off period.

10. Temperature Override Object - Provide an object whose purpose is to provide the capability of overriding a binary output to an "On" state in the event a user specified high or low limit value is exceeded. This object is to be linked to the desired binary output object as well as to an analog object for temperature monitoring, to cause the override to be enabled. This object will execute a Start command at the Temperature Override level of start/stop command priority unless changed by the user.

11. Composite Object - Provide a container object that allows a collection of objects representing an application to be encapsulated to protect the application from tampering, or to more easily represent large applications. This object must have the ability to allow the user to select the appropriate parameters of the "contained" application that are represented on the graphical shell of this container.

G. The object library shall include objects to support the integration of devices connected to the Network Area Controller or server software. At a minimum, provide the following as part of the standard library included with the programming software:

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1. LonMark/LonWorks devices. These devices shall include, but not be limited to, devices for control of HVAC, lighting, access, and metering. Provide LonMark manufacturer-specific objects to facilitate simple integration of these devices. All network variables defined in the LonMark profile shall be supported. Information (type and function) regarding network variables not defined in the LonMark profile shall be provided by the device manufacturer.

2. For devices not conforming to the LonMark standard, provide a dynamic object that can be assigned to the device based on network variable information provided by the device manufacturer. Device manufacturer shall provide an XIF file and documentation for the device to facilitate device integration.

3. For BACnet devices, provide the following objects at a minimum:

   a. BACnet AI
   b. BACnet AO
   c. BACnet BI
   d. BACnet BO
   e. BACnet Device

4. For each BACnet object, provide the ability to assign the object a BACnet device and object instance number.

2.17   DDE DEVICE INTEGRATION

1. The Network Area Controller shall support the integration of device data via Dynamic Data Exchange (DDE), over the Ethernet Network. The Network Area Controller shall act as a DDE client to another software application that functions as a DDE server.

2. Provide the required objects in the library, included with the Graphical User Interface programming software, to support the integration of these devices into the BMS. Objects provided shall include at a minimum:
   a. DDE Generic AI Object
   b. DDE Generic AO Object
   c. DDE Generic BO Object
   d. DDE Generic BI Object

2.18   RADIO FREQUENCY INTERFACE

A. The NAC shall support an optional Radio Frequency Interface for communication with electric, gas and water meters for remote readings. The interface shall be a standard 900 MHz Spread-Spectrum RF Interface which supports communications distances of up to one mile. This interface shall support a minimum of 400 meters of a mix of any type (gas, electric or water).

2.19   OTHER CONTROL SYSTEM HARDWARE

A. Ethernet Switches

1. 8 Port 10/100 MBPS Switch / Hub
2. Din Rail Mounted
3. LED communication indicators
4. Acceptable Manufacturers

        a.   Contemporary Controls
        b.   INTEL
        c.   Cisco Systems

B.   Temperature Sensors and Transmitters

    1.   General Sensor & Transmitter Requirements

        a.   Provide sensors and transmitters required as outlined in the input/output summary and sequence of operation, and as required to achieve the specified accuracy as specified herein.

        b.   Temperature transmitters shall be equipped with individual zero and span adjustments. The zero and span adjustments shall be non-interactive to permit calibration without iterative operations. Provide a loop test signal to aid in sensor calibration.

        c.   Temperature transmitters shall be sized and constructed to be compatible with the medium to be monitored. Transmitters shall be equipped with a linearization circuit to compensate for non-linearities of the sensor and bridge and provide a true linear output signal.

        d.   Temperature sensors shall be of the resistance type and shall be 10K or 20K Ohm Thermistor type.

            1)   Thermistors are acceptable provided the mathematical relationship of a thermistor with respect to resistance and temperature with the thermistor fitting constraints is contained with the controllers operating software and the listed accuracy's can be obtained. Submit proof of the software mathematical equation and thermistor manufacturer fitting constants used in the thermistor mathematical/expressions. Thermistors shall be of the Thermistor (NTC) Type with a minimum of 50 ohm/°C. resistance change versus temperature to insure good resolution and accuracy.

        e.   The following accuracy's are required and include errors associated with the sensor, lead wire and A to D conversion.

            1)

Point Type	Accuracy
Outside Air	+/-3%
Chilled/Hot Water	+/-1%
Room Temperature	+/-1%
Duct Temperature	+/-3%

            2)   Sensors Used in Energy Water (BTU) or Process Calculations +/-1%

            3)   Sensors used in energy or process calculations shall be accurate over the process temperature range. Submit a manufacturer's calibration report indicating that the calibration certification is traceable to the National Bureau of Standards (NBS) Calibration Report Nos. 209527/222173.

    2.   Thermowells

        a.   When thermowells are required, the sensor and well shall be supplied as a complete assembly including well head and Greenfield fitting, except where wells are to be installed under separate contract.

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

    c.   Thermowells and sensors shall be mounted in a threadolet or 1/2" NPT saddle and allow easy access to the sensor for repair or replacement.

    d.   Thermowells shall be constructed of the following materials:

        1)   Hot Water; brass.
        2)   Chilled Water; brass.
        3)   **[Steam]**; 316 stainless steel.
        4)   Brine (salt solutions): marine grade stainless steel.

3.   Outside Air Sensors

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

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

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

    d.   Solar load sensors shall be provided in locations shown. The use of a thermistor combined with a solar compensator is acceptable. Provide calibration charts as part of the O&M Manual.

4.   Duct Type Sensors

    a.   Duct mount sensors shall mount in a hand box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement. A neoprene grommet (sealtite fitting and mounting plate) shall be used on the sensor assembly to prevent air leaks.

    b.   Duct sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate. Duct sensors probe shall be constructed of 304 stainless steel.

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

5.   Averaging Duct Type Sensors

    a.   Where called out on the drawings and points lists, provide averaging type duct sensors. Thermistor sensors are acceptable. The sensor shall be multi-point sensitive through the length of the temperature conducting tubing. The thermistors shall be configured in a series / parallel method which creates an end result of total average resistance equal to the same span as a standard thermistor.

    b.   Provide capillary supports at the sides of the duct to support the sensing element.

6.   Acceptable Manufacturers

    a.   Honeywell
    b.   Johnson Controls
    c.   ACI
    d.   Bapi

C.   Relative Humidity Sensors/Transmitters

1.   The sensor shall be a solid state, resistance type relative humidity sensor of the Bulk Polymer Design. The sensor element shall be washable and shall resist surface contaminations.

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2. Humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2 wire isolated loop powered, 4-20ma, 0-10.0 VDC linear proportional output.

3. The humidity transmitter shall meet the following overall accuracy including lead loss and A to D conversion.

     a. Room Type Sensor ±2% RH
     b. Duct Type Sensor ±2% RH

4. Outside air relative humidity sensors shall be installed in a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with sealtite fittings and stainless steel bushings.

5. Provide a single point humidity calibrator, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.

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

7. Acceptable Manufacturers:

     a. Vailsala
     b. ACI
     c. Veris
     d. Honeywell
     e. Johnson Controls

D. Differential Pressure Transmitters and Accessories

1. General Air and Water Pressure Transmitter Requirements:

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

     b. Pressure transmitters shall provide the option to transmit a 0 to 5V dc, 0 to 10V dc, or 4 to 20 mA output signal.

     c. Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device and shall be supplied with shutoff and bleed valves in the high and low sensing pick-up lines (3 valve manifolds).

     d. Provide a minimum of a NEMA 1 housing for the transmitter. Locate transmitters in accessible local control panels wherever possible.

     e. Low air pressure, differential pressure transmitters used for room pressurization control (i.e. laboratories, OR's clean rooms, etc.) shall be equipped with a LED display indicating the transmitter output signal.

     f. Duct sensing pressure applications where the velocity exceeds 1500 fpm shall utilize a static pressure traverse probes.

2. Low Air Pressure Applications

3. Low Air Pressure Applications **[(0 to 125 Pa)]**

     a. The pressure transmitter shall be capable of transmitting a linear electronic signal proportional to the differential of the room and reference static pressure input signals with the following minimum performance specifications.

         1) Span: Not greater than two times the design space DP.

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2)   Accuracy: Plus or minus 0.5% of F.S.
3)   Dead Band: Less than 0.3% of output.
4)   Repeatability: Within 0.2% of output.
5)   Linearity: Plus or minus 0.2% of span.
6)   Response: Less than one second for full span input.
7)   Temperature Stability: Less than 0.05% output shift per degree change.

b.   The transmitter shall utilize variable capacitance sensor technology and be immune to shock and vibration.

c.   Acceptable Manufacturers

1)   Auto Tran
2)   Veris
3)   Setra

4.   Medium to High Air Pressure Applications

5.   Medium to High Air Pressure Applications **[(125 Pa to 2500 Pa)]**

a.   The pressure transmitter shall be similar to the Low Air Pressure Transmitter except the performance specifications are not as severe. Provide differential pressure transmitters which meet the following performance requirements.

1)   Zero & span: (% F.S./Deg. C): .05% including linearity, hysteresis and repeatability
2)   Accuracy: 1% F.S. (best straight line)
3)   Static Pressure Effect: 0.5% F.S.
4)   Static Pressure Effect: 0.5% F.S. (**[to 700 KPa]**)
5)   Thermal Effects: <±.05% F.S. /Deg. C.
6)   Thermal Effects: <±.05% F.S. /Deg. C. **[over 5(C. to 40(C]**. (calibrated at 22°C.)

b.   Acceptable manufacturers:

1)   Auto Tran
2)   Veris
3)   Setra

E.   Low Differential, Water Pressure Applications

F.   Low Differential, Water Pressure Applications (**[0 KPa to 5 KPa]**)

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

2.   The differential pressure transmitter shall have non-interactive zero and span adjustments adjustable from the outside cover and meet the following performance specifications.

a.   0 – 10 input differential pressure range
b.   0 – 10 **[KPa]** input differential pressure range
c.   4 - 20 mA output
d.   Maintain accuracy up to 20 to 1 ratio turndown
e.   Reference Accuracy: ± 0.2% of full span

    3.   Provide a two year warranty for each transmitter. Replace all transmitters found to be defective at no cost to the Owner during the warranty period. Acceptable Manufacturers:

        a.   Tobar
        b.   Veris
        c.   Foxboro
        d.   Omega
        e.   Bailey
        f.   Modus

G.   Medium to High Differential Water Pressure Applications

H.   Medium to High Differential Water Pressure Applications (**[5 KPa to 700 KPa]**)

    1.   The differential pressure transmitter shall meet the low pressure transmitter specifications except the following:
        a.   Differential pressure range **[5 KPa to 700 KPa]**.

        b.   Reference Accuracy: ±l% of full span (includes non-linearity, hysteresis, and repeatability)
        c.   Warranty: 1 year.

    2.   Acceptable Manufacturers:

        a.   Auto Tran
        b.   Veris
        c.   ACI
        d.   Setra

    3.   Bypass Valve Assembly: Mount stand-alone pressure transmitters in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with hi and low connections piped and valved. Air bleed units, bypass valves and compression fittings shall be provided

I.   Electronic Valve And Damper Actuators

    1.   General Requirements

        a.   Electronic actuators shall be electric, direct-coupled type capable of being mounted over the shaft of the damper. They shall be UL listed and the manufacturer shall provide a 2 year unconditional warranty from the date of commissioning. Power consumption shall not exceed 8 watts or 15 VA of transformer sizing capacity per high torque actuator nor 2 watts or 4 VA for VAV actuators. Sound level shall not exceed 45 dB for high torque or 35 dB for VAV actuators.
        b.   Electronic overload protection shall protect actuator motor from damage. If damper jams actuator shall not burn-out. Internal end switch type actuators are not acceptable. Actuators may be mechanically and electrically paralleled on the same shaft to multiply the available torque. A reversing switch shall be provided to change action from direct to reverse in relation to control signal as operation requires.
        c.   Warranty must be two years by manufacturer on actuator as a whole and all components.
        d.   Acceptable manufacturers:

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        1)   Honeywell
        2)   Johnson Controls
        3)   Belimo

2.   Control Damper Actuators

    a.   OA (outside air), RA (return air), and EA (exhaust air) actuators shall be spring return type for safety functions. Individual battery backup, capacitor return is not acceptable.

    b.   The control circuit shall be fully modulating using 2 - 10 volt or 4 - 20 mA signals. Accuracy and repeatability shall be within $\pm$ 1/21 of control signal. A 2 - 10 v or 4 - 20 mA signal shall be produced by the actuator which is directly proportional to the shaft clamp position which can be used to control actuators which are paralleled off a master motor or to provide a feedback signal to the automation system indicating damper position. Accuracy shall be within $\pm$ 2.5%.

    c.   Face and bypass dampers and other control dampers shall be modulating using the same control circuit detailed above but shall not be spring return.

3.   Miscellaneous Damper Actuators

    a.   OA combustion and ventilation air intake and EA damper actuators shall be 2 position spring return closed if any water piping, coils or other equipment in the space which the damper serves needs to be protected from freezing. Otherwise drive open, drive closed type 2 position may be used.

    b.   OA combustion and ventilation air intake and EA damper actuators shall be 2 position spring return closed if any water piping, coils or other equipment in the space which the damper serves needs to be protected from freezing. Otherwise drive open, drive closed type 2 position may be used. The minimum torque for any actuator shall be **[5 N-m]**.

    c.   Provide auxiliary switches on damper shaft or blade switch to prove damper has opened on all air handling equipment handling 100% outside air.

    d.   Provide auxiliary switches on damper shaft or blade switch to prove damper has opened on all air handling equipment handling 100% outside air and greater than **[6 KPa TSP]**.

4.   Air Terminals

    a.   Air terminal actuators shall use fully modulating floating (drive open, drive closed) 3 wire control or use control circuit as detailed in control dampers depending on the controllers' requirements.

    b.   Air terminal actuators shall be minimum **[5 N-m]** torque and use fully modulating floating (drive open, drive closed) 3 wire control or use control circuit as detailed in control dampers depending on the controllers' requirements.

5.   Inlet Vanes Actuators
    a.   Inlet vane actuators shall provide at least 150% of the minimum torque specified by the manufacturer as necessary to operate vanes properly. Either direct coupled or gear train with linkages are acceptable as required. The control loop for static control of the actuator shall operate slowly enough to avoid hunting and maintain stable control. See automation system specifications for details.

6.   Combination Smoke and Fire Damper Actuators

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a. Actuators shall be factory mounted and connected to the damper section and shall conform to UL 555S specifications.

J. Valve Actuators

1. Control Valves Actuators (3 inch and smaller)

a. Actuators shall have a gear release button on all non-spring return models to allow manual setting. The actuator shall have either an insulating air gap between it and the linkage or a non-conducting thermoplastic linkage. Care shall be taken to maintain the actuator's operating temperatures and humidity within its specifications. Pipes shall be fully insulated and heat shields shall be installed if necessary. Condensation may not form on actuators and shall be prevented by a combination of insulation, air gap, or other thermal break.

b. The control circuit shall be fully modulating using 2 - 10 volt or 4 - 20 mA signals. Accuracy and repeatability shall be within 1/21 of control signal. A 2 - 10 v or 4 - 20 mA signal shall be produced by the actuator which is directly proportional to the shaft clamp position which can be used to control actuators which are paralleled off a master motor or to provide a feedback signal to the automation system indicating valve position.

c. Valve body and actuators shall be shipped fully assembled and tested at the valve factory prior to shipment.

2. Control Valve Actuators (4 inch and larger).

a. The valve actuator shall consist of a permanent split capacitor, reversible type electric motor which drives a compound epicycle gear. The electric actuator shall have visual mechanical position indication, readable from a distance of 8 meters, showing output shaft and valve position. Unit shall be mounting directly to the valves without brackets and adapters, or readily adapted to suit all other types quarter-turn valves.

b. The actuator shall have an integral terminal strip, which, through conduit entries, will ensure simple wiring to power supplies. Cable entries shall have UL recommended gland stops within the NPT hole to prevent glands from being screwed in too far and damaging cable.

c. The actuator shall be constructed to withstand high shock and vibrations without operations failure. The actuator cover shall have captive bolts to eliminate loss of bolts when removing the cover from the base. One copy of the wiring diagram shall be provided with the actuator.

d. The actuator shall have a self-locking gear train which is permanently lubricated at the factory. The gearing shall be run on ball and needle bearings. Actuators with 70 N-m or more output torque shall have two adjustable factory calibrated mechanical torque limit switches of the single-pole, double-throw type. The motor shall be fitted with thermal overload protection. Motor rotor shaft shall run in ball bearings at each end of motor.

e. The actuator housing shall be hard anodized aluminum for full environmental protection.

f. The environmental temperature range of the actuator shall be -22 to 140 deg F.

g. For intermittent on/off service, the actuator shall be rated at a 20% duty cycle (i.e., 12 minutes extended duty in every hour, or alternatively; one complete cycle every 2 minutes). For more frequent cycling and modulating service, an actuator shall be rated for continuous duty. The actuator rated for continuous duty shall be capable of operating 100% of the time at an ambient temperature of 104 deg F.

h. The actuator shall have an integral self-locking gear train. Motor brakes shall not be required to maintain desired valve position. Levers or latches shall not be required to engage or disengage the manual override. Mechanical travel stops, adjustable to 15° in each direction of 90° rotation shall be standard, as well as two adjustable travel limit

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switches with electrically isolated contacts. Additional adjustable switches shall be available as option.

    i.   Single Phase Motor: The motor shall have Class B insulation capable of withstanding locked-rotor for 25 seconds without overheating. Wiring shall also be Class B insulation. An auto-reset thermal cut-out protector shall be embedded in the motor windings to limit heat rise to 175 deg Fin a 104 deg Fambient. All motors shall be capable of being replaced by simply disconnecting the wires and then removing mounting bolts. Disassembly of gears shall not be required to remove the motor.

    j.   Materials of Construction: The electric actuator shall have a pressure die-cast, hard anodized aluminum base and cover. The compound gear shall be made of die-cast, hard anodized aluminum or steel. An alloy steel worm gear shall be provided for manual override and torque limiting. Bearings for gears shall be of the ball and needle type; bronze bearings shall be used on the shafting parts.

    k.   Accessories:

        1)   Potentiometer for providing continuous feedback of actuator position at the controller (for valves specified position feedback).

    l.   Acceptable manufacturers:

        1)   Honeywell
        2)   Johnson Controls
        3)   Belimo

K.   Control Valves

    1.   Control valves shall be 2-way or 3-way pattern as shown constructed for tight shutoff and shall operate satisfactorily against system pressures and differentials. Two-position valves shall be 'line' size. Proportional control valves shall be sized for a maximum pressure drop of 5 psigat rated flow (except as may be noted on the drawings). Valves with sizes up to and including NPS 2shall be "screwed" configuration and NPS 2-1/2inch and larger valves shall be "flanged" configuration. Electrically controlled valves shall include spring return type actuators sized for tight shut-off against system pressures and furnished with integral switches for indication of valve position (open-closed). Three-way butterfly valves, when utilized, shall include a separate actuator for each butterfly segment.

    2.   Acceptable manufacturers:

        a.   Honeywell
        b.   Belimo

L.   Pressure Independent Modulating Control Valves (PICV)

    1.   PICV valves shall have control and flow control performed by the same valve. PICV valves utilizing a separate ball, globe or butterfly valve in association with a dynamic balancing valve or flow measuring station shall not be acceptable.

    2.   Valve bodies 2" (50mm) and smaller shall be brass. Valve bodies 3" thru 6" shall be ductile iron.

    3.   Valves shall have (2) factory installed pressure/temperature ports as part of the actual valve body.

    4.   Piston and Spring Assembly: Stainless steel or corrosion resistant, tamper proof, self cleaning, removable.

        a.   Field adjustable flow rate without removing cartridge from the valve body.

        1) In lieu of field adjustability, provide up to 10% of the total project PICV quantity of up or down sized flow rate cartridges as requested by Engineer during TAB.

    5. Combination Assemblies: Include bonze or brass-alloy ball valve with stainless steel ball.

    6. Identification Tag: Marked with zone identification, valve number, and flow rate.

    7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.

    8. Minimum CWP Rating: 175 psig.

    9. Maximum Operating Temperature: 250 deg F.

    10. Maximum Pressure Drop: 5 ft of head pressure drop at rated flow.

    11. Seals: EDPM and Teflon

M. Switches

    1. Differential Pressure Switches

        a. All pressure sensing elements shall be corrosion resistant. Pressure sensing elements shall be bourdon tubes, bellows, or diaphragm type. Units shall have tamper-proof adjustable range and differential pressure settings.

        b. Pressure sensor switch contacts shall be snap action micro-switch type. Sensor assembly shall operate automatically and reset automatically when conditions return to normal. Complete sensor assembly shall be protected against vibration at all critical movement pivots, slides and so forth.

        c. Differential pressure switches shall be vented to withstand a 50% increase in working pressure without loss of calibration.

        d. Acceptable Manufacturers: Mercoid, Dryer, McDonnell Miller.

    2. Electric Low Limit Thermostat (Freeze Stat)

        a. Duct type, fixed 4 deg Fdifferential, range 32 to 60 deg F. Sensing element shall be a 20 feetlong capillary tube responding to the lowest temperature sensed along any 12 inchesof bulb length. Switch shall be SPDT 120/240 volts AC, rated for 10 amps at 120 volts full load. Unit shall be manually reset. Provide one low limit thermostat for each 20 sq. ft.or fraction thereof of coil surface area.

        b. Provide DPST switches, 1 NO, 1 NC contact.

        c. Provide manual type low limit thermostat set at 36 deg Fon each air handling unit.

        d. Provide thermostat override on air handling units for smoke control in area being served.

    3. Water Flow Switches

        a. UL listed, suitable for all service application conditions. Body minimum working pressure rating shall equal or exceed service pressure. Switch electrical rating shall be 230 volts AC 3.7 ampere, 115 volts AC 7.4 ampere, and 125 VAC 115-230 VAC AC Pilot duty. Unit shall have two SPDT switches. Actuating flow rated shall be field adjustable for the specified and indicated service. Switch location shall preclude exposure to turbulent or pulsating flow conditions. Flow switch shall not cause pressure drop exceeding 2 psi at maximum system flow rate.

        b. Acceptable Manufacturer: McDonnel-Miller.

    4. Strap-On Aquastat

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      a.   UL listed, provided with a suitable removable spring clip for attaching aquastat to pipe and a snap-action SPDT switch. Switch set-point shall be as indicated. Electrical rating shall be 5 amperes, 120 VAC.

   5.   Current Sensitive Switches: Solid state, split core current switch that operates when the current level (sensed by the internal current transformer) exceeds the adjustable trip point. Current switch to include an integral LED for indication of trip condition and a current level below trip set point.

N.   Flow, Pressure And Electrical Measuring Apparatus

   1.   Traverse Probe Air Flow Measuring Stations
      a.   Traverse probes shall be a dual manifolded, cylindrical, type constructed of 3003 extruded aluminum with an anodized finish to eliminate surface pitting and unnecessary air friction. The multiple total pressure manifold shall have sensors located along the stagnation plane of the approaching air flow and without the physical presence of forward projecting sensors into the airstream. The static pressure manifold shall incorporate dual offset static tips on opposing sides of the averaging manifold so as to be insensitive to flow-angle variations of as much as $\pm20°$ in the approaching airstream.
      b.   The air flow traverse probe shall not induce a measurable pressure drop, nor shall the sound level within the duct be amplified by its singular or multiple presence in the airstream. Each airflow measuring probe shall contain multiple total and static pressure sensors placed at equal distances along the probe length. The number of sensors on each probe and the quantity of probes utilized at each installation shall comply with the ASHRAE Standards for duct traversing.
      c.   Traverse probes shall be accurate to ±25% of the measured airflow range.
      d.   Traverse probes shall be accurate to ±25% of the measured airflow range down to **[60 Pa]**static pressure.
      e.   Each flow measuring station shall be complete with its own dedicated microprocessor with a 4-line, 80 character, Alpha Numeric display and full function key pad. The panel shall be fully programmable and display calculated liters per minute directly on a LED monitor on the panel face.
      f.   Provide 24 volt 1 phase power to each flow measuring station.
      g.   Acceptable Manufacturers:
         1)   Air Monitor
         2)   Ultratech
         3)   Air Sentinel.

   2.   Shielded Static Pressure Sensor

      a.   Provide for each zone where required a shielded static pressure sensor suitable for ceiling surface mounting, complete with multiple sensing ports, pressure impulse suppression chamber, airflow shielding, and 3/8" compression takeoff fittings, all contained in a welded stainless steel casing, with polish finish on the exposed surfaces.
      b.   Provide for each zone where required a shielded static pressure sensor suitable for ceiling surface mounting, complete with multiple sensing ports, pressure impulse suppression chamber with minimum volume of **[800 cubic centimeters]**, airflow shielding, and 3/8" compression takeoff fittings, all contained in a welded stainless steel casing, with polish finish on the exposed surfaces.
      c.   These probes shall be capable of sensing the static pressure in the proximity of the sensor to within 1% of the actual pressure value while being subjected to a maximum airflow of 1000 feet/min. from a radial source.

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    d.   The shielded static sensing devices shall be used for both reference and space pressure sensing.

    e.   Pressure sensors used for outside air pressure reference purposes shall be equipped with a conduit seal for pneumatic tubing and bushings for a weather tight installation.

3.   Static Pressure Traverse Probe

    a.   Provide multipoint traverse probes in the duct at each point where static pressure sensing is required.

    b.   Each duct static traverse probe shall contain multiple static pressure sensors located along the exterior surface of the cylindrical probe. Pressure sensing points shall not protrude beyond the surface of the probe.

    c.   The duct static traverse probe shall be of 304 stainless steel construction and (except for 3/4" dia. probes with lengths of 24 inchesor less) be complete with threaded end support rod, sealing washer and nut, and mounting plate with gasket and static pressure signal fitting. The static traverse probe shall be capable of producing a steady, non-pulsating signal of standard static pressure without need for correction factors, with an instrument accuracy of $\pm$ 1/2%.

    d.   Acceptable Manufacturers:

        1)   Auto Tran
        2)   Veris
        3)   Setra

O.   Relays And Contactors

1.   Relays other than those associated with digital output cards shall be general purpose, enclosed type and protected by a heat and shock resistant duct cover. Number of contacts and operational function shall be as required.

2.   Solid State Relays (SSR): Input/output isolation shall be greater than IOE^9 ohms with a breakdown voltage of 1500V root mean square or greater at 60 Hz. The contact life shall be 10 x 10 E^6 operations or greater. The ambient temperature range of SSRs shall be -18 to 140 deg F. Input impedance shall not be less than 500 ohms. Relays shall be rated for the application. Operating and release time shall be for 100 milliseconds or less. Transient suppression shall be provided as an integral part of the relay.

3.   Contactors: Contactors shall be of the single coil, electrically operated, mechanically held type. Positive locking shall be obtained without the use of hooks, latches, or semipermanent magnets. Contractor shall be double-break-silver-to-silver type protected by arcing contacts. The number of contacts and rating shall be selected for the application. Operating and release times shall be 100 milliseconds or less. Contactors shall be equipped with coil transient suppression devices.

P.   Temperature Control Panels

1.   Furnish temperature control panels of code gauge steel with locking doors for mounting all devices as shown. Panels shall conform to NEMA 1 standards, unless otherwise indicated.

2.   Control panels shall meet all requirements of UL508A and shall be so certified.

3.   All external wiring shall be connected to terminal strips mounted within the panel.

4.   Provide engraved phenolic nameplates identifying all devices mounted on the face of control panels and the identification number of the panel.

5.   A complete set of 'as-built' control drawings (relating to the controls within that panel) shall be furnished within each control panel.

Q.   Variable Frequency Drives

1.   Furnish Variable Frequency Drives (VFD) for installation by the electrical contractor (Div. 16). Drives shall be factory equipped with a LonTalk FTT-10A communications interface.

2.   The variable frequency drive (VFD) shall generate the required variable frequency through three main input voltage lines connected to an LC filter and diode bridge. This shall produce a DC voltage for an insulated gate bi-polar transistor (IGBT) bridge. The IGBT bridge shall produce a pulse-width modulated (PWM) AC voltage for the motor. A microprocessor shall control the motor according to measured signals and control commands sent from the VFD control panel.

3.   The VFD enclosure shall be INSERT ENCLOSURE TYPE (NEMA 1, NEMA 12, OPEN CHASSIS).

4.   VFD shall be suitable for INSERT DESIRED VOLTAGE RANGE (208-240 VAC, 380-500 VAC, or 525-690 VAC). The VFD shall maintain functionality from -15% to +10% of nominal voltage at a frequency of 45-66 Hz. Ambient operating temperature range shall be 14 F to 104 F, and the humidity range: 5 to 95% RH (non-condensing).

5.   The VFD shall accommodate inputs of 0-10 VDC, 4-20 mA, up to six digital inputs. VFD outputs shall include current of 0-20 mA, 500 ohm maximum with 10 bit resolution, and two programmable changeover relay outputs with switching capacity of 24 VDC, 8A; 250 VAC, 8A; and 125 VDC, 0.4A.

6.   The VFD shall accommodate Modbus, LonTalk, and BACnet communications protocols for field bus control.

7.   The variable frequency drive shall have separate pre-loaded user-programmable applications which can be modified using a personal computer-based commissioning tool with an optional software package, or an alpha-numeric LCD user interface. Aforementioned application functionality shall include but not be limited to:

a.   Basic Functionality Application providing the following:
1)   Control I/O signals (two (2) analog inputs, one (1) digital input, and one (1) analog output) are fixed
2)   One (1) programmable digital input and one (1) programmable digital output
3)   All parameters have default values,
4)   No more than nine (9) parameter settings are required for startup and operation.

b.   Expanded Functionality Application providing all capabilities in the previous application as well as the following:
1)   One (1) programmable digital input and all outputs are programmable
2)   Frequency limit and prohibit capability
3)   Programmable start/stop and reversing logic
4)   Automatic restart
5)   Programmable actions for motor thermal and stall protection
6)   DC brake at stop

c.   Application that provides all previously mentioned capability as well as enabling the use of two different control and frequency sources. Each source must be programmable.

d.   Application which provides all functionality from the Expanded Functionality Application as well as accommodates multiple, required fixed speed references.

e.   PID Control Application – Uses internal PID control loop to control motor frequency as well as providing:

f.   Input and output phase supervision

g.   Programmable capability for three (3) digital inputs and all outputs

h.   Sleep function

i.   Multi-purpose Control Application – The frequency reference can be selected from analog inputs, joystick control, motor potentiometer, or a mathematical function of the analog inputs.

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      j.   Application specifically designed to control one leading variable speed drive and up to 3 auxiliary drives.

8. Variable frequency drives shall be UL listed and sized for the power and loads applied.
9. Drives shall include built-in radio frequency interference (RFI) filters and be constructed to operate in equipment rooms and shall not be susceptible to electromagnetic disturbances typically encountered in such environments. Similarly, the drives must not excessively disturb the environment within which it is used.
10. All VFDs over 3 horsepower shall be provided with an AC choke before rectifiers. All included chokes and filters shall be integrated in the factory enclosure.
11. VFDs shall be installed in strict conformance to the manufacturer's installation instructions, and shall be rated to operate over a temperature range of 14 to 104 F.
12. VFD automatic operation shall be suitable for 4-20 ma input signal. Each VFD shall be fan cooled and have an integral keypad and alphanumeric "plain-language" display unit for user interface. The display shall indicate VFD status (RUN motor rotation, READY, STOP, ALARM, and FAULT), and shall indicate the VFD current control source (DDC input signal, keypad, or field bus control). In addition to the alphanumeric display, the display unit shall have three pilot lights to annunciate when the power is on (green), when the drive is running (green, blinks when stopping and ramping down), and when the drive was shut down due to a detected fault (red, fault condition presented on the alphanumeric display).
13. Three types of faults shall be monitored, "FAULT" shall shut the motor down, "FAULT Auto-reset" shall shut the motor down and try to restart it for a programmable number of tries, and "FAULT Trip" shall shut the motor down after a FAULT Auto-reset fails to restart the motor. Coded faults shall be automatically displayed for the following faults:
    a.   Over current
    b.   Over voltage
    c.   Earth ground
    d.   Emergency stop
    e.   System (component failure)
    f.   Under voltage
    g.   Phase missing
    h.   Heat sink under temperature
    i.   Heat sink over temperature
    j.   Motor stalled
    k.   Motor over temperature
    l.   Motor underload
    m.   Cooling fan failure
    n.   Inverter bridge over temperature
    o.   Analog input control under current
    p.   Keypad failure
    q.   Other product unique monitored conditions

14. In addition to annunciating faults, at the time of fault occurrence the VFD shall capture and make available to the user certain system data for subsequent analysis during fault trouble shooting, including duration of operation (days, hours, minutes, seconds),output frequency, motor current, motor voltage, motor power, motor torque, DC voltage, unit temperature, run status, rotation direction, and any warnings. The last 30 fault occurrences shall be retained as well as the fault data listed in the previous sentence of each fault. New faults beyond 30 shall overwrite the oldest faults.
15. The display unit keypad shall allow setting operational parameters including minimum and maximum frequency, and acceleration and deceleration times. The display shall offer user

monitoring of faults, frequency, unit temperature, and motor speed, current, torque, power, voltage, and temperature.

16. Acceptable manufacturers:
  a. ABB
  b. Honeywell
  c. Square D

R. Temperature Control Air Compressor (when required): A duplex air compressor system (two compressors mounted on one tank) shall be furnished and installed by the temperature control contractor. Air compressor system shall be sized to fit the pneumatic control system, to insure no more than 33% run time. The tank shall be sized for a maximum of 6 starts per hour. An automatic alternator shall be connected to the motors and pressure switches, in a 'lead-lag' manner, and shall alternate compressor operation after each on-off cycle. Alternator shall be further connected to energize the 'lag' operation after each on-off cycle. Alternator shall be further connected to energize the 'lag' compressor at the setting of the lower pressure switch if the "lead" compressor fails or is disabled for service. Air compressor system shall include a refrigerated air dryer sized for the capacity of the air compressor. Accessories such as filters, pressure regulators, valves, spring isolators, automatic tank drain etc. shall also be furnished for a complete operating system.

S. Any automatic control dampers not specified to be integral with other equipment. Frames shall not be less than 0.094 inch galvanized steel. Blades shall not be over 8 incheswide nor less than 0.063 inch galvanized steel roll formed. Bearings shall be oilite, ball-bearing or nylon with steel shafts. Side seals shall be stainless steel of the tight-seal spring type. Dampers and seals shall be suitable for temperature ranges of -40 to 200 deg F.

  1. Individual damper sections shall have a maximum of 16 sq. ft. of damper surface and each individual damper section to have its own damper operator.
  2. All proportional control dampers shall be opposed blade type and all two-position dampers shall be parallel blade types.
  3. Dampers shall be sized to meet ductwork or opening size.
  4. Dampers shall be ultra-low leakage dampers and the blade edges shall be fitted with replaceable, snap-on, inflatable seals to limit damper leakage to 6 CFM per square foot for dampers in excess of sixteen inches square at 1-inch wg.

T. Thermally Isolated Dampers: Tampco Series 9000 or equivalent extruded aluminum thermally isolated control dampers with insulated air-foiled shaped blades.

U. Thermally Isolated Dampers: Ruskin Model CDTI50 or equivalent extruded aluminum thermally isolated control dampers with insulated air-foiled shaped blades.

  1. Smoke Evacuation System Dampers: UL Listed.

V. Digital Wall Module: Each wall module shall provide temperature indication to the digital controller.

  1. Provide software-limited set point adjustment and occupied/unoccupied override capability where indicated.
  2. Module mounted adjustments shall use buttons, no slides or wheels.
  3. Where indicated, provide plate type security temperature sensors.

W. Digital Wall Module: Each wall module shall provide temperature indication to the digital controller, provide the capability for a software-limited set point adjustment, occupied/unoccupied override capability

and fan speed selection/mode. An integral LCD shall annunciate room temperature, set point, fan speed and operating mode. In addition an integral humidity sensor with display shall be available.

X.   Wireless Temperature Transmitter: Module shall provide temperature indication to the digital system.

1. Supply Power: Lithium batteries, 8 year battery life at 10 second transmit rate
2. Inputs: Built in thermistor
3. Accuracy: ±0.2 °C
4. Transmitted Range: -40° to 85°C
5. Environmental Operation Range:

   a. Temp: 0° to 60°C
   b. Humidity: 5% to 95% RH non-condensing

6. Material: ABS Plastic
7. Material Rating: UL94 V-0
8. Radio Frequency: 418 MHz
9. Transmitter Interval: ~10 seconds
10. Antenna: Built inside the enclosure
11. Associated Products:

   a. 418 or 900 MHz Receivers: Receives the RF signal from one or more transmitters or repeaters and outputs the values to Analog Output Modules.
   b. Analog Output Modules: Converts the signal from the Receiver into a resistance, voltage or current for sending to the controller.
   c. Repeater: Extends the range of the Transmitter up to 1,000 feet.

Y.   Duct smoke detectors shall be furnished and connected to the building fire alarm under Division 28. Contacts shall be provided for the BMS contractor to connect for fan shutdown as specified in the Sequence of Operations.

Z.   Carbon Monoxide sensor/transmitter shall be Armstrong Monitoring Corporation AMC-3701 or approved equal. Solid state sensor with 4-20mA linear signal output corresponding to 0-100 PPM CO, Aluminum enclosure, remote calibration feature with non-interactive zero and span, protection against overvoltage and polarity reversal, capable of covering up to 7500 Sq. Ft.. Sensors shall be mounted 3 to 4 feet above finished floor where indicated on drawings.

AA. Nitrogen Dioxide sensor/transmitter shall be shall be Armstrong Monitoring Corporation AMC-2281 or approved equal. Electrochemical type sensor with 4-20mA linear signal output corresponding to 0-10 PPM NO2, PVC housing, remote calibration feature with non-interactive zero and span, protection against overvoltage and polarity reversal, capable of covering up to 7500 Sq. Ft..). Sensors shall be mounted 12 inchesbelow ceiling where indicated on drawings.

BB. Carbon Dioxide sensors shall be 0-10 Vdc analog output type, with corrosion free gold-plated Non-dispersive Infrared sensing, designed for duct mounting. Sensor shall incorporate internal diagnostics for power, sensor, analog and output checking, and Automatic Background Calibration algorithm for reduced maintenance. Sensor range shall be 0-3000 PPM with +/- 5% and +/- 50 PPM accuracy.

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2.20   ELECTRICAL POWER MONITOR (ALTERNATE NO. 7)

A.   Provide Veris Model H8163 or equivalent electrical power monitor to monitor the electrical consumption for the entire facility. The monitoring shall be installed on the 480 volt side of the power coming into the building. Provide a meter for each feed into the building **[(two required)]**. All communications to building DDC control system shall be BACnet.

      1.   Monitor shall have a normally open pulse output with selectable pulse output rates of 0.10, 0.25, 0.50, or 1.00 kWh per pulse.
      2.   Monitor shall have a normally closed phase-loss alarm output operating at 100mA @ 24VAC/DC.

B.   Monitor shall consist of digital electronic circuitry, conforming to ANSI C12.1 metering accuracy standards, and shall consist of a meter and current transformers calibrated together as a system. The monitor's accuracy shall be +/- 1% from 2% to 100% of the rated current over a temperature range of 0-50°C.

      1.   Monitor electronics shall automatically correct for current transformer phase reversal.

C.   Monitor shall require no annual recalibration by users in the field and shall derive operating power from its metering connections.

D.   Monitor shall be factory assembled shall have a visual display to show accumulated kWh on the top half of the display while the bottom half of the display scrolls through Amps, Voltage, PF, KVAR, KVA, KW Real Power.

E.   The information and capabilities provided by the monitor shall include the following:

      1.   Current, per phase and three-phase total
      2.   Voltage, per phase and three-phase total, phase-to-phase & phase-neutral
      3.   Real Power (kW), per phase and three-phase total
      4.   Reactive Power (kVAR), three phase total
      5.   Apparent Power (kVA), three phase total
      6.   Power Factor, per-phase and three-phase total
      7.   Real Energy (kWh), three phase total

PART 3 - EXECUTION

3.1   GENERAL

A.   The BMS shall be designed, installed, and commissioned in a turnkey operational manner; including all labor not noted in Work by Others paragraph of PART I of this section of these specifications, and not noted in other sections of these specifications.

B.   Where control devices are installed on insulated piping or ductwork, provide standoff brackets or thermowells sized to clear insulation thickness. Provide extended sensing elements, actuator linkages, and other accessories as required.

3.2   SEQUENCE OF OPERATION

A.   Refer to Section 23 0993 for sequence of operations.

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3.3   INSTALLATION

A.   All controls Installer work shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work.

B.   Install system and materials in accordance with manufacturer's instructions, and as detailed on the project drawing set.

C.   Drawings of BMS are diagrammatic only and any apparatus not shown, such as relays, accessories, etc., but required to make the system operative to the complete satisfaction of the Engineer shall be furnished and installed without additional cost.

D.   Line and low voltage electrical connections to control equipment shown, specified, or shown on the control diagrams shall be furnished and installed by the controls Installer in accordance with these specifications.

E.   All control devices mounted on the face of control panels shall be clearly identified as to function and system served with permanently engraved phenolic labels.

F.   All wiring and tubing shall be properly supported and run in a neat and workmanlike manner. All wiring and tubing exposed and in equipment rooms shall run parallel to or at right angles to the building structure. All tubing and wiring within enclosures shall be neatly bundled and anchored to prevent obstruction to devices and terminals. All wiring shall be in accordance with all local and national codes. All line voltage wiring, all wiring exposed, and all wiring in equipment rooms shall be installed in conduit in accordance to the electrical specifications. All electronic wiring shall be #18 AWG minimum THHN and shielded if required, except standard network (Ethernet, LonWorks, etc.) cabling shall be as tested and recommended in lieu of #18 gauge twisted, #22 or #24 gauge is acceptable if used as a part of an engineered structured cabling system. The control manufacturer must submit technical and application documentation demonstrating that this cabling system has been tested and approved for use by the manufacturer of both the control system and the engineered structured cabling system.

     1.   Low voltage system cables shall be neatly routed and independently supported with cable rings to the nearest cable tray, technology closet, conduit run or equipment connection.
     2.   All wiring in ceiling plenums shall be plenum rated.

G.   This contractor shall provide all sensing, control, and interlock wiring and tubing for the following unless shown or specified elsewhere by others:

     1.   Cooling tower interlocks.
     2.   Condensing units interlocks.
     3.   Hydronic piping pressure sensors.
     4. CO_2 sensors.
     5.   Connection between occupancy sensors provided by Division 26 and control devices.
     6.   Air to Air Energy Recovery Unit interlocks.
     7.   Refrigerant alarm panel interlocks and sensor tubing.
     8.   Smoke detection devices and HVAC equipment shut-down devices.

H.   The controls contractor shall install all software and enter all computer data into the network area controllers, hardware, and related computers including all control programs, initial approved parameters and settings, and graphics.

I.   The controls contractor shall install all software and enter all computer data into the network area controllers, **[laptop computers,]**hardware, and related computers including all control programs, initial approved parameters and settings, and graphics.

J.   Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 40 inches above the floor.

3.4   ACCEPTANCE

A.   The BMS contractor shall completely check out, calibrate and test all connected hardware and software to insure that the system performs in accordance with the approved specifications and sequences of operations.

1.   Coordinate with other Installers the checkout of each controlled system

B.   The controls Installer shall perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the DDC system operation.

C.   Upon completion of the performance tests described above, repeat these tests, point by point as described in the validation log above in presence of Owner's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the Owner's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.

D.   System Acceptance: Satisfactory completion is when the controls Installer has performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

E.   The control contractor shall furnish a portable UC programming tool with preloaded software and necessary interface cable to the balancing contractor for use during system balancing. The balancing contractor shall be responsible for proper use and care of this tool, and shall return it to the control contractor immediately upon balancing completion. The control contractor shall provide the balancing contractor up to four hours training on the use of this tool in order to exercise actuators and enter calibration and balancing parameters. Additional training or assistance required by the balancing contractor shall be contracted directly with the control contractor by the balancing contractor.

3.5   TRAINING (Alternate #1)

A.   All training shall be by the BMS Installer and shall utilize operators' manuals and as-built documentation.

B.   The controls Installer shall provide 40 hours of instruction to the Owner's designated personnel on the operation of the BMS and describe its intended use with respect to the programmed functions specified. Operator orientation of the BMS shall include, but not be limited to; device programming software, graphical development software, graphical user interface, the overall operation program, equipment functions (both individually and as part of the total integrated system), commands, systems generation, advisories, and appropriate operator intervention required in responding to the System's operation.

C.   The training shall be in three sessions as follows:

1. Initial Training: One day session (8 hours) after system is started up and at least one week before first acceptance test. Manual shall have been submitted at least two weeks prior to training so that the Owners' personnel can start to familiarize themselves with the system before training begins.
2. Follow-Up Training: Two one day sessions (8 hours each) after initial training, and before Formal Acceptance. These sessions will deal with more advanced topics and answer questions.
3. Warranty Follow Up: Two one day sessions (8 hours each) to be scheduled at the request of the Owner during the one year warranty period. These sessions shall cover topics as requested by the owner such as; how to add additional points, create and gather data for trends, graphic screen generation or modification of control routines.

D. On-Line Service: Include 40 hours of on-line service assistance to include but not be limited to:

1. Programming changes or modifications, including changes and adjustments to control algorithms
2. Graphic changes or modifications as requested by the Owner or consulting engineer.
3. Operator assistance to include short (1 hour or less) refresh training on system diagnostics and operation, i.e., geothermal optimization, scheduling, trending or operator setup.
4. Consulting engineer assistance to include assistance on control system optimization.

3.6   POINTS LIST

A. Refer to Section 23 0993 for points list. Provide all additional points as required to accomplish all BMS sequences indicated in the drawings and specifications.

END OF SECTION 23 0900

RFI #	Company Submitting RFI	Date Received	RFI Description	RFI Response
1	SA Morman	7/23/2024	A501 Door Schedule does not include Hardware Sets. Specifications 087100 Door Hardware does not include Opening Assignments for the Hardware Sets. Please advise.	TP: This will be addressed in Addendum No. 2
2	Earley Concrete	7/26/2024	Is termite treatment required on this project.	TP: Termite treatment is not required.
3	Ritsema	7/31/2024	Is 3" EIFS required at the soffits. The existing soffit underside appears to be painted plywood. Can the EIFS be eliminated from this project?	TP: EIFS soffit is required.
4	MCM	7/31/2024	Who is required to remove and reinstall ceilings in the coordidoors.	TSC: Bid Category No. 05 per Addendum No. 02.
5	Davenport Masonry	7/31/2024	Everything that I see talking about the grout inside the CMU says grout solid. Are we grouting all the CMU solid?	TP: TP: Refer to SG 005, "CMU Wall Reinforcing and Schedule", note 7. "Grout CMU cells as follows: A. All cells containing reinforcing bars B. Below lintel bearing, down to foundation C. Where required for anchoring to CMU, and D. Where specifically shown in the details."
6	Davenport Masonry	7/31/2024	On sheet A101C, it says "wall touch up to match existing". Can you elaborate on what that will entail?	TP: This will be addressed in Addendum No. 2
7	Division 5 Metalworks	8/6/2024	IS AISC certification mandatory for the Structural Steel Bid Category.	TP: This will be addressed in Addendum No. 3
8	Jergens	8/6/2024	Please clarify the intent for the temporary start-up cartridge filter piping detail on drawing M501. If we are to clean all strainers at each piece of equipment, can you quantify how many pieces of equipment there are throughout the building? Also, is the intent that we are flushing and filling the entire existing heating system vs just our newly installed pipe? Would there be any consideration towards a separate allowance specifically for the flushing and cleaning of the existing heating system given the unknown condition of the existing system?	TP: The intent is to flush the entire heating system during start-up (not just the newly installed piping) in accordance with "Cleaning & Treatment of Hydronic Systems" under specification section 23 2500 HVAC Water Treatment. During start-up the full flow of the heating system would go through the temporary cartridge filter for a period of 8 to 72 hours. After flushing the entire system all strainers in the heating system are to be opened, cleaned, and inspected. Quantity of strainers to be determined in the field.
9	Lounsbury Excavating	8/6/20024	Per sheet C200, Is the existing BB court an alternate to mill 1.5", repave 1.5", strip, added asphalt and reset BB hoops? Or is this in the base bid and no alternate? Existing Court seems to be in horrible shape, and I can't see that milling the surface will end well. I believe this will cause more damage in the end. Could this be a removal and proof roll existing gravel subgrade and repave court?	TP: This will be addressed in Addendum No. 2. Base bid: Base bid is restriping the revised basket ball court. Basket ball hoops are to be removed, salvaged and reinstalled as part of basebid as well. Alternate: Is mill and repave 1.5" of asphalt.
10	Quality Air	8/8/2024	According to Drawing A301, it shows the new louvers as 3'x5'. These louvers would go to Unit Ventilators. However, according to the Technical Manual for that equipment the louvers provided would be 4'x4'. Please be advised of this discrepancy.	TP: Louvers wil not be provided by the unit ventilator manufacutre. Louver size is to be 3'x5'
11	Quality Air	8/8/2024	According to Drawing M102C, the Hot Water loop is going from rooms being remodeled and under Phase 1 to rooms being added under Phase 2. Due to the schedule, the loop will not be able to be completed before Phase #1 needs to be completed for the start of school. A temporary bypass on the return line and temporary cap on supply work until connection to Phase 2 could happen, will need to be made to work? Is there a specific route that would be preferred? Also, would the temporary pipe work need to be removed with the completion of Phase 2, or can we leave it the ceiling?	TP: Install a temporary bypss on the heating water return as required to complete both phases of the project. Upon completion of Phase 2, temporary bypass piping is required to be removed. Drawings showing bypass piping route will be provided in an upcoming addendum.