1.   Part 1 – General

1.1   General and Related Work

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

.2   If the Contractor believes there are conflicts or missing information in the Contract Documents then the Contractor shall promptly request clarification and instruction from the Contract Administrator before proceeding.

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

.4   The Contractor shall have visited the Project site and obtained information as necessary prior to submittal of the bid to ensure that prevailing physical conditions and Project arrangements that may be material to the performance of the Work have been ascertained and accommodated in the bid. No claims for additional payments will be accepted due to the Contractor's failure to complete this survey.

.5   If, in order to complete the Work of the Controls Contract, private and/or public telephone lines and connections, including ISDN lines and/or LAN/WAN support and connections, are required then these shall be provided by the City to the Contractor, at the City's direct cost, in a timely manner.

.6   The City has an existing central monitoring system in place. Where DDC points are identified as centrally monitored points, the controls contractor shall provide and install required hardware and software to interface to the City's Johnson Controls Metasys EA servers and workstations. These are located at the Central Control Offices, 510 Main Street, Winnipeg, Manitoba.

1.2   Control Systems Description

.1   The Building Management System (BMS) shall be a complete system designed for use with the enterprise IT systems in place at the City of Winnipeg. This functionality shall extend into the equipment rooms. Devices residing on the automation network located in equipment rooms and similar shall be fully IT compatible devices that mount and communicate directly on the IT infrastructure in the facility. Contractor shall be responsible for coordination with the City's IT staff to ensure that the FMS will perform in the City's environment without disruption to any of the other activities taking place on that LAN.

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

.3   Where necessary and as dictated elsewhere in these Specifications, the City of Winnipeg's existing ADX Server shall be used for the purpose of providing a location for extensive archiving of system configuration data, and historical data such as trend data and operator transactions.

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

.5   The BMS work shall consist of the provision of all labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces,

wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, cleaning, cutting and patching, warranties, services, and items, even though these may not be specifically mentioned in these Division documents which are required for the complete, fully functional and commissioned BMS.

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

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

.8   The Controls System as provided shall comprise, at a minimum, the following primary elements:

    1.   NAE/NCE Web server(s), or integrate-able into existing.

    2.   Network and application nodes.

    3.   Field devices.

    4.   Control wiring.

1.3   Quality Assurance

.1   General

    1.   The following companies are approved Controls Contractors:
        .1 Johnson Controls Branch Office

.2   Workplace Safety And Hazardous Materials

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

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

    3.   The Contractor and its employees and subtrades comply with federal, provincial and local safety regulations.

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

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

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

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

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

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

1.4   Submittals

.1   Shop Drawings, Product Data, and Samples

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

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

3.   Allow 15 working days for the review of each package by the Contract Administrator in the scheduling of the total BMS work.

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

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

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

7.   At a minimum, submit the following (as required):
.1   BMS network architecture diagrams including all nodes and interconnections.
.2   Systems schematics, sequences and flow diagrams.
.3   Points schedule for each point in the BMS, including: Point Type, Object Name, Expanded ID, Display Units, Controller type, and Address.
.4   Detailed Bill of Material list for each system or application, identifying quantities, part numbers, descriptions, and optional features.
.5   Details of all BMS interfaces and connections to the work of other trades.
.6   Product data sheets or marked catalog pages including part number, photo and description for all products including software.

1.8   Record Documentation

.1   Operation and Maintenance Manuals

1.   Three (3) copies of the Operation and Maintenance Manuals shall be provided to the City's Representative upon completion of the project. The entire Operation and Maintenance Manual shall be furnished on Compact Disc media, and include the following for the BMS provided:
.1   Table of contents.
.2   As-built system record drawings. Computer Aided Drawings (CAD) record drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.

.3   Manufacturers product data sheets or catalog pages for all products including software.
.4   System Operator's manuals.
.5   Archive copy of all site-specific databases and sequences.
.6   BMS network diagrams.
.7   Interfaces to all third-party products and work by other trades.

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

1.9   Warranty

.1   Standard Material and Labor Warranty:

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

2.   If within twelve (12) months from the date of acceptance of product, upon written notice from the City, it is found to be defective in operation, workmanship or materials, it shall be replaced, repaired or adjusted at the option of the BMS Contractor at the cost of the BMS Contractor.

2.   Part 2 – Products

2.1   Control System Architecture

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

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

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

.4   Acceptable Manufacturers

1.   Johnson Controls Metasys Extended Architecture

2.2   BMS Architecture

.1   Automation Network

1.   The automation network shall be based on a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard "off the shelf" products available through normal PC vendor channels.

2. The BMS shall network multiple user interface clients, automation engines, system controllers and application-specific controllers. Provide application and data server(s) as required for systems operation.

3. The automation network shall be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication.

4. Network Automation Engines (NAE) and Network Control Engines (NCE) shall reside on the automation network.

5. The automation network will be compatible with other enterprise-wide networks. Where indicated, the automation network shall be connected to the enterprise network and share resources with it by way of standard networking devices and practices.

6. The City shall provide all private and public telephones lines, ISDN lines and Internet Service Provider services and connections as necessary for the Contractor to complete the work as contracted at the City's direct cost. The Contractor shall identify the specific requirements in their shop drawing submittal.

.2 Control Network

1. NAE(s) and NCE(s) shall provide supervisory control over the control network and shall support all three (3) of the following communication protocols:

     .1 BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9.
     .2 LonWorks enabled devices using the Free Topology Transceiver (FTT-10a).
     .3 The Johnson Controls N2 Field Bus.

2. Control networks shall provide either "Peer-to-Peer," Master-Slave, or Supervised Token Passing communications, and shall operate at a minimum communication speed of 9600 baud.

3. DDC Controllers shall reside on the control network.

4. Control network communication protocol shall be BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, or Johnson Controls N2 Field Bus.

5. A BACnet Protocol Implementation Conformance Statement shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.

.3 Integration (if required)

1. Hardwired

     .1 Analog and digital signal values shall be passed from one system to another via hardwired connections.
     .2 There will be one separate physical point on each system for each point to be integrated between the systems.

2. Direct Protocol (Integrator Panel)

     .1 The BMS system shall include appropriate hardware equipment and software to allow bi-directional data communications between the BMS system and 3rd party manufacturers' control panels. The BMS shall receive, react to, and return information from multiple building systems, including but not limited to the chillers, boilers, variable frequency drives, power monitoring system, and medical gas.
     .2 All data required by the application shall be mapped into the Automation Engine's database, and shall be transparent to the operator.

.3   Point inputs and outputs from the third-party controllers shall have real-time interoperability with BMS software features such as: Control Software, Energy Management, Custom Process Programming, Alarm Management, Historical Data and Trend Analysis, Totalization, and Local Area Network Communications.

3.   BACnet Protocol Integration - BACnet

.1   The neutral protocol used between systems will be BACnet over Ethernet and comply with the ASHRAE BACnet standard 135-2003.

.2   A complete Protocol Implementation Conformance Statement (PICS) shall be provided for all BACnet system devices.

.3   The ability to command, share point object data, change of state (COS) data and schedules between the host and BACnet systems shall be provided.

2.3   User Interface

.1   Dedicated Web Based User Interface

1.   Where indicated on plans, the BMS Contractor shall provide and install a personal computer for command entry, information management, network alarm management, and database management functions. All real-time control functions, including scheduling, history collection and alarming, shall be resident in the BMS Network Automation Engines to facilitate greater fault tolerance and reliability.

2.   Dedicated User Interface Architecture – The architecture of the computer shall be implemented to conform to industry standards, so that it can accommodate applications provided by the BMS Contractor and by other third party applications suppliers, including but not limited to Microsoft Office Applications. Specifically it must be implemented to conform to the following interface standards.

.1   Microsoft Internet Explorer for user interface functions

.2   Microsoft Office Professional for creation, modification and maintenance of reports, sequences other necessary building management functions

.3   Microsoft Outlook or other e-mail program for supplemental alarm functionality and communication of system events, and reports

.4   Required network operating system for exchange of data and network functions such as printing of reports, trends and specific system summaries.

3.   PC Hardware – The personal computer(s) shall be configured as follows:

.1   Memory – 1 GB (512 MB Minimum)

.2   CPU– Pentium 4 processor. 2.8 Hz Clock Speed (2.0 GHz minimum)

.3   Hard Drive – 80 GB free hard drive space (40GB minimum)

.4   Hard drive backup system – CD/RW, DVD/RW or network backup software provided by IT department

.5   CD ROM Drive – 32X performance

.6   Ports – (2) Serial and (1) parallel, (2) USB ports

.7   Keyboard – 101 Keyboard and 2 Button Mouse

.8   CRT configuration – 1-2 CRTs as follows:

.1 Each Display – 17" Flat Panel Monitor 1280 x 1024 resolution minimum.

.2 16 bit or higher color resolution

.3 Display card with multiple monitor support

.9   LAN communications – Ethernet communications board; 3Comm or equal.

4.   Operating System Software

.1   Windows

       .2   Where user interface is not provided via browser, provide complete operator workstation software package, including any hardware or software keys. Include the original installation disks and licenses for all included software, device drivers, and peripherals.

       .3   Provide software registration cards to the City for all included software.

   5.   Peripheral Hardware

       .1   Reports printer:
          .1   Printer Make – Hewlett Packard DeskJet
          .2   Print Speed – 600 DPI Black, 300 DPI Color
          .3   Buffer – 64 K Input Print Buffer
          .4   Color Printing – Include Color Kit

.2   Distributed Web Based User Interface

   1.   All features and functions of the dedicated user interface previously defined in this document shall be available on any computer connected directly or via a wide area or virtual private network (WAN/VPN) to the automation network and conforming to the following specifications.

   2.   The software shall run on any major browser.

   3.   Minimum hardware requirements:

       .1   256 MB RAM
       .2   2.0 GHz Clock Speed Pentium 4 Microprocessor.
       .3   40.0 GB Hard Drive.
       .4   1 Keyboard with 83 keys (minimum).
       .5   SVGA 1024x768 resolution display with 64K colors and 16 bit color depth.
       .6   Mouse or other pointing device

.3   User Interface Application Components

   1.   Operator Interface

       .1   An integrated browser based client application shall be used as the user operator interface program.

       .2   All Inputs, Outputs, Setpoints, and all other parameters as defined within Part 3, shown on the design drawings, or required as part of the system software, shall be displayed for operator viewing and modification from the operator interface software.

       .3   The user interface software shall provide help menus and instructions for each operation and/or application.

       .4   All controller software operating parameters shall be displayed for the operator to view/modify from the user interface. These include: setpoints, alarm limits, time delays, PID tuning constants, run-times, point statistics, schedules, and so forth.

       .5   The Operator Interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:
          .1   User access for selective information retrieval and control command execution
          .2   Monitoring and reporting
          .3   Alarm, non-normal, and return to normal condition annunciation
          .4   Selective operator override and other control actions
          .5   Information archiving, manipulation, formatting, display and reporting
          .6   FMS internal performance supervision and diagnostics
          .7   On-line access to user HELP menus
          .8   On-line access to current FMS as-built records and documentation

    .9   Means for the controlled re-programming, re-configuration of FMS operation and for the manipulation of FMS database information in compliance with the prevailing codes, approvals and regulations for individual FMS applications.

  .6   The operation of the control system shall be independent of the user interface, which shall be used for operator communications only. Systems that rely on an operator workstation to provide supervisory control over controller execution of the sequences of operations or system communications shall not be acceptable.

2.   Navigation Trees

  .1   The system will have the capability to display multiple navigation trees that will aid the operator in navigating throughout all systems and points connected. At minimum provide a tree that identifies all systems on the networks.

  .2   Provide the ability for the operator to add custom trees. The operator will be able to define any logical grouping of systems or points and arrange them on the tree in any order. It shall be possible to nest groups within other groups. Provide at minimum 5 levels of nesting.

  .3   The navigation trees shall be "dockable" to other displays in the user interface such as graphics. This means that the trees will appear as part of the display, but can be detached and then minimized to the Windows task bar or closed altogether. A simple keystroke will reattach the navigation to the primary display of the user interface.

3.   Alarms

  .1   Alarms shall be routed directly from Network Automation Engines to PCs and servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the user interface shall, at the minimum, provide the following functions:

    .1   Log date and time of alarm occurrence.

    .2   Generate a "Pop-Up" window, with audible alarm, informing a user that an alarm has been received.

    .3   Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.

    .4   Provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the user, the alarm, the action taken on the alarm, and a time/date stamp.

    .5   Provide the ability to direct alarms to an e-mail address or alphanumeric pager. This must be provided in addition to the pop up window described above. Systems that use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.

    .6   Any attribute of any object in the system may be designated to report an alarm.

  .2   The FMS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions

  .3   The FMS shall annunciate application alarms at minimum, as required by Part 3.

4.   Reports and Summaries

  .1   Reports and Summaries shall be generated and directed to the user interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall provide the following reports:

  .1 All points in the BMS

  .2 All points in each BMS application

  .3 All points in a specific controller

  .4 All points in a user-defined group of points

  .5 All points currently in alarm

  .6 All points locked out

  .7 All BMS schedules

  .8 All user defined and adjustable variables, schedules, interlocks and the like.

.2 Summaries and Reports shall be accessible via standard UI functions and not dependent upon custom programming or user defined HTML pages.

.3 Selection of a single menu item, tool bar item, or tool bar button shall print any displayed report or summary on the system printer for use as a building management and diagnostics tool.

.4 The system shall allow for the creation of custom reports and queries via a standard web services XML interface and commercial off-the-shelf software such as Microsoft Access, Microsoft Excel, or Crystal Reports.

5. Schedules

.1 A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:

  .1 Weekly schedules

  .2 Exception Schedules

  .3 Monthly calendars.

.2 Weekly schedules shall be provided for each group of equipment with a specific time use schedule.

.3 It shall be possible to define one or more exception schedules for each schedule including references to calendars

.4 Monthly calendars shall be provided that allow for simplified scheduling of holidays and special days for a minimum of five years in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the exception schedules.

.5 Changes to schedules made from the User Interface shall directly modify the Network Automation Engine schedule database.

.6 Schedules and Calendars shall comply with ASHRAE SP135/2003 BACnet Standard.

.7 Selection of a single menu item or tool bar button shall print any displayed schedule on the system printer for use as a building management and diagnostics tool.

6. Password

.1 Multiple-level password access protection shall be provided to allow the user/manager to user interface control, display, and database manipulation capabilities deemed appropriate for each user, based on an assigned password.

.2 Each user shall have the following: a user name (24 characters minimum), a password (12 characters minimum), and access levels.

.3 The system shall allow each user to change his or her password at will.

.4 When entering or editing passwords, the system shall not echo the actual characters for display on the monitor.

.5   A minimum of five levels of access shall be supported individually or in any combination as follows:
    .1   Level 1 = View Data
    .2   Level 2 = Command
    .3   Level 3 = Operator Overrides
    .4   Level 4 = Database Modification
    .5   Level 5 = Database Configuration
    .6   Level 6 = All privileges, including Password Add/Modify
.6   A minimum of 100 unique passwords shall be supported.
.7   Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on.
.8   The system shall automatically generate a report of log-on/log-off and system activity for each user. Any action that results in a change in the operation or configuration of the control system shall be recorded, including: modification of point values, schedules or history collection parameters, and all changes to the alarm management system, including the acknowledgment and deletion of alarms.

7.   Screen Manager - The User Interface shall be provided with screen management capabilities that allow the user to activate, close, and simultaneously manipulate a minimum of 4 active display windows plus a network or user defined navigation tree.

8.   Dynamic Color Graphics

.1   The graphics application program shall be supplied as an integral part of the User Interface. Browser or Workstation applications that rely only upon HTML pages shall not be acceptable.
.2   The graphics applications shall include a create/edit function and a runtime function. The system architecture shall support an unlimited number of graphics documents (graphic definition files) to be generated and executed. The graphics shall be able to display and provide animation based on real-time data that is acquired, derived, or entered.
.3   Graphics runtime functions – A maximum of 16 graphic applications shall be able to execute at any one time on a user interface or workstation with 4 visible to the user. Each graphic application shall be capable of the following functions:
    .1   All graphics shall be fully scalable
    .2   The graphics shall support a maintained aspect ratio.
    .3   Multiple fonts shall be supported.
    .4   Unique background shall be assignable on a per graphic basis.
    .5   The color of all animations and values on displays shall indicate if the status of the object attribute.
.4   Operation from graphics – It shall be possible to change values (setpoints) and states in system controlled equipment by using drop-down windows accessible via the pointing device
.5   Graphic editing tool – A graphic editing tool shall be provided that allows for the creation and editing of graphic files. The graphic editor shall be capable of performing/defining all animations, and defining all runtime binding.
    .1   The graphic editing tool shall in general provide for the creation and positioning of point objects by dragging from tool bars or drop-downs and positioning where required.

.2   In addition, the graphic editing tool shall be able to add additional content to any graphic by importing backgrounds in the SVG, BMP or JPG file formats.

.6   Aliasing – Many graphic displays representing part of a building and various building components are exact duplicates, with the exception that the various variables are bound to different field values. Consequently, it shall be possible to bind the value of a graphic display to aliases, as opposed to the physical field tags.

9.   Historical trending and data collection

.1   Each Automation Engine shall store trend and point history data for all analog and digital inputs and outputs, as follows:

.1   Any point, physical or calculated, may be designated for trending. Three methods of collection shall be allowed:

Defined time interval

Upon a change of value

.2   Each Automation Engine shall have the capability to store multiple samples for each physical point and software variable based upon available memory, including an individual sample time/date stamp. Points may be assigned to multiple history trends with different collection parameters.

10.   Trend data viewing and analysis

.1   Provide a trend viewing utility that shall have access to all database points.

.2   It shall be possible to retrieve any historical database point for use in displays and reports by specifying the point name and associated trend name.

.3   The trend viewing utility shall have the capability to define trend study displays to include multiple trends

.4   Displays shall be able to be single or stacked graphs with on-line selectable display characteristics, such as ranging, color, and plot style.

.5   Display magnitude and units shall both be selectable by the operator at any time without reconfiguring the processing or collection of data. This is a zoom capability.

.6   Display magnitude shall automatically be scaled to show full graphic resolution of the data being displayed.

.7   Trend studies shall be capable of calculating and displaying calculated variables including highest value, lowest value and time based accumulation.

2.4   Network Automation Engines (NAE)

.1   Network Automation Engine (**NAEXX**)

1.   The Network Automation Engine (NAE) shall be a fully user-programmable, supervisory controller. The NAE shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.

2.   Automation network – The NAE shall reside on the automation network and shall support a subnet of system controllers.

3.   User Interface – Each NAE shall have the ability to deliver a web based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.

.1   The web based UI software shall be imbedded in the NAE. Systems that require a local copy of the system database on the user's personal computer are not acceptable.

.2   The NAE shall support up four (4) concurrent users.

.3   The web based user shall have the capability to access all system data through one NAE.

.4   Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one NAE.

.5   Systems that require the user to address more than one NAE to access all system information are not acceptable.

.6   The NAE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NAE.

.7   Systems that support UI Graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.

.8   The web based UI shall support the following functions using a standard web browser:
   .1   Configuration
   .2   Commissioning
   .3   Data Archiving
   .4   Monitoring
   .5   Commanding
   .6   System Diagnostics

.9   Systems that require workstation software or modified web browsers are not acceptable.

.10   The NAE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.

4.   Processor – The NAE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NAE size and capability shall be sufficient to fully meet the requirements of this Specification.

5.   Memory – Each NAE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.

6.   Hardware Real Time Clock – The NAE shall include an integrated, hardware-based, real-time clock.

7.   The NAE shall include troubleshooting LED indicators to identify the following conditions:
   .1   Power - On/Off
   .2   Ethernet Traffic – Ethernet Traffic/No Ethernet Traffic
   .3   Ethernet Connection Speed – 10 Mbps/100 Mbps
   .4   FC Bus – Normal Communications/No Field Communications
   .5   Peer Communication – Data Traffic between NAE Devices
   .6   Run – NAE Running/NAE in Startup/NAE Shutting Down/Software Not Running
   .7   Bat Fault – Battery Defective, Data Protection Battery Not Installed
   .8   Fault – General Fault
   .9   Modem RX – NAE Modem Receiving Data
   .10   Modem TX – NAE Modem Transmitting Data

8. Communications Ports – The NAE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator's terminals.

    .1 Up to two (2) USB port
    .2 Up to two (2) URS-232 serial data communication port
    .3 Up to two (2) RS-485 port
    .4 One (1) Ethernet port

9. Diagnostics – The NAE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Automation Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.

10. Power Failure – In the event of the loss of normal power, The NAE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.

    .1 During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.
    .2 Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.

11. Certification – The NAE shall be listed by Underwriters Laboratories (UL).

12. Controller network – The NAE shall support the following communication protocols on the controller network:

    .1 The NAE shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
        .1 A BACnet Protocol Implementation Conformance Statement shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.
        .2 The Conformance Statements shall be submitted 10 day prior to bidding.
        .3 The NAE shall support a minimum of 100 control devices.
    .2 The NAE shall support LonWorks enabled devices using the Free Topology Transceiver FTT10.
        .1 All LonWorks controls devices shall be LonMark certified.
        .2 The NAE shall support a minimum of 255 LonWorks enabled control devices.
    .3 The NAE shall support the Johnson Controls N2 Field Bus.
        .1 The NAE shall support a minimum of 100 N2 control devices.
        .2 The Bus shall conform to Electronic Industry Alliance (EIA) Standard RS-485.
        .3 The Bus shall employ a master/slave protocol where the NAE is the master.
        .4 The Bus shall employ a four (4) level priority system for polling frequency.
        .5 The Bus shall be optically isolated from the NAE.
        .6 The Bus shall support the Metasys Integrator System.

2.5   Network Control Engine (NCE 25XX)

1. The Network Control Engine (NCE) shall be a fully user-programmable, supervisory controller. The NCE shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.

2. The Network Control Engine (NCE) shall be a fully user-programmable, digital controller that includes a minimum of 33 I/O points.

3. Automation Network – The NCE shall reside on the automation network and shall support a subnet of 32 Field controllers.

4. User Interface – Each NCE shall have the ability to deliver a web based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.

    .1 The web based UI software shall be imbedded in the NCE. Systems that require a local copy of the system database on the user's personal computer are not acceptable.

    .2 The NCE shall support a minimum of two (2) concurrent users.

    .3 The NCE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NCE.

    .4 Systems that support UI Graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.

    .5 The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer:

        .1 Configuration
        .2 Commissioning
        .3 Data Archiving
        .4 Monitoring
        .5 Commanding
        .6 System Diagnostics

    .6 Systems that require workstation software or modified web browsers are not acceptable.

    .7 The NCE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.

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

6. The NCE shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.

7. The NCE shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.

8. The NCE shall support the following number and types of inputs and outputs:

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

        .1 Analog Input, Voltage Mode
        .2 Analog Input, Current Mode
        .3 Analog Input, Resistive Mode
        .4 Binary Input, Dry Contact Maintained Mode
        .5 Binary Input, Pulse Counter Mode

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

        .1   Dry Contact Maintained Mode

        .2   Pulse Counter Mode

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

        .1   Analog Output, Voltage Mode

        .2   Analog Output, Current Mode

    .4   Seven Binary Outputs - shall output the following:

        .1   24 VAC Triac

    .5   Four Configurable Outputs - shall be configured to output either of the following:

        .1   Analog Output, Voltage Mode

        .2   Binary Output, 24 VAC Triac Mode

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

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

    .2   The SA Bus shall support a minimum of 10 devices.

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

10.   The NCE shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the Field Trunk or the SA Bus.

11.   The NCE shall support, but not be limited to, the following applications:

    .1   Central Equipment including chillers and boilers

    .2   Lighting and electrical distribution

    .3   Built-up air handling units for special applications

    .4   Power generation and energy monitoring equipment

    .5   Interfaces to security and fire detection systems

12.   The NCE shall support a Local Controller Display (DIS1710) either as an integral part of the NCE or as a remote device communicating over the SA Bus.

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

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

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

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

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

        .1   Input/Output

        .2   Parameter/Setpoint

        .3   Overrides

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

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

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

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

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

.11   The Display shall be panel mountable.

13.   The NCE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NCE size and capability shall be sufficient to fully meet the requirements of this Specification.

14.   The NCE shall employ an industrial single board computer.

15.   Each NCE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.

16.   The NCE shall include an integrated, hardware-based, real-time clock.

17.   The NCE shall employ nonvolatile Flash memory to store all programs and data. The NCE shall employ a data protection battery to save data and power the real time clock when primary power is interrupted.

18.   The NCE shall provide removable, color coded, screw terminal blocks for 24 VAC power, communication bus and I/O point field wiring.

19.   The NCE shall include troubleshooting LED indicators to identify the following conditions:
   .1   Power
   .2   Fault
   .3   SA Bus
   .4   FC Bus
   .5   Modem TX
   .6   Modem RX
   .7   Battery Fault
   .8   Ethernet
   .9   10 LNK
   .10   100 LNK
   .11   Run
   .12   Peer Com

20.   Communications Ports – The NCE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator's terminals.
   .1   USB port
   .2   RS-232 serial data communication port
   .3   RS-485 port
   .4   RJ-45 Ethernet port
   .5   RJ-12 jack

21.   The NCE shall support an optional internal modem with RJ-12 6-pin telephone line connector.

22.   Diagnostics – The NCE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Control Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.

23.   Power Failure – In the event of the loss of normal power, The NCE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.

    .1 During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.

    .2 Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.

  24. Certification – The NCE shall be listed by Underwriters Laboratories (UL).File E107041, CCN PAZX, UL 916, Energy Management Equipment. FCC Compliant to CFR47, Part 15, Subpart B, Class A

  25. Field Controller Bus – The NCE shall support the following communication protocols on the Field Controller Bus:

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

      .1 The NCE shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.

      .2 The NAE shall be tested and certified as a BACnet Building Controller (B-BC).

      .3 A BACnet Protocol Implementation Conformance Statement shall be provided for the NCE.

      .4 The Conformance Statements shall be submitted 10 days prior to bidding.

      .5 The NCE shall support a minimum of 32 control devices.

    .2 The NCE shall support LonWorks enabled devices using the Free Topology Transceiver FTT10 on the Field Controller Bus (LonWorks Network).

      .1 All LonWorks controls devices shall be LonMark certified.

      .2 The NCE shall support a minimum of 32 LonWorks enabled control devices.

    .3 The NCE shall support the N2 devices on the Field Controller Bus (Johnson Controls N2 Bus).

      .1 The NCE shall support a minimum of 32 N2 control devices.

      .2 The Bus shall conform to Electronic Industry Alliance (EIA) Standard RS-485.

      .3 The Bus shall employ a master/slave protocol where the NCE is the master.

      .4 The Bus shall employ a four (4) level priority system for polling frequency.

      .5 The Bus shall be optically isolated from the NCE.

      .6 The Bus shall support the Metasys Integrator System.

2.6 BACnet DDC System Controllers

  .1 Field Equipment Controller (**FEC**)

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

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

    3. Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts

loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.

4. The FEC shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.

5. The FEC shall include a removable base to allow pre-wiring without the controller.

6. The FEC shall include troubleshooting LED indicators to identify the following conditions:

    .1   Power On
    .2   Power Off
    .3   Download or Startup in progress, not ready for normal operation
    .4   No Faults
    .5   Device Fault
    .6   Field Controller Bus - Normal Data Transmission
    .7   Field Controller Bus - No Data Transmission
    .8   Field Controller Bus - No Communication
    .9   Sensor-Actuator Bus - Normal Data Transmission
    .10   Sensor-Actuator Bus - No Data Transmission
    .11   Sensor-Actuator Bus - No Communication

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

8. The FEC shall support the following types of inputs and outputs:

    .1   Universal Inputs - shall be configured to monitor any of the following:
          .1   Analog Input, Voltage Mode
          .2   Analog Input, Current Mode
          .3   Analog Input, Resistive Mode
          .4   Binary Input, Dry Contact Maintained Mode
          .5   Binary Input, Pulse Counter Mode
    .2   Binary Inputs - shall be configured to monitor either of the following:
          .1   Dry Contact Maintained Mode
          .2   Pulse Counter Mode
    .3   Analog Outputs - shall be configured to output either of the following
          .1   Analog Output, Voltage Mode
          .2   Analog Output, current Mode
    .4   Binary Outputs - shall output the following:
          .1   24 VAC Triac
    .5   Configurable Outputs - shall be capable of the following:
          .1   Analog Output, Voltage Mode
          .2   Binary Output Mode

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

    .1   The FC Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.
    .2   The FC Bus shall support communications between the FECs and the NAE.
    .3   The FC Bus shall also support Input/Output Module (IOM) communications with the FEC and with the NAE.
    .4   The FC Bus shall support a minimum of 100 IOMs and FEC in any combination.
    .5   The FC Bus shall operate at a maximum distance of 15,000 Ft. between the FEC and the furthest connected device.

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

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

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

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

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

12. The FEC shall support, but not be limited to, the following:

    .1 Special programs as required for systems control

2.7 Field Devices

.1 Input/Output Module **(IOM)**

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

2. The IOM shall communicate with the FEC over either the FC Bus or the SA Bus using BACnet Standard protocol SSPC-135, Clause 9.

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

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

5. The IOM shall support the following types of inputs and outputs:

    .1 Universal Inputs - shall be configured to monitor any of the following:
        .1 Analog Input, Voltage Mode
        .2 Analog Input, Current Mode
        .3 Analog Input, Resistive Mode
        .4 Binary Input, Dry Contact Maintained Mode
        .5 Binary Input, Pulse Counter Mode

    .2 Binary Inputs - shall be configured to monitor either of the following:
        .1 Dry Contact Maintained Mode
        .2 Pulse Counter Mode

    .3 Analog Outputs - shall be configured to output either of the following
        .1 Analog Output, Voltage Mode
        .2 Analog Output, current Mode

    .4 Binary Outputs - shall output the following:
        .1 24 VAC Triac

    .5 Configurable Outputs - shall be capable of the following:
        .1 Analog Output, Voltage Mode
        .2 Binary Output Mode

6. The IOM shall include troubleshooting LED indicators to identify the following conditions:

    .1 Power On
    .2 Power Off
    .3 Download or Startup in progress, not ready for normal operation
    .4 No Faults
    .5 Device Fault
    .6 Normal Data Transmission

.7   No Data Transmission

.8   No Communication

2.8   Input Devices

.1   General Requirements

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

.2   Flow Monitoring

1.   Air Flow Monitoring

.1   Fan Inlet Air Flow Measuring Stations

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

.2   Each traverse probe shall be of a dual manifolded, cylindrical, type 3003 extruded aluminum configuration, having an anodized finish to eliminate surface pitting and unnecessary air friction. The multiple total pressure manifold shall have sensors located along the stagnation plane of the approaching airflow. The manifold should not have forward projecting sensors into the air stream. The static pressure manifold shall incorporate dual offset static tops on the opposing sides of the averaging manifold so as to be insensitive to flow-angle variations of as much as $\pm\,20°$ in the approaching air stream.

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

.4   Airflow measuring stations shall be manufactured by Air Monitor Corp., Tek-Air Systems, Inc., Ebtron, or Dietrich Standard.

.2   Single Probe Air Flow Measuring Sensor

.1   The single probe airflow-measuring sensor shall be duct mounted with an adjustable sensor insertion length of up to eight inches. The transmitter shall produce a 4-20 mA or 0-10 VDC signal linear to air velocity. The sensor shall be a hot wire anemometer and utilize two temperature sensors and a heater element temperature. The other sensor shall measure the downstream air temperature. The temperature differential shall be directly related to airflow velocity.

.3   Duct Air Flow Measuring Stations

.1   Each device shall be designed and built to comply with, and provide results in accordance with, accepted practice as defined for system testing in the ASHRAE Handbook of fundamentals, as well as in the Industrial Ventilation Handbook.

.2   Airflow measuring stations shall be fabricated of 14-gauge galvanized steel welded casing with 90 Deg. connecting flanges in configuration and size equal to that of the duct into which it is mounted. Each station shall be complete with an air directionalizer and parallel cell profile suppressor (3/4" maximum cell) across the entering air stream and mechanically fastened to the casing in such a way to withstand

velocities up to 6000 feet per minute. This air directionalizer and parallel cell honeycomb suppressor shall provide 98% free area, equalize the velocity profile, and eliminate turbulent and rotational flow from the air stream prior to the measuring point.

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

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

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

.6   Total and static pressure manifolds shall terminate with external ports for connection to control tubing. An identification label shall be placed on each unit casing, listing model number, size, area, and specified airflow capacity.

.7   Installation Considerations

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

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

(iii)   Where the stations are installed in insulated ducts, the airflow passage of the station shall be the same size as the inside airflow dimension of the duct. Station flanges shall be two inch to three inch to facilitate matching connecting ductwork.

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

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

.8   Acceptable manufacturers: Air Monitor Corp., Tek-Air, Ebtron, and Dietrich Standard.

.4   Static Pressure Traverse Probe

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

.2   Acceptable manufacturers: Cleveland Controls

.5   Shielded Static Air Probe

.1   A shielded static pressure probe shall be provided at each end of the building. The probe shall have multiple sensing ports, an impulse

suppression chamber, and airflow shielding. A suitable probe for indoor and outdoor locations shall be provided.

.3   Power Monitoring Devices

    1.   Current Measurement (Amps)

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

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

           .1   Operating frequency – 50 - 400 Hz.
           .2   Insulation – 0.6 Kv class 10Kv BIL.
           .3   UL recognized.
           .4   Five amp secondary.
           .5   Select current ration as appropriate for application.
           .6   Acceptable manufacturers: Veris Industries

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

           .1   6X input over amp rating for AC inrushes of up to 120 amps.
           .2   Manufactured to UL 1244.
           .3   Accuracy: +.5%, Ripple +1%.
           .4   Minimum load resistance 30kOhm.
           .5   Input 0-20 Amps.
           .6   Output 4-20 mA.
           .7   Transducer shall be powered by a 24VDC regulated power supply (24 VDC +5%).
           .8   Acceptable manufacturers: Veris Industries

.4   Smoke Detectors

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

.5   Status and Safety Switches

    1.   General Requirements

        .1   Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.

    2.   Current Sensing Switches

        .1   The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.

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

        .3   Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.

.4   Acceptable manufacturers: Veris Industries

3.   Air Flow Switches

.1   Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.

.2   Acceptable manufacturers: Johnson Controls, Cleveland Controls

2.9   Output Devices

.1   Control Relays

1.   Control Pilot Relays

.1   Control pilot relays shall be of a modular plug-in design with retaining springs or clips.
.2   Mounting Bases shall be snap-mount.
.3   DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.
.4   Contacts shall be rated for 10 amps at 120VAC.
.5   Relays shall have an integral indicator light and check button.
.6   Acceptable manufacturers: Johnson Controls, Lectro

2.   Lighting Control Relays

.1   Lighting control relays shall be latching with integral status contacts.
.2   Contacts shall be rated for 20 amps at 277 VAC.
.3   The coil shall be a split low-voltage coil that moves the line voltage contact armature to the ON or OFF latched position.
.4   Lighting control relays shall be controlled by:
      .1   Pulsed Tri-state Output – Preferred method.
      .2   Pulsed Paired Binary Outputs.
      .3   A Binary Input to the Facility Management System shall monitor integral status contacts on the lighting control relay. Relay status contacts shall be of the "dry-contact" type.
.5   The relay shall be designed so that power outages do not result in a change-of-state, and so that multiple same state commands will simply maintain the commanded state. Example: Multiple OFF command pulses shall simply keep the contacts in the OFF position.

2.10   Miscellaneous Devices

.1   Thermostats

1.   Electric room thermostats of the heavy-duty type shall be provided for ventilation fans. All these items shall be provided with concealed adjustment. Finish of covers for all room-type instruments shall match and, unless otherwise indicated or specified, covers shall be manufacturer's standard finish.

3.   Part 3 – Performance / Execution

3.1   BMS Specific Requirements

.1   Graphic Displays

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

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

.2 Custom Reports:

1. Provide custom reports as required for this project:

3.2   Installation Practices

.1 BMS Wiring

1. All conduit, wiring, accessories and wiring connections required for the installation of the Building Management System, as herein specified, shall be provided by the BMS Contractor unless specifically shown on the Electrical Drawings under Division 16 Electrical. All wiring shall comply with the requirements of applicable portions of Division 16 and all local and national electric codes, unless specified otherwise in this section.

2. All BMS wiring materials and installation methods shall comply with BMS manufacturer recommendations.

3. The sizing, type and provision of cable, conduit, cable trays, and raceways shall be the design responsibility of the BMS Contractor. If complications arise, however, due to the incorrect selection of cable, cable trays, raceways and/or conduit by the BMS Contractor, the Contractor shall be responsible for all costs incurred in replacing the selected components.

4. Class 2 Wiring

    .1 All Class 2 (24VAC or less) wiring shall be installed in conduit unless otherwise specified.
    .2 Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5' from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements.

5. Class 2 signal wiring and 24VAC power can be run in the same conduit. Power wiring 120VAC and greater cannot share the same conduit with Class 2 signal wiring.

6. Provide for complete grounding of all applicable signal and communications cables, panels and equipment so as to ensure system integrity of operation. Ground cabling and conduit at the panel terminations. Avoid grounding loops.

.2 BMS Line Voltage Power Source

1. 120-volt AC circuits used for the Building Management System shall be taken from panel boards and circuit breakers provided by Division 16.

2. Circuits used for the BMS shall be dedicated to the BMS and shall not be used for any other purposes.

3. DDC terminal unit controllers may use AC power from motor power circuits.

.3 BMS Raceway

1. All wiring shall be installed in conduit or raceway except as noted elsewhere in this specification. Minimum control wiring conduit size 1/2".

2.   Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Contract Administrator.

3.   All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the surface to which they are attached.

4.   Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls. Flexible Metal Conduit shall be UL listed.

.4   Penetrations

1.   Provide fire stopping for all penetrations used by dedicated BMS conduits and raceways.

2.   All openings in fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.

3.   All wiring passing through penetrations, including walls shall be in conduit or enclosed raceway.

4.   Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true, and square.

.5   BMS Identification Standards

1.   Node Identification. All nodes shall be identified by a permanent label fastened to the enclosure. Labels shall be suitable for the node location.

        Cable types specified in Item A shall be color coded for easy identification and troubleshooting.

.6   BMS Panel Installation

1.   The BMS panels and cabinets shall be located in the mechanical building at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer's recommendations.

2.   The BMS contractor shall be responsible for coordinating panel locations with other trades and electrical and mechanical contractors.

.7   Input Devices

1.   All Input devices shall be installed per the manufacturer recommendation

2.   Locate components of the BMS in accessible, but vandal proof, local control panels wherever possible.

.8   HVAC Input Devices – General

1.   All Input devices shall be installed per the manufacturer recommendation

2.   Locate components of the BMS in accessible, but vandal proof, local control panels wherever possible.

3.   The mechanical contractor shall install all in-line devices such as temperature wells, pressure taps, airflow stations, etc.

4.   Input Flow Measuring Devices shall be installed in strict compliance with ASME guidelines affecting non-standard approach conditions.

5.   Air Flow Measuring Stations:

     .1   Where the stations are installed in insulated ducts, the airflow passage of the station shall be the same size as the inside airflow dimension of the duct.

.2   Station flanges shall be two inch to three inch to facilitate matching
connecting ductwork.

3.3   Training

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

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

3.4   **Commissioning**

.1   Fully commission all aspects of the Building Management System work.

.2   Acceptance Check Sheet

1.   Prepare a check sheet that includes all points for all functions of the BMS as
indicated on the point list included in this specification.

2.   Submit the check sheet to the Contract Administrator for approval

3.   The Contract Administrator will use the check sheet as the basis for acceptance
with the BMS Contractor.

.3   Promptly rectify all listed deficiencies and submit to the Contract Administrator that this
has been done.

END OF SECTION