DIVISION 23 - MECHANICAL
SECTION 23 09 00 - INTEROPERABLE FACILITY MANAGEMENT SYSTEM

PART 1.00   GENERAL

1.01   OVERVIEW

A.   Furnish all labor, materials, equipment, and service necessary for a complete and operating temperature control system, utilizing Direct Digital Controls, electronic interfaces and actuation devices, as shown on the drawings and as described herein. Drawings are diagrammatic only. Equipment and labor not specifically referred to herein or on the plans, that is required to meet the functional intent, shall be provided without additional cost to the Owner. Performance and capabilities are based on Native BACNet approved products.

1.02   INSTALLATION

A.   All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the regular employment of the temperature control system manufacturer or its exclusive factory authorized installing contracting field office (representative). The installing office shall have a minimum of five years of installation experience with the manufacturer and shall provide documentation in submittal package verifying longevity of the installing company's relationship with the manufacturer. Supervision, calibration and checkout of the system shall be by the employees of the local exclusive factory authorized temperature control contracting field office (branch or representative).

1.03   CONTROL WIRING

A.   All electrical control wiring and power wiring to the control panels shall be the responsibility of the FMCS contractor.

B.   The electrical contractor (Div. 26) shall furnish all power wiring to electrical starters and motors.

C.   All wiring shall be in accordance with the Project Electrical Specifications Division 26.

1.04   UNACCEPTABLE BIDS

A.   Bids by wholesalers, dealers or any other firm whose principal business is not that of manufacturing or installing automatic temperature control systems shall not be acceptable. Bid documents that are not complete in their response to these documents or take exception to any of the capabilities defined within these documents will be rejected.

1.05   SHOP DRAWINGS/SUBMITTALS

A.   Eight copies of shop drawings of the entire control system shall be submitted and shall consist of a complete list of equipment and materials, including manufacturers catalog data sheets and installation instructions. Shop drawings shall also contain complete wiring and schematic diagrams, software descriptions, calculations, and any other details required to demonstrate

that the system has been coordinated and will properly function as a system. Terminal identification for all control wiring shall be shown on the shop drawings. A complete written Sequence of Operation as well as a hard copy graphical depiction of the application control programs shall also be included with the submittal package.

B.   Upon completion of the work, provide a complete set of drawings and application software on disk media. Drawings shall be provided as AutoCAD or ViSiO compatible files.

1.06   MATERIALS

A.   All materials and equipment used shall be standard components, of regular manufacture for this application. All systems and components shall have been thoroughly tested and proven in actual use. Products shall be BACNet Testing Lab (BTL) approved for this application. Products manufactured by other companies shall not be considered. Exceptions to the specification will qualify the bid as unacceptable.

1.07   WARRANTY

A.   The temperature contractor shall provide a one-year warranty.

B.   The temperature control contractor's office shall be within a 50-mile radius of the job site.

C.   The contractor shall respond to the job site emergency calls within a reasonable amount of time during normal working hours.

1.08   SOFTWARE LICENSE AGREEMENT

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

1.09   AGENCY AND CODE APPROVALS

A.   All products of the BAS shall be provided with the following agency approvals. With the submittal documents, verification that the approvals exist for all submitted products shall be provided. Systems or products not currently offering the following approvals are not acceptable.
UL-916; Energy Management Systems.
ULC; UL - Canadian Standards Association
FCC, Part 15, Subpart J, Class A Computing Devices

B.   All products shall be labeled with the appropriate approval markings. System installation shall comply with NFPA, NEMA, Local and National codes.

C.   The FMCS manufacturer shall provide documentation supporting compliance with ISO-9001 certification mark from applicable registrar.

PART 2.00   FACILITY MANAGEMENT CONTROL SYSTEM

2.01   GENERAL

A.   The Facility Management Control System (FMCS) shall be comprised of a network of interoperable, stand-alone digital controllers

2.02   SPECIFICATION NOMENCLATURE

A.   FMCS   Facility Management Control System

B.   IDC   Interoperable Digital Controller

C.   IBC   Interoperable BACNet Approved Controller

D.   GDC   Gateway Digital Controller

E.   GP   Graphical Programmer

F.   HMI   Human Machine Interface

G.   GUI   Graphical User Interface

PART 3.00   OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES

3.01   NETWORK

A.   The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system under each internet server. The FMCS requires the incorporation of BACNet Technologies.

3.02   NAC

A.   The Network Area Controller (NAC) shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NAC. It shall be capable of executing application control programs to provide:
        1.   Calendar functions
        2.   Scheduling
        3.   Trending
        4.   Alarm monitoring and routing
        5.   Time synchronization
        6.   Integration of LONWorks controller data and BACNet controller data
        7.   Network Management functions for all LONWorks based devices

B.   The Network Area Controller must provide the following hardware features as a minimum:
        1.   One Ethernet Port - 10Mbps
        2.   One RS-232 port
        3.   One LONWorks Interface Port - 78KB FTT - 10A or one MSTP Port
        4.   Battery Backup

5.   Flash memory for long term data backup (If battery or flash memory is not supplies, the controller must contain a hard disk with at least 1 gigabyte storage capacity)
6.   The NAC must be capable of operation over a temperature range of 0 to 55C
7.   The NAC must be capable of withstanding storage temperatures of between 0 and 70C
8.   The NAC must be capable of operation over a humidity range of 5 to 95% RH, non-condensing
9.   The NAC shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the NAC shall be an ODBC-compliant database or must provide an ODBC data mechanism to read and write data stored within it.
10.   The NAC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 16 simultaneous users.

C.   The NAC shall provide alarm recognition, storage, routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
1.   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.
2.   Provide for the creation of a minimum of eight alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.
3.   Provide timed (schedule) routing of alarms by class, object, group, or node.
4.   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.
5.   Control equipment and network failures shall be treated as alarms and annunciated.
6.   Alarms shall be annunciated in any of the following manners as defined by the user:
7.   Screen message text
8.   Pagers via paging services that initiate a page on receipt of email message
9.   Graphic with flashing alarm object(s)
10.   Printed message, routed directly to a dedicated alarm printer
11.   The following shall be recorded by the NAC for each alarm (at a minimum):
12.   Time and date
13.   Location (building, floor, zone, office number, etc.)
14.   Equipment (air handler#, access way, etc.)
15.   Acknowledgment time, date and user who issued acknowledgment.
16.   Number of occurrences since last acknowledgment.
17.   Alarm actions may be initiated by user defined programmable objects created for that purpose.
18.   Defined users shall be given proper access to acknowledgment any alarm, or specific types or classes of alarms defined by the user.
19.   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.
20.   Provide a "query" feature to allow review of specific alarms by user defined parameters.
21.   A separate log for system alerts (controller failures, network failures, etc.) Shall be provided and available for review by the user.
22.   An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

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

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

    2. Designating the log as interval or deviation.

        a. For interval logs, the object is configured for the time of day, day of week and the sample collection interval.

        b. 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.

    3. 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.

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

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

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

    7. 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

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

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

E. The GUI shall run on Microsoft Windows XP Professional or later.

    1. The GUI shall employ browser-like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu–pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills. These shall include, but are limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.

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

    3. Graphic screens shall be developed using any drawing package capable of generating a GIF, BMP, or JPG file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of a graphical background, the GUI shall support the use of scanned pictures.

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

    5. Graphics shall support layering and each graphic object is configurable for

assignment to one a layer. A minimum of six layers shall be supported.

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

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

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

9. 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.

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

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

12. Create, delete or modify control strategies.

13. Add/delete objects to the system.

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

15. Enable or disable control strategies.

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

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

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

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

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

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

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

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

PART 4.00   WEB BROWSER CLIENTS

4.01   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 standard Web browser) to be resident on the client machine, or manufacture-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 FMCS, shall not be acceptable.

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

D.   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.   Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.
3.   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.
4.   Storage of the graphical screens shall be in the Network Area Controller (NACS), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
5.   Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.
6.   Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
7.   Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
8.   Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
9.   Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
10.   Commands to start and stop binary objects shall be done by right-clicking the selecting the appropriate command from the pop-up menu. No entry of text shall be required.
11.   View logs and charts
12.   View and acknowledge alarms

13. Setup and execute SQL queries on log and archive information
14. 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 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.
15. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

4.02 SYSTEM PROGRAMMING

A. The Graphical User Interface software (GUI) shall provide the ability to perform system programming and graphic display engineering as part of a complete software package. Access to the programming functions and features of the GUI shall be through access as assigned by the system administrator. The GUI shall include graphics generation of all HVAC equipment with values and status displayed. The graphics shall be a graphical representation of each piece of equipment being controlled and shall be recognizable as the piece of equipment it is representing. The graphics shall be submitted to owner and engineer for approval prior to installation.

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

C. 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 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, editing

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.

4.03   NETWORK MANAGEMENT

A.   The Graphical User Interface software (GUI) shall provide a complete set of integrated LONWorks or BACNet network management tools for working with LONWorks or BACNet networks. These tools shall manage a database for all devices by type and revision, and shall provide a software mechanism for identifying each device on the network. These tools shall also be capable of defining network data connections between devices, known as "binding". Systems requiring the use of third party network management tools shall not be accepted.

B.   Network management shall include the following services: device identification, device installation, device configuration, device diagnostics, device maintenance and network variable binding.

C.   The Network configuration tool shall also provide diagnostics to identify devices on the network, to reset devices, and to view health and status counters within devices.

D.   These tools shall provide the ability to "learn" an existing LONWorks or BACNet network, regardless of what network management tool(s) were used to install the existing LONWorks or BACNet devices and newly added devices are part of a single network management database.

E.   The network management database shall be resident in the Network Area Controller (NACS), ensuring that anyone with proper authorization has access to the network management database at all times. Systems employing network management databases that are not resident, at all times, within the control system, shall not be accepted.

4.04   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 and 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 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 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 object library shall include objects to support the integration of devices connected to the Network Area Controller (NACS). At a minimum, provide the following as part of the standard library included with the programming software:

1. LONMark/LONWorks & BACNet devices. These devices shall include, but not be limited to, devices for control of 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 or BACNet 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.

4.05   GRAPHICAL USER INTERFACE COMPUTER HARDWARE (DESKTOP)
Workstation Server Hardware Station: IBM-compatible microcomputer with minimum configuration as follows:

A.   Processor: Intel Pentium IV, 1.2 GHz., or faster.

B.   Random-Access Memory: 4 GB., minimum.

C.   Graphics: Super video graphic adapter (SVGA), minimum 1024 x 768 pixels, 2.0-MB EDO video memory.

D.   Monitor: 21 inches minimum, noninterlaced, color, with maximum 0.28-mm dot pitch.

E.   Keyboard: QWERTY, 105 keys in ergonomic shape.

F.   Hard-Disk Drive: 200.0 GB., minimum.

G.   DVD-RW-ROM Drive: 12x max. variable DVD-ROM with software decoding.

H.   Mouse: Two button.

PART 5.00   INTEROPERABLE CONTROLLERS

5.01   GENERAL

A.   BACNet (IBC) Interoperable Controllers
   1.   Controls shall be microprocessor based Interoperable BACNet Controllers, bearing the applicable BTL logo on each product delivered. IBC shall be provided for AHU's, Fan Coils, VAV Terminal Boxes and other applications as shown on the drawings. IBC's shall be based on ASHRAE – 135 interoperability.
   2.   To simplify controls and mechanical service troubleshooting, the IBC shall be mounted directly in the control compartment of the unitary system. The IBC shall be provided with a sheet metal or polymeric enclosure that is constructed of material allowing for the direct mounting within the primary air stream, as defined by UL-465. The direct mounting shall allow all controls maintenance and troubleshooting to be made while at the unitary equipment.
   3.   The IBC'S shall communicate with the SDC at a baud rate of not less than 78.8K baud. The IBC shall provide LED indication of communication and controller performance to the technician without cover removal.
   4.   The IBC shall be fully supported and communicate with any and all GUI(s) on the bus.

B.   IC Sensor
   1.   The IC Sensor shall connect directly to the IBC and shall not utilize any of the I/O points of the controller. The IC Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive. The IC Sensor shall provide a

communications jack for connection to the communication trunk to which the controller is connected. The IC Sensor, the connected controller, and all other devices on the bus shall be accessible by the Graphical Programming tool.

2.   The IC Sensor shall be supplied in the following variations;
   a.   Tamper-resistant (no display)
   b.   Tamper-resistant with tenant override
   c.   Basic user functions (LCD display and setpoint adjustment and tenant override)
   d.   Full user functions (LCD display and network-variable access and tenant override)
   e.   ASHRAE 95 compliance (LCD display and sub-base functionality)

3.   The IC Sensor shall be provided in a modular configuration that allows for the rough in of all wiring without the presence of the electronics or esthetic covering. The IC Sensor shall allow for the customization of the color on the esthetic covering as a standard offering. User interface with the IC Sensor shall be provided as a configurable function by the FMCS, and shall offer password protection for access to network variable editing. Multiple network variables shall be accessible and editable by the IC Sensor. Icons shall be utilized to represent sensor and controller function status, affording independence from a single language for use interface. All IC sensors shall monitor and display space temperature and humidity.

5.02   IBC FUNCTIONALITY

A.   IBC Functionality

1.   The IBC shall provide a -40 to 140 degree F ambient operating temperature range. The IBC shall be provided in a modular configuration that allows for the rough in of all wiring without the presence of any of the IBC electronics. IBC devices that require the electronics to be present at the time of wiring, will require an additional controller to be provided for every 10 devices on the drawings, to allow for the preconfiguration and storing for service purposes.

2.   All input/output signals shall be directly hardwired to the controller. For all-non-VAV terminal applications, a minimum of two input points of the IBC shall employ a universal configuration that allows for flexibility in application ranging from dry contact, resistive, to voltage/current sourced inputs. If universal points are not available, a minimum of two input points (each) of the dry contact, resistive and analog voltage/current types must be provided on every controller. The outputs of the IBC shall be of the relay and type. IBC devices utilizing non-relay outputs shall provide an interface relay for all points. All analog outputs shall be programmable for their start points and span to accommodate the control devices. Configuration of all I/O points shall be accomplished without physical hardware jumpers, switches or settings. Troubleshooting of input/output signals shall be easily executed with the Graphical Programming tool (GP) or a volt-ohm meter (VOM). All I/O points shall be utilized by the local IBC or shall be available as I/O points for other controllers throughout the network.

3.   All IBC's shall be fully application programmable and shall at all times maintain their BTL certification. 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.

4. The IBC shall be provided with the ability to interface with the Graphical Programming tool. The interface port shall be provided at the wall sensor or within the unitary equipment, as specified on the plans. The interface port shall allow the GP to have full functionality as described in GP section of this specification. Through the connected controller all IBC devices shall be accessible by the Graphical Programming tool.

PART 6.00   OTHER SYSTEM HARDWARE

6.01   OTHER SYSTEM HARDWARE

A.   Control Valves: Control system contractor shall be responsible for selection of the proper control valves including line size, pressure rating, flow-coefficient, shut-off rating and allowable leakage factor. Modulating water valves shall be sized for nominal 4 psi maximum pressure drop. All chilled water valves shall be two-way with the exception of the chilled water valve on AHU-3 which is a 3-way valve and all hot water valves shall be 3-way modulating with linear throttling plug. Valve stems shall be silicone brass or stainless steel.

B.   Wall Mount Room Thermostats: Each room thermostat shall provide temperature indication to the digital controller; provide the capability for a software-limited set point adjustment and operation override capability. And integral LCD shall annunciate current room temperature and set point as well as override status indication. In addition, the thermostat shall include a port for connection of the portable operator's terminal described elsewhere in this specification.

C.   Duct Mount and Outside Air Temperature Sensors: 1000ohm RTD temperature sensors with an accuracy of 0.2 degrees C. Outside air sensors shall include an integral sun shield.

D.   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.

E.   Temperature Control Panels: Furnish temperature control panels of code gauge steel with locking doors fro mounting all devices as shown. All electrical devices within a control panel shall be factory wired. All external wiring shall be connected to terminal strips mounted within the panel. Provide engraved phenolic nameplates identifying all devices mounted on the face of control panels. A complete set of "as-built" control drawings (relating to the controls within that panel) shall be furnished within each control panel.

F.   Humidity Sensors: Accuracy shall have an accuracy of 3% minimum.

G.   Air Flow Measuring Station: Furnish air flow measuring station which utilizes thermal dispersion technology with a minimum of 2 sensing points. Station shall be Ebtron Model ST series or prior approved equal.

H.   Differential pressure transmitter: Shall be equipped with a local display. The range shall be selected so that the anticipated setpoint shall be midrange. Transmitters for chilled water and hot water applications shall have a bypass manifold for serving.

I.   CO2 transmitter: CO2 transmitters shall have a range from 0 to 2000ppm and shall be accurate to $\pm$ 5% of reading.

J.   Flow transmitter: Shall be a dual turbine flow meter as manufactured by Onicon.

PART 7.00   SEQUENCE OF OPERATION

7.01   VAV UNITS:

A.   System shall be started and stopped from the FMCS when the starter H-O-A switch is in the auto position. All safety controls shall stop the unit regardless of which position the H-O-A switch is in.

B.   Discharge air temperature sensor shall transmit temperature to the local panel of FMCS. FMCS shall modulate cooling coil 2-way valve to maintain setpoint (adjustable at GUI).

C.   Return air humidity shall be transmitted to the local panel of the FMCS. The FMCS shall open the chilled water valve 100% when the return air humidity rises above setpoint (Adjustable at GUI).

D.   A manual reset high limit static pressure controller located at the air handling unit will stop the fan on a rise in static pressure above its setpoint.

E.   A high limit thermostat located in the unit return air will stop the fan on a rise in temperature above its setpoint. Thermostat shall be set at 125 degrees F and require a manual reset. Smoke detector shall stop the fan through the fire alarm system.

F.   Smoke dampers shall open when the air unit supply fan is energized and closed when the supply fan is de-energized or as commanded by the fire alarm system.

G.   Return Air CO2 and outside air CFM shall be transmitted to the local panel of the FMCS. FMCS shall modulate the outside air and return dampers to maintain the minimum required outside air CFM and to keep the CO2 levels below 700ppm. (adjustable at GUI).

H.   A differential pressure transmitter located 2/3 down the longest duct run shall transmit duct static pressure to the local panel of the FMCS. FMCS shall modulate the VFD to maintain set point.

7.02   VAV TERMINAL BOXES WITH ELECTRIC HEAT

A.   The VAV boxes shall only operate when its associated air unit is operating. As temperature rises, box damper shall modulate open to maintain setpoint. As temperature drops below setpoint the VAV box shall maintain its minimum CFM setpoint. Upon a further drop in temperature stages of electric heat shall be energized to maintain set point.

B.   During unoccupied periods the heating and cooling setpoints shall be reset to the unoccupied heating and cooling setpoints which are individually adjustable at the GUI. Each VAV Box thermostat will include an override button. The duration of override shall be individually adjustable at the GUI. Each VAV Box shall have an individual schedule and this schedule shall

be adjustable at the GUI. Master schedules (maximum of 4) shall be programmed by this contractor to control the VAV Boxes in groups.

7.03   KITCHEN ROOF TOP UNIT:

A.   System shall be started and stopped from the FMCS when the starter H-O-A switch is in the auto position. All safety controls shall stop the unit regardless of which position the H-O-A switch is in.

B.   Space temperature sensor shall transmit temperature to the local panel of FMCS. FMCS shall modulate cooling 2-way valve and energize stages of electric heat to maintain space temperature setpoint (adjustable at GUI).

C.   Discharge air temperature sensor shall transmit temperature to the local panel of the FMCS. FMCS shall open the chilled water valve 100% and close the outside air damper when the discharge air temperature drops below 38degf. Discharge air transmitter shall be located between the heating and cooling coils.

D.   Return air humidity shall be transmitted to the local panel of the FMCS. The FMCS shall open the chilled water valve 100% when the return air humidity rises above set point (Adjustable at GUI).

E.   A high limit thermostat located in the unit return air will stop the fan on a rise in temperature above its set point. Thermostat shall be set at 125 degrees F and require a manual reset. Smoke detector shall stop the fan through the fire alarm system.

7.04   CAFETORIUM AIR UNITS:

A.   System shall be started and stopped from the FMCS when the starter H-O-A switch is in the auto position. All safety controls shall stop the unit regardless of which position the H-O-A switch is in.

B.   Space temperature sensor shall transmit temperature to the local panel of FMCS. FMCS shall modulate cooling and heating valves to maintain space temperature set point (adjustable at GUI).

C.   Discharge air temperature sensor shall transmit temperature to the local panel of the FMCS. FMCS shall open the chilled water valve 100% and close the outside air damper when the discharge air temperature drops below 38degf. Discharge air transmitter shall be located between the heating and cooling coils.

D.   Return air humidity shall be transmitted to the local panel of the FMCS. The FMCS shall open the chilled water valve 100% when the return air humidity rises above set point (Adjustable at GUI).

E.   Return Air CO_2 shall be transmitted to the local panel of the FMCS. FMCS shall modulate the outside air and return dampers to maintain the minimum required outside air CFM and to keep the CO_2 levels below 700ppm. (adjustable at GUI).

F.   A high limit thermostat located in the unit return air will stop the fan on a rise in temperature above its set point. Thermostat shall be set at 125 degrees F and require a manual reset. Smoke detector shall stop the fan through the fire alarm system.

7.05   CONVENT AIR UNITS:

A.   System shall be started and stopped from the FMCS when the starter H-O-A switch is in the auto position. All safety controls shall stop the unit regardless of which position the H-O-A switch is in.

B.   Space temperature sensor shall transmit temperature to the local panel of FMCS. FMCS shall modulate cooling and heating control valves to maintain space temperature set point (adjustable at GUI).

C.   Discharge air temperature sensor shall transmit temperature to the local panel of the FMCS. FMCS shall open the chilled water valve 100% and close the outside air damper when the discharge air temperature drops below 38degf. Discharge air transmitter shall be located between the heating and cooling coils.

D.   Return air humidity shall be transmitted to the local panel of the FMCS. The FMCS shall open the chilled water valve 100% when the return air humidity rises above set point (Adjustable at GUI).

E.   A high limit thermostat located in the unit return air will stop the fan on a rise in temperature above its set point. Thermostat shall be set at 125 degrees F and require a manual reset. Smoke detector shall stop the fan through the fire alarm system.

7.06   EXHAUST FANS 2 & 3:

A.   Exhaust fans shall be energized when their associated air unit is energized in the occupied mode only and off 100% of the time during the unoccupied mode regardless of the associated air units fan status

7.07   CHILLED WATER SYSTEM

A.   System shall be started and stopped from the FMCS when the starter H-O-A switch is in the auto position. All safety controls shall stop the unit regardless of which position the H-O-A switch is in.

B.   FMCS shall monitor the chilled water differential pressure transmitter (located at the AHU-3) and shall modulate the chilled water pumps to maintain the chilled water differential pressure setpoint (adjustable at GUI). Lead chilled water pump shall be rotated on a weekly basis. Lead pump shall be selected based on runtime. If the lead pump fails to start then the lag pump shall take the lead position and an alarm shall be sounded at the GUI.

C.   FMCS shall monitor the chilled water flow transmitter and shall modulate the 2-way chilled water valve located in the chilled water bypass line to maintain the minimum flow through the chiller.

I/O SUMMARY CHART

	DO	DI	AI	AO
VAV Units				
Fan start/stop	X			
Fan status		X		
Supply temperature			X	
Cooling valve				X
VFD drive				X
Return air temperature			X	
Return air Humidity			X	
Outside air CFM			X	
Return air CO2			X	
Outside air Damper				X
Return air Damper				X.
Duct Static Pressure			X	
VAV Terminal Boxes				
Space Temperature			X	
Space Temperature Setpoint			X	
Discharge Temperature			X	
CFM			X	
Electric Heat	X			
Override Button		X		
Kitchen Roof Top Unit				
Fan start/stop	X			
Fan status		X		
Supply temperature			X	
Cooling valve				X
Electric Heat Stages	X			
Space Temperature			X	
Space Temperature Setpoint			X	
Override Button		X		
Outside Air Damper	X			
Cafetorium Air Units				
Fan start/stop	X			
Fan status		X		
Supply temperature			X	
Cooling valve				X
Heating valve				X
Space Temperature			X	
Space Temperature Set point			X	
Override Button		X		
	DO	DI	AI	AO
Return air temperature			X	
Return air Humidity			X	
Return air CO2			X	
Outside air Damper				X
Return air Damper				X.
Convent Air Units				

Fan start/stop	X			
Fan status		X		
Supply temperature			X	
Cooling valve				X
Heating valve				X
Space Temperature			X	
Space Temperature Set point			X	
Override Button		X		
Return air temperature			X	
Return air Humidity			X	
Exhaust Fans 2 & 3				
Fan start/stop	X			
Fan status		X		
Chilled Water System				
Chiller stop/start	X			
Chiller status		X		
Chiller alarm		X		
Chiller set point				X
Chilled water pump start/stop	X			
Chilled water pump status			X	
Chilled water differential pressure			X	
Chilled water supply temperature			X	
Chilled water return temperature			X	
Chilled water pump VFD				X
Chilled water 2-way bypass valve				X
Misc.				
Outside air temperature			X	
Outside Air Humidity			X	

END OF SECTION