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July 24, 2023

To: All Plan Holders

CITY BID NUMBER: 274-ESIFS-JPFEH-2023

Project: Frank Evans – HVAC Replacement

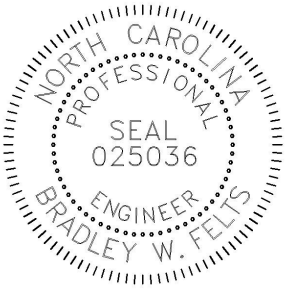
Addendum #1

The bidders are hereby informed that the following additions, deletions, changes and/or clarifications supersede and supplement the contract documents for the referenced project.

1. See revised Section 230900 that replaces current version. Also note the new naming conventions for control points per City of Raleigh Standards.
2. The use of wireless communicating thermostats is acceptable for control of units. The thermostats must communicate with existing CISCO Meraki Access Point and meet the following criteria.
    a. Must use BACnet/IP; the only open (TCP/UDP) port shall be 47808 for BACnet. The Controls contractor shall disable all other ports.
    b. The Controls contractor shall ensure the wifi signal strength is between -30dBm to -60dBm. The Controls Contractor shall use a hardwired solution if the wifi signal strength is not between -30dBm to -60dBm.
    c. After wifi Thermostat installation and if the owner encounters wifi signal strength problems, the Controls Contractor shall be responsible for replacing the wifi connection with a hardwired solution.
    d. Existing wireless temperature sensors on the first floor may be reused.
3. Existing JACE 8000 at Evans shall be reused with new programming.
4. The controls shall monitor the run condition of the generator. When generator is supplying power to the building the electric heat strips shall be disabled.

End of Addendum #1

Attachments: Revised Specification 230900
Control Point Naming Convention



SECTION 230900 – INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. This section describes the scope of work for the Facility Management and Control System that must be installed by a qualified FCMS Contractor and integrated to the Enterprise Server by the Enterprise Developer. This section also coordinates the responsibilities of the Mechanical and Electrical trade contractors pertaining to control products or systems, furnished by each trade, and that will be integrated by this Division.

B. All labor, material, equipment and software not specifically referred to herein or on the plans, that is required to meet the functional intent of this specification, shall be provided without additional cost to the Owner.

C. It is the owner's goal to implement an open system that will allow products from various suppliers to be integrated into a unified system. Allowing various system integrators the ability to maintain, service and preform work on NAC and all controllers that are integrated into the system in order to provide flexibility and expansion of the system. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s).

1.2 SCOPE OF WORK

A. The Facility Management and Control System (FMCS) shall be comprised of Network Area Controllers (NAC) within each facility. The NAC shall connect to the owner's local or wide area network, depending on configuration. Access to the system by and End User shall be accomplished, either locally in each building, or remotely from a central site or sites, shall be accomplished through a standard Web browser via the Internet and/or local area network. Authorized users shall also be able to configure a dashboard view of pertinent data and this view shall be saved for later use. Each NAC shall communicate to unitary BACnet IP controllers (BIPC), Niagara IP Controllers (NIPC) or MODBUS IP controllers (MIPC) on equipment such as air handling units, VAV boxes, switchgear, etc. or provided by the FCMS Contractor. The NAC shall also connect to other open and legacy protocol systems devices provided under other Divisions. It is the owner's goal to eliminate any gateway or redundant device(s) between NAC and IP controllers.

B. The Facility Management and Control System (FMCS) as provided in this Division shall be the Vykon JACE (NAC) based on the Niagara4 Framework (or "Niagara4"), a device framework developed by Tridium. Vykon provides an open automation infrastructure, an open license, and is available from multiple systems integrators. Vykon integrates diverse systems and devices (regardless of manufacturer, communication standard or software) into a unified platform that can be easily managed in real time over a secure network using a standard Web browser.

C. The work provided in this specification shall be performed by two entities. The FMCS Contractor shall have overall responsibility for the Division work. The Enterprise Developer shall be appointed by the Owner and shall provide all work at the Enterprise Server level. The successful general contractor shall include all costs of the Enterprise developer in their bid

documents. Owner will oversee all work of the Enterprise Developer and services they provide. See Section 1.3 for more detail on the division of work.

D. All materials and equipment used shall be standard components. All systems and components shall have been thoroughly tested and proven in actual use for at least two years.

E. All wiring shall be done in accordance with all local and national codes.

1.3 DIVISION OF WORK

A. The Division 23 FMCS contractor shall be responsible for all Network Area Controllers (NAC), Local IP controllers (LIPC), any miscellaneous third-party factory mounted equipment controllers, control devices, control panels, controller programming, controller programming software, controller input/output and power wiring and controller network wiring specified to be provided in Division 23.

B. The Division 26 (if applicable) contractors shall be responsible for all Security NAC, miscellaneous control devices, control panels, controller programming, controller programming software, controller input/output and power wiring and controller network wiring specified to be provided in Division 26. These devices shall be configured and commissioned by Division 26 contractors and later managed in the NAC by FMCS contractor. Exception - Security NACs provided in Division 26 shall be connected to the Enterprise Server by the Enterprise Developer.

C. The FMCS contractor shall also be responsible for the software and programming of the NAC, graphical user interface software (GUI), User Configurable Dashboard software, and connection of the NAC to the local or wide area network. FMCS shall be responsible for development of all graphical screens, Web browser pages, setup of schedules, logs and alarms, and network management for all LIPCs, and other third party devices provided in Division 23 and 26. Any third party devices not provided by FMCS contractor shall be configured and commissioned by appropriate contractor and later managed in the NAC or LIPC by FMCS contractor.

D. For reasons of security and consistency, it is the owner’s intention to divide the work defined in this section into two sections. Work performed at the NAC level and below shall be performed by a pre-qualified FMCS Systems Integrator. All work provided at the Enterprise Server and between the server and other systems shall be provided by the owner appointed Enterprise Developer. The Enterprise Developer shall be responsible for the “learning” of the WBI (web browser graphics) from the NAC to the Enterprise Server, the configuration of the Periscope Dashboard software and the global integration strategies across NACs and other intelligent building systems. The Enterprise Developer shall also be responsible for all Security integration at the Server level, if applicable.

E. The Enterprise Developer shall be responsible for all Server upgrades and ongoing maintenance licensing for Server and NACs.

1.4 RELATED WORK SPECIFIED ELSEWHERE

A. Products integrated and installed but not furnished under this section

1. Project specific equipment

a. NAC shall be a JACE-8000 w/ minimum 1G DDR3 SDRAM, 2 isolated RS-485 ports, 2 10/100MB Ethernet ports, Tridium's standard drivers, USB Backup and Restore and Wi-Fi connectivity.
b. Removeable micro-SD card with 4GB flash total storage/2GB user storage
c. WPM-8000 universal power supply for NAC
d. Provide additional non-standard communications drivers per specifications
e. Provide additional RS-485, RS-232 and IO modules as needed to connect to BAS and third-party systems or networks. At a minimum, provide one (1) IO-R-16 at each NAC.
f. Add Device pack license as needed to communicate with FMCS devices. NAC shall have the capacity to connect to a minimum of 25 devices and should be sized to provide a minimum of 20% spare capacity
g. Provide initial 18-month Software Maintenance Agreement on all NACs.

1.5 QUALITY ASSURANCE

A. The FMCS system shall be designed and installed, commissioned and serviced by factory trained personnel. Systems Integrator shall have an in-place support facility within 100 miles of the site with technical staff, spare parts inventory and necessary test and diagnostic equipment.

1. The Systems Integrator shall provide full time, on site, experienced project manager for this work, responsible for direct supervision of the design, installation, start up and commissioning of the FMCS.
2. The Bidder shall be regularly engaged in the manufacturing, installation and maintenance of FMCS systems and shall have a minimum of ten (10) years of demonstrated technical expertise and experience in the manufacture, installation and maintenance of FMCS systems similar in size and complexity to this project with a maintained service organization. Provide a list of 10 projects, similar in size and scope to this project, completed within the last five years.

B. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.

C. All FMCS peer-to-peer network controllers, central system controllers and local user displays shall be UL Listed under Standard UL 916, category PAZX; Standard ULC C100, category UUKL7; and under Standard UL 864, categories UUKL, UDTZ, and QVAX and be so listed at the time of bid. All floor level controllers shall comply, at a minimum, with UL Standard UL 91 6category PAZX; Standard UL 864, categories UDTZ, and QVAX and be so listed at the time of Bid.

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

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

F. This system shall have a documented history of compatibility by design for a minimum of 15 years. Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability to upgrade existing field panels to a compatible level of technology, and extend new field panels on a previously installed network.

1. Compatibility shall be defined as the ability for any existing field panel microprocessor to be connected and directly communicate with new field panels without bridges, routers or protocol converters.

1.6 SUBMITTALS

A. Provide individuals experienced with the installation and startup of equipment related to this type of integration.

1. Eight copies of shop drawings of the entire FMCS 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. The FMCS Systems Integrator shall submit an architecture layout that depicts devices from the Server to NAC down to the device level.
2. A complete written Sequence of Operation shall also be included with the submittal package. The FMCS Systems Integrator shall coordinate data from other contractors supplying products and systems, as part of their package and shall provide catalog data sheets, wiring diagrams and point lists to the owner for proper coordination of work.

B. Submittal shall also include a trunk cable schematic diagram depicting operator workstations, control panel locations and a description of the communication type, media and protocol. The FMCS Systems Integrator shall be responsible for integrating all network level devices into the overall trunk cable schematic diagrams for the entire Wide Area Network (WAN).

C. Submittal shall also include a complete point list of all points to be connected FMCS by the Systems Integrator. FMCS System Integrator shall provide necessary point lists, protocol documentation, and factory support information for systems provided in their respective divisions but integrated into the FMCS.

D. Submittal shall also include a copy of each of the graphics developed for the Graphic User Interface including a flowchart (site map) indicating how the graphics are to be linked to one another for system navigation. The graphics are intended to be 80% - 90% complete at this stage with the only remaining changes to be based on review comments from the A/E design team and/or Owner. Submittal shall also include a copy of the expected Dashboard viewlets being provided for owner configuration. It is expected that the successful Systems Integrator shall utilize the City of Raleigh graphic templates as much as possible. The owner will provide an example of an acceptable graphic template. Where a particular graphic template does not exist, the Integrator shall create a similar template and gain approval during submittal process.

E. Upon completion of the work, provide a complete set of ‘as-built’ drawings and application software on compact disk. Drawings shall be provided as AutoCAD™ or Visio™ compatible files. Eight copies of the ‘as-built’ drawings shall be provided in addition to the documents on compact disk. Division 23 and 26 contractors shall provide as-builts for their portions of work.

The FMCS Systems Integrator shall be responsible for as-builts pertaining to overall FMCS architecture and network diagrams. All as built drawings shall also be installed into the FMCS server in a dedicated directory.

1.7 SPECIFIC NOMENCLATURE

A. Acronyms used in this specification are as follows:

FMCS	Facility Management and Control System
TCS	Temperature Control System
NAC	Network Area Controller (Vykon JACE 8000)
LIPC	Local IP Controllers (includes BIPC, NIPC and MIPC)
BIPC	BACnet IP Controller
NIPC	Niagara IP Controller
MIPC	Modbus IP Controller
GUI	Graphical User Interface
WBI	Web Browser Interface
POT	Portable Operator's Terminal
PMI	Power Measurement Interface
DDC	Direct Digital Controls
LAN	Local Area Network
WAN	Wide Area Network
OOT	Object Oriented Technology
PICS	Product Interoperability Compliance Statement

1.8 SOFTWARE LICIENCE 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.

B. It is the owner's express goal to implement an open system that will allow products from various suppliers to be integrated into a unified Vykon system in order to provide flexibility for expansion, maintenance, and service of the system. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s). In addition, the Owner shall receive ownership of all job specific configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use with the NAC, FMCS Server(s), and any related LAN / WAN / Intranet and Internet connected routers and devices. Any and all required IDs and passwords for access to any component or software program shall be provided to the owner.

1.9 DELIVERY, STORAGE AND HANDLING

A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons through shipping, storage, and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.

1.10 JOB CONDITIONS

A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to ensure that the Work will be carried out in an orderly fashion. It shall be this Systems Integrator's responsibility to check the Contract Documents for possible conflicts between his Work and that of other crafts in equipment location, pipe, duct and conduit runs, electrical outlets and fixtures, air diffusers, and structural and architectural features.

1.11 WARRANTY

A. Provide all services, materials and equipment necessary for the successful operation of the entire FMCS for a period of one year after beneficial use.

B. The adjustment, required testing, and repair of the system includes all computer equipment, transmission equipment and all sensors and control devices.

C. With owner pre-approval, the on-line support services shall allow the local FMCS Systems Integrator to connect over telephone lines to monitor and control the facility's building automation system. Pending owner approval, this remote connection to the facility shall be within 2 hours of the time that the problem is reported. This coverage shall be extended to include normal business hours, after business hours, weekends and holidays.

1. If the problem cannot be resolved on-line by the local office, the national office of the building automation system manufacturer shall have the same capabilities for remote connection to the facility.
2. If the problem cannot be resolved with on-line support services, the FMCS manufacturer shall dispatch the appropriate personnel to the job site to resolve the problem within a reasonable time frame.

1.12 ACCEPTABLE SYSTEM INTEGRATORS

A. The FMCS Systems Integrator shall provide NAC hardware, software, local IP controllers (LIPC) and DDC components. NAC hardware and software shall be the Vykon brand.

B. Local IP Controllers shall be either Vykon (NIPC) or Distech Controls (BIPC) IP devices.

C. The FMCS Systems Integrator shall have a technical support group accessible that is staffed with qualified personnel, capable of providing instruction and technical support service for networked control systems.

D. The successful FMCS Systems Integrator shall not have password access to the Enterprise Server and shall be restricted to NAC access only.

E. Acceptable Systems Integrators of the hardware and software components as specified herein are as follows:

1. Vykon by Envirocon
2. Vykon by Mechanical Contractors
3. Vykon by Energy Automation Technologies

PART 2 - PRODUCTS

2.1 GENERAL

A. The Facility Management Control System (FMCS) shall be comprised of a network of interoperable, stand-alone digital controllers, a computer system, graphical user interface software, printers, network devices and other devices as specified herein.

B. The installed system shall provide secure password access to all features, functions and data contained in the overall FMCS.

2.2 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES

A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate ANSI/ASHRAE Standard 135-2001 BACnet, MODBUS, , and other existing open and proprietary communication protocols if applicable in one open, interoperable system.

B. The supplied computer software shall employ component-based technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry standards including ANSI / ASHRAE™ Standard 135-2001, BACnet to assure interoperability between all system components is required. For each BACnet device, the device supplier must provide a PICS document showing the installed device's compliance level. Minimum compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet (BACnet IP). BACnet RS-485 (BACnet MSTP) solutions are not acceptable unless written approval by Owner has been received prior to bid date.

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

D. The supplied system must incorporate the ability to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs. An Open Database Connectivity (ODBC) Systems requiring proprietary database and user interface programs shall not be acceptable.

E. An IP topology is required to manage DDC Controllers and the flow and sharing of data without unduly burdening the customer's internal Intranet network. FMCS Contractor shall provide/install a separate isolated IP network including cabling, switches, routers, power supplies, cabinets, etc. for the BIPC, NIPC and MIPC devices to communicate back to a local NAC. Only NACs will reside on the City's WAN/LAN.

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

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

2.3 NETWORK

A. The Local Area Network (LAN) shall be a minimum 100 Megabits/sec Ethernet network supporting BACnet, Java, XML, HTTP, and OBIX for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Area Controllers (NACs), user workstations and, if specified, a local server.

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

1. Ethernet; IEEE standard 802.3
2. Cable; 100 Base-T, UTP-8 wire, category 5
3. Minimum throughput; 100 Mbps.

2.4 NETWORK ACCESS

A. Remote Access.

For Local Area Network installations, the Owner shall provide a connection to the Internet to enable access via the City's Intranet to a corporate server. FMCS Systems Integrator shall connect to IP drop provided by the Owner within 25 feet.

2.5 NETWORK AREA CONTROLLER (NAC)

A. The FMCS Systems Integrator shall supply one or more Network Area Controllers (NAC) as part of this contract to manage devices/points in all specification sections except for Division 280000 Security. Security NACs are provided under Division 280000 and all card access, video and intrusion detection shall be integrated into the existing Enterprise software by the Division 280000 Systems Integrator. This division shall be required to integrate BACnet zone information provided by the Division 280000 Systems Integrator into the HVAC and Lighting Sequence of Operation. The number of NACs provided by this Systems Integrator is dependent on the type/quantity of devices and points. It is the responsibility of the FMCS Systems Integrator to coordinate with all Division contractors to determine the quantity and type of NACs needed to fulfill the operating sequences.

B. 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 BACnet IP/Modbus TCP/IP controller data
7. Network Management functions for all third-party BACnet and Modbus based devices if specified as such.
8. Provide license for a minimum of 25 devices connected.

C. The Network Area Controller must provide the following hardware features as a minimum (also see section 1.4.a):

1. Two Ethernet Port – 10/100 Mbps
2. One RS-232 port
3. Two isolated RS-485 port
4. USB Backup and Restore
5. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity)
6. The NAC must be capable of operation over a temperature range of -20 to 60°C
7. The NAC must be capable of withstanding storage temperatures of between -40 to 85°C
8. The NAC must be capable of operation over a humidity range of 5 to 95% RH, non-condensing

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

E. NAC Alarm Notification and actions

1. The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
2. The NAC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up telephone connection, or wide-area network.
3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:
   a. To alarm
   b. Return to normal
   c. To fault
4. Provide for the creation of a minimum of eight of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.
5. Provide timed (schedule) routing of alarms by class, object, group, or node.
6. Provide alarm generation from binary object “runtime” and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
7. Control equipment and network failures shall be treated as alarms and annunciated.
8. Alarms shall be annunciated in any of the following manners as defined by the user:
   a. Screen message text

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

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

c. Pagers via paging services that initiate a page on receipt of email message
d. Graphic with flashing alarm object(s)

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

a. Time and date

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

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

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

e. Number of occurrences since last acknowledgement.

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

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

12. 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.

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

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

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

F. NAC Data Collection and Storage

1. The NAC shall have the ability to collect data for any property of any object and store this data for future use. See points list for required logs.
2. The data collection shall be performed by log objects, resident in the NAC that shall have, at a minimum, the following configurable properties:

a. Designating the log as interval or deviation.

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

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

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

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

3. All log data shall be archived to a database in the Enterprise Server and the data shall be accessed from a standard Web browser and the Periscope Dashboard.

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

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

   a. HTML

   b. XML

   c. Plain Text

   d. Comma or tab separated values

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

7. The NAC shall have the ability to archive its log data remotely to a server on the network. Provide the ability to configure the following archiving properties, at a minimum:

   a. Archive on time of day

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

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

   d. Provide ability to clear logs once archive.

G. NAC AUDIT LOG

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

   a. Time and date

   b. User ID

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

H. NAC DATABASE BACKUP AND STORAGE

1. The NAC shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval. Enterprise Developer shall coordinate with Owner to establish/implement a backup procedure.

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

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

2.6 INTEGRATED DEVELOPMENT ENVIRONMENT (IDE)

A. An integrated development environment for development of graphic screens, control logic, security, alarm notification and data storage has been established using the Vykon Workbench Tool and currently resides on a Server in the existing datacenter and several laptops. The successful FMCS Systems Integrator shall utilize its own laptop for all programming and graphical development. The Enterprise Developer shall utilize the IDE at the server via a VPN connection or its own separate laptop IDE. The IDE residing on the central server shall be the most current version of the Vykon Workbench toolset and the FMCS Systems Integrator shall utilize the exact same version when programming NACs. Provide licenses for any new software configuration, programming or graphical tools that are required for viewing or managing the new BIPC, NIPC or MIPC devices.

B. The server and NAC IDE tools shall be identical; however, it shall be possible to limit views and commands via a unique user profile and password in either. The IDE shall include a quick viewing of, and access to, the hierarchical structure of the database. Menu-pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.

C. Security. Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data. The Owner shall control/set all passwords and security levels for all operators. The Owner shall provide the FMCS and Enterprise Developer with the standard passwords required to be used in the Enterprise Server and the NAC. The FMCS Systems Integrator shall not use any passwords except those provided by the owner. 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.

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

E. Alarm Management

1. The system will be provided with a dedicated alarm window or console. Refer to Sequence of Operations/Points List for Alarm strategies. The Alarm Console will notify the operator of an alarm condition and allow the operator to view details of the alarm and acknowledge the alarm. The use of the Alarm Console can be enabled or disabled by the system administrator. Alarms shall be created and grouped per the owner's requirements by the FMCS Systems Integrator at the NAC level. The Enterprise Developer shall bring

the NAC alarms into the existing Enterprise server and generate the strategies to send alarms to the appropriate city or contractor parties.

2. Alarms shall be capable of being routed to any of the following:
    a. Local Alarm Console (by FMCS Systems Integrator)
    b. Remote Alarm Station (by Enterprise Developer)
    c. Email recipient (multiple if needed) (by Enterprise Developer)
    d. Local Printer connected to Personal Computer (by Enterprise Developer)
3. 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. Alarms shall be able to be mapped into groupings where the groupings have common displays, sounds or hyperlinks. This grouping shall be used to distinguish alarms when alarms are coming in from multiple sites or classes (i.e. buildings, regions, trades, etc.) for faster recognition.
4. The system shall be provided with an alarm database management view. The view shall allow a user with appropriate password to:
    a. Filter or Clear old records before a certain date and time
    b. Clear records older than the currently highlighted record
    c. Clear all records
    d. Modify the alarm table options including which alarm details are displayed, column width, etc.
    e. Export the alarm database records to .pdf, text or CSV formats.

2.7 WEB BROWSER CLIENTS

A. The NAC system shall also allow use of an unlimited number of clients using a standard Web browser such as Internet Explorer™ or Chrome. The system shall be capable of providing a rich user experience (including full use of the engineering toolset) using java applets or a simple user interface using only HTML5. Refer to Sequence of Operations for the client side display types that are required on this project.

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 graphics, schedules, calendars, logs, etc. as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.

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 (unless clearly stated in the sequence of operation). Any animated graphical objects supported by the GUI shall be supported by the Web browser interface. Enterprise Developer shall provide a FMCS Systems Integrator with a basis of performance/expectation for GUI. FMCS Systems Integrator shall use this standard graphic template or modify the graphics slightly to achieve the desired specification requirement/outcome.

3. Storage of the graphical screens shall be in the Network Area Controller (NAC) and these graphics shall be "learned" by the Enterprise Server.

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

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

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

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

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

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

    c. View logs and charts

    d. View and acknowledge alarms

    e. Setup and execute SQL queries on log and archive information

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

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

8. BIPC, and NIPC Devices shall also serve an appropriate standard HTML5 graphic representative of the physical equipment being controller. The owner shall also be able to connect directly to these devices to see a local HTML page graphic of the equipment being controller. A HMTL Summary Page graphic shall also be provided for any MIPC from the Niagara Server.

2.8 END USER DASHBOARD CLIENTS

A. The Owner has an existing browser-based Periscope dashboard application that provides rapid identification of real-time and historical trends, including energy use, operational efficiencies

and critical metrics. In this project, the Enterprise Developer shall provide the latest Periscope HTML5 product including the following part numbers:

a. PERN4-BASE

b. PER-ENERGY

c. PER-SUSTAIN

d. PER-ANALYTIC

e. PER_MAP

B. The Dashboard service shall run as a module on a Niagara4 station and shall utilize the existing Niagara4 licensing and security model. All user profiles defined in the station shall be available for dashboard access and conform to the defined security levels and categories. The Enterprise Developer shall build a new dashboard for this building only.

C. The Enterprise Developer shall map the necessary point and trend data required into the Server and Dashboard application.

D. The Dashboard interface is designed to complement the Niagara4 HTML5 Pages by providing multiple, concurrent, user-centric "Views" or "Viewlets" that can be easily configured and frequently modified by non-technical end-users.

E. Configure an initial Dashboard for the building staff per the Owner's requirements and provide an Eight 8-hour training session for the Owner's staff. The initial configuration shall include:

1) Setup of the new Sites including Site name, address, square footage, and any utility resource costs.

2) Discovery of Point and trend data from the new location. Enterprise Developer shall assist Owner in understanding the Niagara4 point names and importing the desired point and trend values.

3) Setup of 2 customizable dashboard views for the Owner. The Enterprise Developer shall demonstrate how the Owner can add Views to create a preferred daily view.

F. The Dashboard shall save the User's custom configuration so that returning users are greeted with previously saved views.

G. Additional Views shall be made available to Owner for purchase as developed. Owner shall be able to receive notification from the manufacturer on new viewlets and software updates.

2.9 SERVER FUNCTIONS AND HARDWARE

A. An existing Vykon Enterprise Server is located on the City of Raleigh Wide Area Network. The server shall support all Network Area Controllers (NAC) connected to the customer's network whether local or remote. All programming, software upgrades and setup of the Enterprise Server shall be by Enterprise Developer.

B. Local connections shall be via an Ethernet LAN. It shall be possible to provide access to all Network Area Controllers via a single connection to the server. In this configuration, each Network Area Controller can be accessed from a remote Graphical User Interface (GUI) or from a standard Web browser (WBI) by connecting to through the server. Provide a general, intuitive navigational path from the server to the NACs. Store all required O&M data sheets, drawings, help files, etc. on the server and link from each NAC where applicable.

2.10 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 password access as assigned by the system administrator.

B. A library of control, application, and graphic components shall be provided to enable the creation of all applications and user interface screens. Applications are to be created by selecting the desired control components 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 components to the application components to provide "real-time" data updates. Any real-time data value or component property may be connected to display its current value on a user display. Systems requiring a separate software tool to create applications and browser user interface displays shall not be acceptable.

C. Programming Methods

1. Provide the capability to copy component s from the supplied libraries, or from a user-defined library to the user's application. Component shall be linked by a graphical linking scheme by dragging a link from one component to another. Component links will support one-to-one, many-to-one, or one-to-many relationships. Linked components shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to components 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 component will be done through the component's property sheet using fill-in the blank fields, list boxes, and selection buttons. Requiring the use of custom programming, scripting language, or a manufacturer-specific procedural language for every component 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 component s shall not be allowed.

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

2.11 COMPONENT LIBRARIES

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

B. The components 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 components created in their application and store the new instances of these components 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 components and applications as they are developed.

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

E. The component library shall include components to support the integration of devices connected to the Network Area Controller (NAC). At a minimum, provide the following as part of the standard library included with the programming software:

1. For BACnet devices, provide the following components at a minimum:

    a. Analog In
    b. Analog Out
    c. Analog Value
    d. Binary
    e. Binary In
    f. Binary Out
    g. Binary Value
    h. Multi-State In
    i. Multi-State Out
    j. Multi-State Value
    k. Schedule Export
    l. Calendar Export
    m. Trend Export
    n. Device

2. For each BACnet component, provide the ability to assign the component a BACnet device and component instance number.

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

    a. Segmentation
    b. Segmented Request
    c. Segmented Response
    d. Application Services
    e. Read Property
    f. Read Property Multiple
    g. Write Property
    h. Write Property Multiple

i. Confirmed Event Notification
j. Unconfirmed Event Notification
k. Acknowledge Alarm
l. Get Alarm Summary
m. Who-has
n. I-have
o. Who-is
p. I-am
q. Subscribe COV
r. Confirmed COV notification
s. Unconfirmed COV notification
t. Media Types
u. Ethernet
v. BACnet IP Annex J
w. MSTP
x. BACnet Broadcast Management Device (BBMD) function
y. Routing

2.12 BACNET NETWORK MANAGEMENT

A. The Network Area Controller shall support the integration of device data from BACnet TCP/IP for all devices provided in Division 230900. If third-party equipment not provided in this section cannot be supplied as BACnet IP or supplied with a BACnet IP gateway, then FMCS Supplier shall provide the appropriate BACnet MSTP or Modbus driver to connect to the third-party system device. The solution to connect the third-party device must be approved in advance by Owner's representative. (also see section 1.5.F.1)

B. Provide the required components in the library, included with the Graphical User Interface programming software, to support the integration of the BACnet system data into the FMCS. Components provided shall include at a minimum:

1. Read/Write BACnet AI Points
2. Read/Write BACnet AO Points
3. Read/Write BACnet AV Points
4. Read/Write BACnet BI Points
5. Read/Write BACnet BO Points
6. Read/Write BACnet BV Points

C. All scheduling, alarming, logging and global supervisory control functions, of the BACnet system devices, shall be performed by the Network Area Controller.

D. The FMCS supplier shall provide a BACnet IP system communications driver. The equipment system vendor that provided the equipment utilizing BACnet shall provide documentation of the system's interface and shall provide factory support at no charge during system commissioning

E. BACnet Conformance:

1. Logic controllers shall as a minimum support MS/TP BACnet LAN type. They shall communicate directly via this BACnet LAN at 9.6, 19.2, 38.4 and 76.8 Kbps, as native BACnet devices. Logic controllers shall be of BACnet conformance class 3 and support all BACnet services necessary to provide the following BACnet functional groups:

    a. Files Functional Group
    b. Reinitialize Functional Group
    c. Device Communications Functional Group

2. Refer to Section 22.2, BACnet Functional Groups, in the BACnet Standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

2.13 BACnet IP COMMUNICATING THERMOSTATS

A. The manufacturer of the Thermostat hardware and software components must be primarily engaged in the manufacture of BAS as specified herein and must have been so for a minimum of five (5) years.

B. The manufacturer shall be ISO 9001:2000 certified. This is to ensure that all manufacturing, design and support policies comply with a minimum quality assurance standard. Corporate quality assurance policies should be available for examination upon request by the owner or his agent.

C. The manufacturer of the hardware and software components shall have a technical support group accessible via a toll-free number that is staffed with qualified personnel, capable of providing instruction and technical support service for networked control systems.

D. Acceptable providers of the Communicating Thermostat hardware and software components as specified herein are as follows. Acceptance as a product provider does not provide approval to be an acceptable FMCS Systems Integrator.

1. Distech Controls
2. Contemporary Controls
3. Viconics

E. Communicating Thermostats shall be BACnet IP thermostats. FMCS Systems Integrator shall standardize on BACnet IP protocol for all thermostats.

2.14 BACNET IP VAV BOX CONTROLLERS (BIPC)

A. The manufacturer of the hardware and software components must be primarily engaged in the manufacture of BAS as specified herein and must have been so for a minimum of five (5) years.

B. The manufacturer shall be ISO 9001:2000 certified. Certification is to ensure that all manufacturing, design and support policies comply with a minimum quality assurance standard.

Corporate quality assurance policies should be available for examination upon request by the owner or his agent.

C. The manufacturer of the hardware and software components shall have a technical support group accessible via a toll-free number that is staffed with qualified personnel, capable of providing instruction and technical support service for networked control systems.

D. Acceptable manufacturers of the hardware and software components as specified herein are as follows. Acceptance as a product manufacturer does not provide approval to be an acceptable Systems Integrator.

1. Distech
2. ABB

2.15 NETWORK IP CONTROLLER(S) STANDARDS

A. Where beneficial, provide Plant, AHU, and VAV IP Controllers that can meet the required sequence of operation and can be custom programmed. All controllers shall be designed for easy installation and servicing including removable enclosures, removable terminals, and factory applied labels for all I/O. All internal points shall be fully supported by the Graphical User Interface (GUI), allowing the user to easily modify them and monitor them. All of the internal programming points (e.g. variables, constants, PID's, timers, inputs and outputs) shall be exposed to the network on dedicated network variable outputs.

B. IP Equipment Control Units (Primary Systems such as Chiller, Boiler, Water System and a VAV AHU)

a. Acceptable Plant IP Controllers (Primary Systems such as Chiller, Boiler, Water Systems):

i. Vykon Edge 10

ii. Eclypse S-1000 Controllers

iii. ABB

b. IP Plant Controllers shall include:

i. NXP iMX6 SoloX2: 800 MHz ARM Cortex-A9/M4 or equal

ii. 512 MB DDR SDRAM

iii. 2GB total eMMC flash storage with user space set at 1GB

iv. Powered from 24VAC/DC source

v. 5 Universal inputs: Type 3 (10K) thermistors, 0-100K ohm, 0-10VDC, 0-20mA with external resistor, Dry Contact

vi. 2 Analog outputs: 0-10VDC, 4mA max output current

vii. 3 Digital outputs: Triac, 24VAC @.5 amp

viii. 2 10/100MB Ethernet ports capable of daisy chaining

ix. 1 RS-485 serial port

c. VAV IP Controller Products:

i. Distech IP VAV Control Units (IP-VAV)

ii. ABB

a) The IP-VAV-CTRL shall be 32-bit microprocessor-based operating at a minimum of 400 MHz

b) They shall be multi-tasking, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules.

c) Controller size shall be sufficient to fully meet the requirements of this specification and the attached point list.

d) Each IP-VAV-CTRL shall have minimum of 512MB memory, with a minimum of 1GB non-volatile flash, to support its own operating system and databases, including:

a. Control processes

b. Maintenance support applications

c. Custom processes

e) The IP-VAV-CTRL shall have a Real Time clock with rechargeable battery.

f) Power Requirements

a. 24 VAC with local transformer power

b. 50 VAC utilizing Power Over Ethernet (POE)

g) The IP-VAV-CTRL will support the following communications protocols:

a. BACnet/IP

i. Supporting IPv4 addressing.

ii. DHCP support and Auto DNS.

iii. 2 - RJ45 ports each capable of supporting 10/100 Base-T.

b. If the above functionality is not available, then appropriate router(s) and switches must be supplied to provide the functionality.

h) 2 x USB 2.0 Expansion ports for:

a. 802.11 Wi-Fi Adapter enabling wireless connectivity including:

1. 'Hot Spot'

2. Client

3. Access Point

b. If the above functionality is not available, then appropriate wireless router(s) and switches must be supplied to provide the functionality.

c. Shall contain a "FIPS 140-2 Inside" cryptographic module

i) The controllers shall also function normally under ambient conditions of 32 ˚F to 122 ˚F and 5% to 90% RH (non-condensing).

iii. Variable Air Volume (VAV) Terminal Control Units (TCU)

a) The VAV TCU controllers shall be powered from a 24 VAC source and shall function normally under an operating range of 20 to 28 VAC (±15%), allowing for power source fluctuations and voltage drops.

b) The BAS contractor shall provide a dedicated power source and separate isolation transformer for each controller unable to function normally under the specified operating range.

c) The controllers shall also function normally under ambient conditions of 32 ˚F to 122 ˚F and 5% to 90% RH (non-condensing).

d) Provide each controller with a suitable cover or enclosure to protect the intelligence board assembly.

e) The VAV TCU shall include a built-in 'flow thru' differential pressure transducer.

a. The controller shall convert this value to actual air flow.

b. Single point differential pressure sensing device is not acceptable.

c. Membrane based pressure differential transducer is not acceptable.

d. The VAV TCU differential pressure transducer shall have a measurement range of 0 to 2 in. W.C. and measurement accuracy of ±4% at 0.05 to 2 in. W.C. and a minimum resolution of 0.0001 in. W.C., insuring primary air flow conditions shall be controlled and maintained to within ±5% of setpoint at the specified minimum and maximum air flow parameters.

e. VAV TCU differential pressure transducer requiring periodic zero value air flow calibration is not acceptable.

f) The BAS contractor shall verify the type of differential pressure sensors used in the existing boxes and ensure compatibility with the VAV TCU controllers.

g) The VAV TCU shall include provision for air flow balancing using a local air flow balancing interface.

h) An Intelligent Space Sensor (ISS) shall be used for balancing air flow.

a. In lieu of an ISS, a portable air flow balancing interface capable of balancing air flow is acceptable.

i) The portable air flow balancing interface shall connect to the VAV TCU or the matching room temperature sensor.

j) The VAV TCU shall also provide an air flow balancing tool.

k) This tool shall allow the air balancer to manually control the action of the actuator including the following function: open VAV damper, close VAV damper, open all VAV dampers, and close all VAV dampers.

l) Systems not able to provide a web based air balance tool or a portable air flow balancing interface or an Intelligent Space Sensor (ISS) capable of balancing air flow as part of the VAV TCU controller shall provide an individual full time technician during the air flow balancing process to assure full balance compliance.

m) The VAV box controller shall interface to a matching room temperature sensor as previously specified. The controller shall function to maintain space temperature to within ±1.5 ˚F of setpoint at the room sensor location.

n) Each controller shall also incorporate an algorithm that allows for resetting of the associated air handling unit discharge temperature if required to satisfy space requirements.

a. This algorithm shall function to signal the respective controller to perform the required discharge temperature reset in order to maintain space temperature setpoint.

o) It shall be possible to view and reset the space temperature, temperature setpoint, maximum airflow setting, minimum airflow setting, and actual airflow, through the BAS LAN.

2.16 MODBUS SYSTEM INTEGRATION

A. The Network Area Controller shall support the integration of device data from Modbus RTU, Ascii, or TCP control system devices. The connection to the Modbus system shall be via an RS-232, RS485, or Ethernet IP as required by the device.

B. Provide the required components in the library, included with the Graphical User Interface programming software, to support the integration of the Modbus system data into the FMCS. Components provided shall include at a minimum:

1. Read/Write Modbus AI Registers
2. Read/Write Modbus AO Registers
3. Read/Write Modbus BI Registers
4. Read/Write Modbus BO Registers

C. All scheduling, alarming, logging and global supervisory control functions, of the Modbus system devices, shall be performed by the Network Area Controller.

D. The FMCS supplier shall provide a Modbus system communications driver. The equipment system vendor that provided the equipment utilizing Modbus shall provide documentation of the system's Modbus interface and shall provide factory support at no charge during system commissioning

E. Provide a Modbus Interface to the following equipment:

1. switchgear
2. packaged pumping system
3. building energy metering

2.17 THIRD PARTY INTEGRATION

A. The Network Area Controller shall support the integration of device data from the existing control system. The connection to the existing system shall be via an RS-232 connection between the Network Area Controller and the existing control system {if applicable on this project}.

B. Provide the required data points from the third-party integration per sequence of operations and/or points list

2.18 SENSORS

A. All control items, except thermostats, sensors and transmitters located in rooms shall be properly identified with engraved plastic nameplates permanently attached. Nameplates shall have white letters on a black background.

B. All sensors shall be provided in NEMA 4X enclosures where exposed to the Pool environment.

C. Room thermostat, sensor and transmitter locations shall be coordinated to align vertically or horizontally with adjacent light switches or other control devices. Room thermostats and sensors shall be mounted with the bottom 5'-0" above the floor. Sensors installed in areas where they are subject to physical abuse (ex: gymnasiums) shall be furnished with protective type aspirating guards. Sensors installed on exterior walls shall be installed on non-conductive (cork) sub-base. Sensors shall have plus or minus local control feature.

D. Temperature Sensors: Thermistor type with an accuracy of plus or minus 0.40 degree F over the entire control range. Sensors for pipe installations shall be immersion type, brass well, and thermistor with integral lead wire. Sensors for duct application shall be insertion probe type, stainless steel probe, integral handi-box, and thermistor with integral lead wire. Space

temperature sensors shall be compatible with the unit controller and shall be provided in a decorative metal or plastic enclosure (NEMA 4X where exposed to pool environment). Space temperature sensors shall be provided with setpoint and temperature indication only. Outdoor temperature sensors shall be mounted inside a protective weather and sun shield and shall be located on a North wall.

E. Humidity Sensors: Thin-film capacitive type sensor with on-board nonvolatile memory, accuracy to plus or minus two percent (2%), 12 - 30 VDC input voltage, analog output (0 - 10 VDC). Operating range shall be 5 to 95% RH and -40 to 170 degree F. Duct mounted type sensors shall have a stainless steel insertion element, sealed to prohibit corrosion. Sensors shall be selected for wall, duct or outdoor type installation as appropriate.

F. Carbon Dioxide Sensors (CO2): Sensors shall utilize Non-dispersive infrared technology (N.D.I.R.), repeatable to plus or minus 20 PPM. Sensor range shall be 0 - 2000 PPM. Accuracy shall be plus or minus five percent (5%) or 50 PPM, whichever is greater. Response shall be less than one minute. Input voltage shall be 20 to 30 VAC/DC. Output shall be 0 - 10 VDC. Sensor shall be wall or duct mounted type, as appropriate for the application, housed in a high impact plastic enclosure.

G. Differential Air Pressure Switch: Differential pressure switches for proving fan operation or sense dirty air filters shall be SPDT type, UL approved, and selected for the appropriate operating range of the equipment to which it is applied. Sensor shall have ¼" compression type fittings and shall have an adjustable setpoint. Furnish with ¼" barbed type static pressure tips.

H. Current Switches (Type 1): For proving fan or pump operational status, provide solid or split-core type current status switches with adjustable setpoint and solid-state internal circuitry. Current switch shall have induced power, trip point set adjustment to plus or minus 1% over a range of 1 to 135 amps, trip and power LED, and field adjustable to indicate both On-Off conditions and loss of load (broken belt, etc.). Units shall have a five-year manufacturer's warranty. Current switches shall be Hawkeye Series H-908 by Veris Industries, or approved equal.

I. Current Switches (Type 2): For proving fan or pump operational status, provide solid or split-core type current switches ("Go/No" type). Current switch shall have induced power, 100 percent solid state with no moving parts. Units shall have a five-year manufacturer's warranty. Current switches shall be Hawkeye series H-900 by Veris Industries, or approved equal.

J. Low Temperature Sensors: For sensing low temperatures in air handling units, provide SPST type switch, 35 to 45 degree F range, manual reset, vapor charged twenty foot long sensing element, and 120-volt electrical power connection. Low temperature sensor ("freeze-stat") shall be JCI Model A11A-1, or equal.

K. Pressure Transmitters: For sensing static pressure in a duct system (usually for VAV systems), provide a pressure transmitter with integral capacitance type sensing action, solid state circuitry, accuracy of plus or minus 1% of range, zero and span adjustments, 10 to 35 VDC operating voltage, 4 to 20mA output, and integral inlet port connections. Select pressure range suitable for the application. Differential pressure transmitter shall be Ashcroft CXLdp, or approved equal.

L. Line Voltage Thermostats: For control of equipment using line voltage on-off thermostats (exhaust fans, unit heaters, etc.) provide 120 volt UL Listed wall mounted thermostats.

Thermostat shall have a range of 50 to 90 degree F with minimum 2 degree F differential, snap acting switch, and dial adjustment for temperature setting. Line Voltage Thermostats shall be Honeywell series T631 series or approved equal.

M. Firestat: For sensing sudden increases in duct temperature (ex: fire condition), provide 120 volt UL Listed SPST switch with adjustable setpoint that breaks the circuit on a rise in temperature above the setpoint and de-energizes the air handling unit fan.

N. Aquastat: For sensing temperature of a fluid within a pipe system, provide 120-volt SPST strap-on type aquastat, temperature control range of 65 to 200-degree F (adjustable). Aquastat shall be HW Model L6006C1018, or equal.

O. Air Flow Monitoring Device

1. Basis-of-Design Product: Subject to compliance with requirements, provide Ebtron Advantage Gold Series for use with GTx116 transmitters or a comparable product by one of the following:

    a. Tek-Air Systems or equal

2. Provide airflow/temperature measurement devices (ATMD) where indicated on the plans. Fan inlet measurement devices shall not be substituted for duct or plenum measurement devices indicated on the plans.
3. Each ATMD shall consist of one or more sensor probes and a single, remotely mounted, microprocessor-based transmitter capable of independently processing up to 16 independently wired sensor assemblies.

    a. Each sensor assembly shall contain two individually wired, hermetically sealed bead-in-glass thermistors.
    b. Thermistors shall be mounted in the sensor assembly using a marine-grade, waterproof epoxy. Thermistor leads shall be protected and not exposed to the environment.
    c. The airflow rate of each sensor assembly shall be equally weighted and averaged by the transmitter prior to output.
    d. The temperature of each sensor assembly shall be velocity weighted and averaged by the transmitter prior to output.
    e. Each transmitter shall have a 16-character alpha-numeric display capable of displaying airflow, temperature, system status, configuration settings and diagnostics.
    f. Devices using chip-in-glass or diode-case chip thermistors are not acceptable.
    g. Devices using less than two thermistors in each sensor assembly are not acceptable.
    h. Devices using platinum wire RTDs are not acceptable.
    i. Devices having electronic circuitry mounted in or at the sensor probe are not acceptable.
    j. Pitot tubes and arrays are not acceptable.
    k. Vortex shedding devices are not acceptable.

4. All Sensor Probes

a. Each sensor assembly shall independently determine the airflow rate and temperature at each measurement point.
b. Each sensor assembly shall be calibrated at a minimum of 16 airflow rates and 3 temperatures to standards that are traceable to the National Institute of Standards and Technology (NIST).
c. Airflow accuracy shall be +/-2% of Reading over the entire operating airflow range.

    i. Devices whose accuracy is the combined accuracy of the transmitter and sensor probes must demonstrate that the total accuracy meets the performance requirements of this specification throughout the measurement range.

d. Temperature accuracy shall be +/-0.15° F over the entire operating temperature range of -20° F to 160° F.
e. The operating humidity range for each sensor probe shall be 0-99% RH (non-condensing).
f. Each sensor probe shall have an integral, U.L. listed, plenum rated cable and terminal plug for connection to the remotely mounted transmitter. All terminal plug interconnecting pins shall be gold plated.
g. Each sensor assembly shall not require matching to the transmitter in the field.
h. A single manufacturer shall provide both the airflow/temperature measuring probe(s) and transmitter for each measurement location.

5. Duct and Probes

a. Probes shall be constructed of extruded, gold anodized, 6063 aluminum tube. All wires within the aluminum tube shall be Kynar coated.
b. Probe assembly mounting brackets shall be constructed of 304 stainless steel. Probe assemblies shall be mounted using one of the following options:

    i. Insertion mounted through the side or top of the duct
    ii. Internally mounted inside the duct or plenum
    iii. Standoff mounted inside the plenum

c. The number of sensor housings provided for each location shall be as follows:

Duct Area (sq.ft.)	Total # Sensors / Location
<2	4
2 to < 4	6
4 to < 8	8
8 to <16	12
>=16	16

d. The operating airflow range shall be 0 to 5,000 FPM unless otherwise indicated on the plans.

6. Fan Inlet Probes

a. Sensor assemblies shall be mounted on 304 stainless steel housings.
b. Mounting rods shall be field adjustable to fit the fan inlet and constructed of nickel plated steel.
c. Mounting feet shall be constructed of 304 stainless steel.
d. The operating airflow range shall be 0 to 10,000 FPM unless otherwise indicated on the plans.

7. Transmitters

a. The transmitter shall have an integral LCD display capable of simultaneously displaying airflow and temperature. The LCD display shall be capable of displaying individual airflow and temperature readings of each independent sensor assembly.
b. The transmitter shall be capable of field configuration and diagnostics using an on-board pushbutton interface and LCD display.
c. The transmitter shall have a power switch and operate on 24 VAC (isolation not required).

i. The transmitter shall use a switching power supply fused and protected from transients and power surges.
ii. The transmitter shall use "watch-dog" circuitry to assure reset after power disruption, transients and brown-outs.

d. All interconnecting pins, headers and connections on the main circuit board, option cards and cable receptacles shall be gold plated.
e. The operating temperature range for the transmitter shall be -20° F to 120° F. The transmitter shall be installed at a location that is protected from weather and water.
f. The transmitter shall be capable of communicating with other devices using the following interface option: Linear analog output signals for airflow and temperature: Field selectable, fuse protected and isolated, 0-10VDC/4-20mA (4-wire)

8. The transmitter shall be capable of accepting an infra-red interface card for downloading airflow and temperature data or uploading transmitter configuration data using a handheld PDA (Palm or Microsoft Windows Mobile operating systems).

a. Provide PDA upload/download software.

i. Download software shall be capable of displaying and saving individual sensor airflow rates, the average airflow rate, individual sensor temperatures and the average temperature received from the transmitter.
ii. Upload software shall be capable of displaying and saving all setup parameters that can be configured using the on-board pushbutton interface and LCD display.

9. The ATMD shall be UL listed as an entire assembly.

10. The ATMD shall carry the CE Mark for European Union shipments.

11. The manufacturer's authorized representative shall review and approve placement and operating airflow rates for each measurement location indicated on the plans.

2.21 DAMPERS AND ACTUATORS

A. Damper actuators shall be sized by the Systems Integrator for the intended application. Unless noted otherwise, dampers will be furnished by the Systems Integrator for all field installed dampers that are not included as part of the equipment. In general, provide opposed blade type dampers for modulating control and parallel type dampers for two-position control applications. Actuators shall be Honeywell MS or ML series actuators.

B. Control Dampers: When indicated to be furnished by the Systems Integrator, control dampers shall be equal to Ruskin CD30VG2 or Honeywell D2 or D3 series dampers. Provide all automatic control dampers not specified to be integral with other equipment. Frames shall be 5 inches wide and of no less than 16-gauge galvanized steel. Inter-blade linkage shall be within the frame and out of the air stream. Blades shall not be over 8 inches wide nor less than 16-gauge galvanized steel triple V type for rigidity. Bearings shall be acetal, oilite, nylon or ball-bearing with ½ inch diameter plated steel shafts. Dampers shall be suitable for temperature ranges of -40 to 180F. All proportional control dampers shall be opposed or parallel blade type as hereinafter specified and all two-position dampers shall be parallel blade types. Dampers shall be sized to meet flow requirements of the application. The sheet metal contractor shall furnish and install baffles to fit the damper to duct size. Baffles shall not exceed 6". Dampers with dimensions of 24 inches and less shall be rated for 3,000 fpm velocity and shall withstand a maximum system pressure of 5.0 in. wc. Dampers with dimensions of 36 inches and less shall be rated for 2,500 fpm velocity and shall withstand a maximum system pressure of 4.0 in. wc. Dampers with dimensions of 48 inches and less shall be rated for 2,000 fpm velocity and shall withstand a maximum system pressure of 2.5 in. wc. Side seals shall be stainless steel of the tight-seal spring type. Dampers shall be minimum leakage type to conserve energy and the temperature control manufacturer shall submit leakage data for all low leakage control dampers with the temperature control submittal. Maximum leakage for low leakage dampers in excess of sixteen inches square shall be 8 CFM per square foot at static pressure of 1 inch of WC. Low leakage damper blade edges shall be fitted with replaceable, snap-on, inflatable seals to limit damper leakage. Testing and ratings shall be in accordance with AMCA Standard 500. Damper blade width shall be no greater than 8 inches, and dampers over 48 inches wide by 74 inches high shall be sectionalized. Testing and ratings to be in accordance with AMCA Standard 500.

C. Damper Actuators: Damper actuators shall be provided for all automatic dampers. Damper actuators controlled through the DDC system shall be low voltage electronic type, either modulating or two-position, as required to achieve the intended sequence of operation. Provide with spring return when required for fail-safe operation. Modulating dampers shall be positive positioning in response to a 2 - 10 VDC or 4 - 20mA control signal. Actuator shall include the capability of adding auxiliary switches for position indication. Furnish actuators other than spring return type with a release button (clutch) or handle on the actuator to allow for manual override. Power supply to the actuator shall be by 120 VAC, 24 VAC, or 24 VDC and the actuator shall be furnished with a factory installed 3-foot cable with end fitting for field connection. All actuators shall be UL Listed by the manufacturer. Actuators shall be Honeywell MS or ML series actuators.

2.22 VARIABLE FREQUENCY DRIVES.

A. All drives shall be Honeywell SmartVFD HVAC™ or equal. No substitutions will be allowed without prior written approval. Substitution requests must be submitted in writing at least 2 weeks prior to bid date and will not be considered without a complete list of deviations from this specification.

B. The VFD shall be 0-320Hz, designed specifically for use in HVAC applications in which speed control of the motor can be applied and shall include a software Wizard for easy setup of Pumps and Fans through answering questions in the Wizard.
C. The VFD shall include a Real Time Clock, (RTC) with automatic daylight savings time and calendar, able to provide three time channels programmed to perform different functions (start/stop and preset frequencies) based on time and sleep function to minimize downtime energy.
D. The VFD shall have built in 2 stand-alone PID control loops to control HVAC (Pumps and Fans) stand-alone, the PID Controller must allow:
    a. Two different feedback signals (minimum and maximum control).
    b. Two set point sources for the PID control (selectable with digital input).
    c. External PID controller (control of an external final control element).
    d. Single input control (analog signal rising edge starts VFD).
    e. Run interlock input (Damper interlock) VFD will not start before input is activated.
    f. Direct or reverse acting regulation.
    g. Feed forward control (faster response to process changes).
    h. The integral controller functionality shall provide control of up to 4 motors.
    i. The integral controller shall maintain set point by regulating one motor and disconnecting the other motors to/from the mains, by means of digital output relay controlled contactors.
    j. The integral controller shall define order/priority in which the motors are started to equalize motor runtime.
E. The VFD efficiency shall be 98.5% or better at full load. Displacement power factor rating shall be 98% or better at all speeds and loads.
F. The VFD shall include built-in dual 5% DC choke to minimize harmonic (THD) from the device.
G. The VFD shall have built-in serial communication RS485 for BACnet and Ethernet communication for BACnet IP, and allow reading monitored values and reading/writing configuration parameters from the FMCS
H. The VFD shall provide a removable operator High Resolution Graphics LCD Display with keypad on the front of the VFD which can optionally be remotely mounted. Providing ability to save and write VFD configurations to keypads and exchange keypads with other VFDs of same model type. The display shall provide the following operator features:
    a. START push button.
    b. STOP push button.
    c. LOCAL/REM push button.
    d. BACK/RESET push button.
    e. ARROWS UP/DOWN/RIGHT/LEFT push buttons.
    f. Indication of RUN, READY, FAULT Status and Operations.
    g. Indication of drive rotation direction
I. Live monitoring of up to nine selectable values simultaneously selectable from parameters, including outputs, operating parameters, temperature, drive status, last active fault, fire mode status and application status. The following values shall be monitored as initial set-up:
    a. Frequency Reference (Hz)
    b. Output Frequency (Hz)
    c. Motor Speed (RPM)
    d. Motor Current (A)
    e. Motor Torque (Nm)
    f. Motor Voltage (V)
    g. DC-Link Voltage (V)
    h. Unit Temperature (°C)
    i. Motor Temperature (°C)

J. The menu driven display shall provide the minimum, maximum, and actual values for all parameters, uploading and downloading of parameters, and multiple help functions including integral parameter descriptions available at the parameter on the VFD keypad display. All information shall be full description, no reference codes, to minimize the need for manual reference for setup, commissioning and maintenance.

K. Diagnostic Screen: The display Diagnostic Screen shall provide a description for every fault, as well as the actual values and references stored at the instant of the fault event. The display shall blink the name of the fault when a fault appears. The last 40 faults with time and date stamps shall be stored in VFD history log.

L. System Performance Monitor: The display shall collect and present operational and energy data values:
    a. Cumulative amount of energy consumed.
    b. Control unit operating time.
    c. Motor running time.
    d. Amount of time the unit has been powered.
    e. Start command count.

M. Fire Mode Wizard
    a. The VFD shall have the ability to initiate an emergency mode which ignores all faults and commands to operate the motor in forward or reverse, according to one of the following:
    b. Preset frequency 1, 2 or 3
    c. Keypad frequency
    d. Fieldbus frequency
    e. AI1, AI2 or AI1 + AI2
    f. PID1 Reference
    g. Motor Pot Reference

N. Protections:
    a. Over voltage.
    b. Under voltage.
    c. Ground fault.
    d. Mains phase supervision.
    e. Motor phase supervision.
    f. Over current protection.
    g. Unit over temperature.
    h. Motor overload.
    i. Motor stall protection.
    j. Motor under load protection.
    k. Short-circuit protection of +24V and +10V ref. voltages.

O. Bypass Variable Frequency Drive
    a. When specified in the drawings, the VFD shall be designed for use in applications to support uninterruptible power to the motor in case of any failure of the VFD. VFD supplier shall be able to provide Bypass in 3 different options, 2 Contactor Bypass, 3 Contactor Bypass and Automatic Bypass. For Bypass only, these features must to be included:
        i. Status lamps: VFD Run, Bypass Run
        ii. Mode selection switch: Bypass, Off, Test, and VFD
        iii. Fused disconnect
        iv. Freeze /Fire /Smoke interlock
        v. Isolation of VFD from power with motor running.
        vi. TEST position provides power to the VFD without powering the motor.

b. Automatic Bypass shall allow any VFD fault to automatically send the VFD into bypass mode, dry contacts shall indicate when the bypass is in bypass mode, alerting the building management system. For Automatic Bypass, these features must to be included:
    i. VFD fault shall automatically send the bypass to BYPASS Mode.
    ii. Contact closure sends bypass to BYPASS Mode.
    iii. Dry contacts indicate when the bypass is in BYPASS Mode, alerting the Facility Management and Control System.

P. Operator Instruction and Training: The contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction shall be done during normal working hours and shall be performed by a competent representative familiar with the VFD hardware, software and accessories.

2.23 CONTROL VALVES

A. Control Valves: (Globe Type) Valves shall be Honeywell or equivalent. Control valves shall be 2-way or 3-way pattern as shown constructed for tight shutoff and shall operate satisfactory against system pressures and differentials. Two-position valves shall be 'line' size. Proportional control valves shall be sized for a maximum pressure drop of 5.0 psi at rated flow (except as may be noted on the drawings). Two-way water valves shall have equal percentage flow characteristics and three-way valves shall have equal percentage flow characteristics straight through and linear through the bypass. Provide valve position indicator on all valves. Leakage rate shall be no more than 0.05% of Cv.

1. Valves 1/2 inch through 1 1/2 inch shall be screwed pattern except where solder connections are specified for valves 1/2 or 3/4 inches. Three-way valves bypass port shall be of one size reduced Cv to preclude the need for a bypass port balancing valve. Valve and cartridge replacement tool shall be configured for maintenance or replacement without draining the coil to prevent water spill; however, an integral isolation valve on the control valve outlet will also be acceptable. Valves shall close off against 58 psi minimum.

2. Two-inch valves shall be "screwed" configuration and 2-1/2 inch and larger valves shall be "flanged" configuration and ANSI-rated to withstand the pressures and temperatures encountered. Valves shall have stainless-steel stems and spring-loaded Teflon packaging with replaceable discs.

B. Control Valves: (Characterized Ball Valves) Valves shall be Honeywell or equivalent. Control valves 1/2 to 2 inches shall be 2-way or 3-way forged brass screwed pattern as shown constructed for tight shutoff and shall operate satisfactory against system pressures and differentials. Two-position valves shall be 'line' size. Proportional control valves shall be sized for a maximum pressure drop of 5.0 psi at rated flow (except as may be noted on the drawings). Two-way water valves shall have equal percentage flow characteristics and three-way valves shall have equal percentage flow characteristics straight through and linear flow through the bypass. Leakage rate shall be ANSI Class IV (no more than 0.01% of Cv). Valves shall be rated for no less than 350 psig at no less than 250 degrees F. Provide a removable handle to operate valves manually during actuator power loss or failure.

C. Two-way valves shall close off against 100 psi minimum, and three-way valves shall close off against 40 psi minimum. Valves shall have stainless-steel or chemically nickel-plated brass stem and throttling port. Valves shall be tagged with Cv rating and model number.

D. Butterfly Control Valves: Valves shall be Honeywell or equivalent. Where specified butterfly control valves over 2" in size shall be cast iron body type for 2-way or 3-way applications specified constructed for tight shutoff and shall operate satisfactory against system pressures and differentials. Valves shall have tapped lugs for standard flange connection and designed for isolation and removal of downstream piping at full rated pressure. Two-position valves shall be 'line' size. Proportional control valves shall be sized for a maximum pressure drop of 5.0 psi at rated flow (except as may be noted on the drawings). Valves shall be rated for bubble tight shutoff at no less than 150 psi. Valve disc shall be aluminum bronze. Valve stems shall be stainless steel, with inboard top and bottom bronze bearings, and an external corrosion resistant top bearing to absorb actuator side thrust.

2.24 ELECTRICAL MISCELLANEOUS

A. Panels: All enclosures for DDC controllers and devices shall be fabricated in accordance with UL Standards from code gauge steel. Enclosures shall be provided with a continuous hinge on the door and a flush latching mechanism. Enclosures shall be shop painted with standard grade enamel coating. Back panels shall be furnished when required to facilitate installation of boards or accessories. All enclosures installed outdoors shall be constructed to NEMA 3R standards. All controllers shall be installed within an approved enclosure unless the controller will be installed within the control cabinet section of the equipment that it is intended to control. Enclosures shall facilitate the mounting of gauges, switches, pilot lights, and the like, on the face panel when required. Control devices that are mounted on the face of the panel shall be identified with engraved nameplates. Panels shall be Hoffman A1 series or approved equal.

B. Power Transformers: Step-down power transformers shall be provided for all DDC controllers and associated accessory devices as required. Transformers shall be sized and selected to accommodate all connected accessory items. Transformers shall be UL Listed Class 2 type with 120 VAC primary, 24 VAC secondary. Transformers shall be Functional Devices TR series or approved equal.

C. Relays: Miscellaneous control relays shall be provided as required to energize or control equipment and devices within the control system. Relays shall be located as close as practical to the controlled device (motor, motor starter, etc.). Where approved by NEC, relays may be installed within starters and equipment control panels where space is available. Relays installed outside of the controlled device shall be provided with a NEMA enclosure suitable for the location where installed. Relays shall be Functional Devices RIB series or approved equal.

2.25 ELECTRICAL WIRING

A. Wiring: All wiring devices and accessories shall comply with the requirements of Division 26 and the NEC. All wiring shall be installed in a neat and professional manner. Control wiring shall not be installed in power circuit conduits or raceways unless specifically approved for that purpose. All wiring, except plenum wiring (where allowed), shall be run in electrical conduits.

Plenum cable will be allowed in concealed locations where accessible. All cable must be installed with 90° angles and strapped according the NEC.

B. Provide all interlock and control wiring. Provide wiring as required by functions as specified and as recommended by equipment and device manufacturers to achieve the specified control functions.

C. Low voltage conductors shall be stranded bare or tinned-copper with premium grade polymer alloy insulation. For shielded cable, furnish multi-conductor of overall polyester supported aluminum foil with stranded tinned copper drain wire to facilitate grounding. Coaxial shield shall be copper braided type. Provide shielded cable where recommended by the equipment or device manufacturer, grounded in strict accordance with the manufacture's recommendations.

D. Magnetic starters and disconnect switches shall not be used as junction boxes. Provide auxiliary junction boxes as required. Terminations for Fire Alarm Control Panel (FACP) interface shall be accomplished by the Electrical Contractor or his designated subcontractor.

E. FMCS Systems Integrator shall provide power for all control devices and components from the closest available power source or as indicated on the power Drawings. When acceptable to the equipment manufacturer, low voltage power may be obtained from the internal equipment power source or transformer. Electrical Power for Systems Integrator's use has been provided at j-boxes located on plans.

F. Magnetic starters shall be furnished and installed by the Electrical Contractor.

G. Disconnects shall be furnished and installed by the Electrical Contractor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All work described in this section shall be performed by system integrators or contractors that have a successful history in the design and installation of integrated control systems. The installing office shall have a minimum of five years of integration experience and shall provide documentation in the submittal package verifying the company's experience.

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

C. Drawings of FMCS network are diagrammatic only and any apparatus not shown but required to make the system operative to the complete satisfaction of the Architect shall be furnished and installed without additional cost.

D. Line and low voltage electrical connections to control equipment shown specified or shown on the control diagrams shall be furnished and installed by the FMCS Systems Integrator in accordance with the specifications in Divisions 23 and 26.

3.2 WIRING

A. All electrical control wiring and power wiring to the NAC, computers and network components shall be the responsibility of the FMCS contractor.

B. All wiring shall be in accordance with the National Electrical Code and any applicable local codes. All FMCS wiring shall be installed in the conduit unless otherwise allowed by the National Electrical Code or applicable local codes. Where FMCS plenum rated cable wiring is allowed it shall be run parallel to or at right angles to the structure, properly supported and installed in a neat and workmanlike manner.

3.3 WARRANTY

A. Equipment, materials and workmanship incorporated into the work shall be warranted for a period of one year from the time of system acceptance.

B. Within this period, upon notice by the Owner, any defects in the work provided under this section due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by the FMCS contractor at no expense to the Owner.

3.4 WARRANTY ACCESS

A. Pending owner pre-approval, the Owner shall grant to the FMCS contractor, reasonable access to the FMCS during the warranty period. The owner shall allow the contractor to access the FMCS from a remote location for the purpose of diagnostics and troubleshooting, via the Internet, during the warranty period.

3.5 SOFTWARE LICENSE

A. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s). The owner requires that all Vykon based software and hardware on this project be the current version of N4.

B. The owner, or his appointed agent, shall receive ownership of all job specific software configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and /or configured for use within Niagara4 based controllers and/or servers and any related LAN / WAN / Intranet and Internet connected routers and devices. Any and all required Ids and passwords for access to any component or software program shall be provided to the owner.

3.6 ACCEPTANCE TESTING

A. Upon completion of the installation, the FMCS contractor shall load all system software and start-up the system. The FMCS contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to insure that the system is functioning in full accordance with these specifications. The FMCS contractor shall coordinate the checkout of the system such that other appropriate Divisions have a representative present during system checkout.

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

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

D. System Acceptance: Satisfactory completion is when the Division 230900 contractor has performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

3.7 OPERATOR INSTRUCTION, TRAINING

A. During system commissioning and at such time acceptable performance of the FMCS hardware and software has been established, the contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction shall be done during normal working hours and shall be performed by a competent representative familiar with the system hardware, software and accessories.

B. The FMCS contractor shall provide 24 hours of instruction to the owner's designated personnel on the operation of the FMCS and describe its intended use with respect to the programmed functions specified. Operator orientation of the FMCS shall include, but not be limited to; the overall operation program, equipment functions (both individually and as part of the total integrated system), commands, systems generation, advisories, and appropriate operator intervention required in responding to the System's operation.

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

1. One day session (8 hours) after system is started up and at least one week before first acceptance test. Manual shall have been submitted at least two weeks prior to training so that the owners' personnel can start to familiarize themselves with the system before classroom instruction begins.
2. One day follow up session (8 hours) after system has been operational for at least 1 month.
3. Warranty Follow Up: Two days (4 hours each) to be scheduled at the request of the owner during the one-year warranty period. These sessions shall cover topics as requested by the owner such as; how to add additional points, create and gather data for trends, graphic screen generation or modification of control routines.

END OF SECTION 230900

Standard Terms

Term	Definition
Circulation (Pump)	A pump within the plant that circulates a fluid through an individual piece of equipment such as a chiller, boiler, cooling tower or heat exchanger.
Command	Indicates a piece of equipment, valve, damper or fan has been command to a Boolean value of on/off or open/close. (See Enabled, Status and Position for related points)
Effective	Indicates the current temperature or pressure setpoint target given the current mode of operation. For a temperature or flow set point this value would change as a piece of equipment moves between occupied and unoccupied and heating and cooling modes.
Enabled	A Boolean software point indicating a piece of equipment is in or out of service and is available or not available to be commanded on or off. It does not indicate a piece of equipment is running or not running. Enabled should never be used to indicate the commanding of a point or piece of equipment on or off. Commonly used to take a piece of equipment out of service for maintenance or repair. Control logic will ignore equipment that is not enabled. (See Command and Status for related points)
Energy	Tracks the consumption of a unit of energy (kWh, MMbtu, etc.). Always an accumulated value with a hisTotalized tag.
Exhaust	Indicates undesired air leaving the building due to contaminants or other undesirable components like excess heat or humidity. Common areas would include mechanical areas, dryers, pools and laboratories.
History Intervals	Numeric history intervals for new projects with newer controlers and adequate memory should be 10 minutes. Retrofit work should coorespond with the existing intervals. In all cases the history interval should be the same for all points on a piece of equipment so that histories align on the same time boundareis.
Frequency	Frequency is a numeric value either commanding or sensing a VFD running at a specific Hz. See Speed for VFD percent control.
Loop (Pump)	A pump that distributes a fluid to a larger area such as a campus, district or building for end equipment use.
Mixed Air Damper	Mixed air damper should only be used when there is a specific third damper controlling mixed air separate from the the outside air damper and the return air damper. A two damper configuration of outside and return air dampers should never name one of the dampers as a mixed air damper.

Standard Terms

Term	Definition
Mode	A software point indicating the current operating intent of a piece of equipment. Used to understand the current system mode (i.e. Occupancy, Dehumidifing, Economizing, IAQ, etc.) when analyzing related points.
Occupancy	A Boolean point indicating a unit is in occupied or unoccupied mode.
Phase	Indicates electrical attributes (amps, volts, power or energy) as measured across an individual phase. A string value containing A, B, C, AB, BC, AC, AN, BN, CN.
Power	Tracks the instantaneous value of power (kW, MMbtu/h, etc.).
Position	A numeric value indicating a valve or damper open position between 0 and 100%.
PreHeat	Preheat indicates heating coils and valves intended to heat outside air to prevent the freezing of cooling coils. Often seen in cold climates with minimum outside air damper positions or large outside air requirements.
Primary	The primary tag is always used in the context of the site. Primary refers to piping, valves, pumps and sensors within the central plant that moves water between equipment in the plant. Common primary equipment includes individual chillers, boilers, heat exchangers, isolation valves, pumps and sensors.
Relief	Indicates excess air leaving the building in order to maintain overall building static pressure and indoor air quality.
Room	This term should not be used. Use "Zone" instead.
Secondary	The secondary tag is always used in the context of the site. Secondary refers to equipment or points moving air or fluids away from a source to another area for use. Common sources may include chilled water or hot water plants within a building or a central or district plant on a campus. Common uses may include campus distribution of chilled water, hot water, or steam; or chilled, hot or domestic water loops within a building.
Space	This term should not be used. Use "Zone" instead.
Speed	A numeric value commanding a fan or pump to run at a percentage of capacity from 0 to 100 percent.
Zone	Zone is the general term used to define any area served by a VAV, FCU or direct zone AHU. The term “Room” or "Space" should not be used.
Total	Indicates the total power or energy across all phases of electricity.

Standard Abbreviations

Term	Abbreviation
Building Loop Pumps	**P**
Carbon Dioxide	**CO2**
Chilled Water	**ChW**
Chilled Water System	**CHWS**
Command	**Cmd**
Condenser Water	**CW**
Circulation Pump (individual equipment)	**CP**
Damper	**Dmpr**
Domestic Hot Water System	**DHW**
Enable	**Enab**
Entering	**E**
Frequency	**Freq**
Heat Exchanger	**Hx**
Hot Water	**HW**
Hot Water System	**HWS**
Leaving	**L**
Load	**Load**
Mechanical	**Mech**
Mixing	**Mix**
Occupancy/Occupied	**Occ**
Position	**Pos**
Power Factor	**PF**
Pre-Heat	**PreHeat**
Pressure	**Press**
Primary	**Pri**
Re-Heat	**ReHeat**
Setpoint	**Sp**
Speed	**Spd**
Static Pressure	**Press**

Standard Abbreviations

Term	Abbreviation
Status	**Sts**
Temperature	**Temp**
Valve	**Vlv**
Variable Frequency Drive	**VFD**
UnOccupied	**Unocc**
Water	**Wtr**

AHU With Return Air

Description	**Point Name navName**
General Points	
Occupied Mode	Occ
Building Static Pressure	BldgPress
Building Static Pressure Setpoint	BldgPressSp
Filters	
Filter Status	FilterSts
Filter Pressure Delta	FilterPressDelta
Single Direct Zone Points	
Zone CO2	ZoneCO2
Zone CO2 Setpoint	ZoneCO2Sp
Zone Pressure	ZonePress
Zone Pressure Setpoint	ZonePressSp
Zone Temperature	ZoneTemp
Zone Temperature Setpoint (effective)	ZoneTempSp
Occupied Cooling Setpoint	OccCoolSp
Occupied Heating Setpoint	OccHeatSp
Unoccupied Cooling Setpoint	UnoccCoolSp
Unoccupied Heating Setpoint	UnoccHeatSp
Discharge Air Points - VAV Zones	
DA Fan Command (single or common)	DaFanCmd
DA Fan Status (single or common)	DaFanSts
DA Fan Speed (single or common)	DaFanSpd
DA Fan Frequency (single or common)	DaFanFreq
DA Humidity	DaHumidity
DA Pressure	DaPress
DA Pressure Setpoint	DaPressSp
DA Temp	DaTemp
DA Temp Setpoint	DaTempSp
Systems with Return Air	
RA CO2	RaCO2

AHU With Return Air

Description	**Point Name navName**
RA CO2 Setpoint	RaCO2Sp
RA Damper Position	RaDmprPos
RA DeHumidify Setpoint	RaDehumidSp
RA Humidify Setpoint	RaHumidSp
RA Humidity	RaHumidity
RA Fan Command (single or common)	RaFanCmd
RA Fan Status (single or common)	RaFanSts
RA Fan Speed (single or common)	RaFanSpd
RA Fan Frequency (single or common)	RaFanFreq
RA Pressure	RaPress
RA Pressure Setpoint	RaPressSp
RA Temp	RaTemp
Systems with Relief Air	
Relief Air Damper Position	RlfDmprPos
Systems with Outside Air	
Outside Air Damper Command (open/closed)	OaDmprCmd
Outside Air Damper Position	OaDmprPos
Outside Air Flow	OaFlow
Outside Air Humidity	OaHumidity
Outside Air Temperature	OaTemp
Mixed Air Points	
Mixed Air Temp	MaTemp
Mixed Air Damper Position	MaDmprPos
Systems with Heating	
Hot Water Circulation Pump Command	HWCPCmd
Hot Water Circulation Pump Status	HWCPSts
Hot Water Valve Position	HWVlvPos
Preheat Valve Position	PreheatVlvPos
Heating Coil Air Leaving Temp	HCALTemp
PreHeat Coil Air Leaving Temp	PreHCALTemp

AHU With Return Air

Description	**Point Name navName**
Systems with Cooling	
Chilled Water Pump Command	ChWCPCmd
Chilled Water Pump Status	ChWCPSts
Chilled Water Valve Position	ChWVlvPos
Chiller Water Valve Status	ChWVlvSts
Chiller Water Temp Entering	CHWEtemp
Chiller Water Temp Leaving	CHWLtemp
Chilled Water Flow	CHWFlow
Cooling Coil Air Leaving Temp	CCALTemp
Cooling Coil Air Leaving Humidity	CCALHumidity
Systems that Economize	
Economize Mode	EconomizeMode
Systems that Humidify	
Humidifier Enable	HumidifierEnab
Humidifier Command	HumidifyCMD
See Return Air Humidity & Humidify Setpoint	
Systems that Dehumidify	
DeHumidify Mode	DeHumidifyMode
See Return Air Humidity & Dehumidify Setpoint	

Energy Points - Heat Recovery Water

Heat Recovery Water Temp Entering	HRUWEtemp
Heat Recovery Water Temp Leaving	HRUWLTemp
Heat Recovery Water Volumertic Flow	HRUWFlow
Heat Recovery Water Energy (accumulated)	HRUWEnergy
Heat Recovery Water Power	HRUWPower
Heat Recovery Pump Command	HRUCPCmd
Heat Recovery Air Leaving Temp	HRUALTemp

FCU

Description	Point Name navName
Occupied Mode	Occ
Chilled Water Valve	ChWVlvPos
Discharge Air Temperature	DaTemp
Fan Command	FanCmd
Fan Status	FanSts
Fan Speed	FanSpeed
Hot Water Valve	HWVlvPos
Zone Temperature	ZoneTemp
Zone Temperature Setpoint (effective)	ZoneTempSp
Occupied Cooling Setpoint	OccCoolSp
Occupied Heating Setpoint	OccHeatSp
Unoccupied Cooling Setpoint	UnoccCoolSp
Unoccupied Heating Setpoint	UnoccHeatSp

While the four occ/unocc heating/cooling setpoints above rarely change, their histories are needed in analytics to determine when temperatures have drifted too high or low.

VAV

Description	Point Name navName
Occupied Mode	Occ
Discharge Air Flow	DaFlow
Discharge Air Flow Setpoint	DaFlowSp
Damper Position	DmprPos
Reheat Valve	HWVlvlPos
Discharge Air Temperature	DaTemp
Zone Temperature	ZoneTemp
Zone Temperature Setpoint (effective)	ZoneTempSp
Occupied Cooling Setpoint	OccCoolSp
Occupied Heating Setpoint	OccHeatSp
Unoccupied Cooling Setpoint	UnoccCoolSp
Unoccupied Heating Setpoint	UnoccHeatSp
Zone Humidity	ZoneHumidity
Zone Humidity Setpoint	ZoneHumiditySp
Zone CO2	ZoneCO2
Zone CO2 Setpoint	ZoneCO2Sp
Optional Commissioning Points	
Cooling Max Flow	CoolMaxFlow
Cooling Min Flow	CoolMinFlow
Heating Max Flow	HeatMaxFlow
Heating Min Flow	HeatMinFlow
Fan Powered Boxes	
Fan Speed	FanSpeed
Fan High Speed	FanSpeedHigh
Fan Medium Speed	FanSpeedMed
Fan Low Speed	FanSpeedLow

Chiller

Description	Point Name navName
Chiller Enable	ChrEnab
Chiller Command	ChrCmd
Chiller Status	ChrSts
Condenser Water Isolation Valve	CWVlvCmd
Condesner Water Circulation Pump	CWCPCmd
Condenser Water Entering Temperature	CWETemp
Condenser Water Leaving Temperature	CWLTemp
Chilled Water Isolation Valve	ChWVlvCmd
Chilled Water Entering Temperature	ChWETemp
Chilled Water Leaving Temperature	ChWLTemp
Chilled Water Setpoint	ChWSp
Chilled Water Flow	ChWFlow
Oil Temp	ChrOilTemp
Oil Heater Command	ChrOilHeatCmd
Oil Heater Status	ChrOilHeatSts
Load	ChrLoad

Energy Points - Electric

Tons	ChrTons
Current	ChrCurrent
Volts	ChrVolts
Energy Total (accumulated)	ChrEnergy
Power Total	ChrPower
Power Factor Total	ChrPF

Energy Points - Water

Chilled Water Temperature Entering	ChWEtemp
Chilled Water Temperature Leaving	ChWLTemp
Chilled Water Flow	ChWFlow
Chilled Water Volume (accumulated)	ChWVolume
Chilled Water Energy (accumulated)	ChWEnergy

Chiller

Description	Point Name navName
Chilled Water Power	ChWPower

Boiler

Description	Point Name navName
Boiler Enable	BlrEnab
Boiler Command	BlrCmd
Boiler Status	BlrSts
Entering Water Temperature	BlrETemp
Leaving Water Temperature	BlrLTemp
Boiler Leaving Setpoint	BlrLTempSp
Boiler Isolation Valve	BlrVlvCmd
Boiler Circulation Pump	BlrCPCmd
Burner Level	BlrLevel
Systems with Heat Recovery	
Heat Recovery Circulation Pump Command	HRUCPCmd
Heat Recovery Circulation Pump Status	HRUCPSts

Energy Points - Gas

Gas Flow	BlrGasFlow
Gas Volume (accumulated)	BlrGasVolume
Gas Energy (accumulated)	BlrGasEnergy
Gas Power	BlrGasPower

Energy Points - Water

Boiler Water Temperature Entering	BlrWEtemp
Boiler Water Temperature Leaving	BlrWLTemp
Boiler Water Flow	BlrWFlow
Boiler Water Volume (accumulated)	BlrWVolume
Boiler Water Energy (accumulated)	BlrWEnergy
Boiler Water Power	BlrWPower

Energy Points - Heat Recovery Water

Heat Recovery Water Temp Entering	HRUWEtemp
Heat Recovery Water Temp Leaving	HRUWLTemp
Heat Recovery Water Flow	HRUWFlow
Heat Recovery Water Volume (accumulated)	HRUWVolume

Boiler

Description	Point Name navName
Heat Recovery Water Energy (accumulated)	HRUWEnergy
Heat Recovery Water Power	HRUWPower

Fans (individual)

Discharge Fan
Return Fan
Exhaust Fan
Relief Fan
FCU Fan
Cooling Tower

Description	Point Name navName
Fan Command	FanCmd
Fan Status	FanSts
Fan Speed	FanSpeed
Fan VFD Speed	FanVFDSpd
Fan VFD Frequency	FanVFDFreq
VFD Energy Total (accumulated)	VFDEnergy
VFD Power Total	VFDPower

Pumps (individual)

Chiller Circ Pump
ChW Pump
Boiler Circ Pump
HW Pump
DHW Pump
GHW Pump
CT Pump
CW Pump

Description	Point Name navName
Pump Enable	PumpEnab
Pump Command	PumpCmd
Pump Status	PumpSts
Pump VFD Speed	PumpVFDSpd
Pump VFD Frequency	PumpVFDFreq
Energy Points - Electric	
VFD Energy Total (accumulated)	VFDEnergy
VFD Power Total	VFDPower
Energy Points - Water	
Water Temperature Entering	Etemp
Water Temperature Leaving	LTemp
Water Flow	Flow
Water Volume (accumulated)	Volume
Water Energy (accumulated)	WtrEnergy
Water Power	WtrPower

Electric Meter

Description	Point Name navName
Energy Points - Electric	
Energy Total (accumulated)	Energy
Power Total	Power
Power Factor Total	PF
Power Quality Points	
Current A	Current_A
Current B	Current_B
Current C	Current_C
Volts AN	Volts_AN
Volts BN	Volts_BN
Volts CN	Volts_CN
Volts AB	Volts_AB
Volts BC	Volts_BC
Volts CA	Volts_CA
Power Factor A	PF_A
Power Factor B	PF_B
Power Factor C	PF_C
Energy A (accumulated)	Energy_A
Energy B (accumulated)	Energy_B
Energy C (accumulated)	Energy_C
Power A	Power_A
Power B	Power_B
Power C	Power_C

Gas Meter

Description	Point Name navName
Gas Flow	GasFlow
Gas Volume (accumulated)	GasVolume
Gas Energy (accumulated)	GasEnergy
Gas Power	GasPower

CHWS (Chilled Water System)

Description	Point Name navName
Chilled Water Flow	ChWFlow
Chilled Water Volume (accumulated)	ChWVolume
Chilled Water Supply Temp	ChWSTemp
Chilled Water Supply Temp Setpoint	ChWSTempSp
Chilled Water Return Temp	ChWRTemp
Chilled Water Pressure Delta	ChWPressDelta
Chilled Water Pressure Delta Setpoint	ChWPressDeltaSp

Energy Points - Water

Chilled Water Temperature Entering	ChWEtemp
Chilled Water Temperature Leaving	ChWLTemp
Chilled Water Flow	ChWFlow
Chilled Water Volume (accumulated)	ChWVolume
Chilled Water Energy (accumulated)	ChWEnergy
Chilled Water Power	ChWPower

Chilled Water Building Loop Pumps

Building Loop Pump Enable	ChWPEnab
Building Loop Pump Command	ChWPCmd
Building Loop Pump Status	ChWPSts
Building Loop Pump VFD Speed	ChWPVFDSpd
Building Loop Pump VFD Frequency	ChWPVFDFreq
Building Loop Return Valve Command	ChWRetVlvCmd
Building Loop Return Valve Sensor	ChWRetVlvSts

Energy Points - Electric

VFD Energy Total (accumulated)	ChWPVFDEnergy
VFD Power Total	ChWPVFDPower

Chilled Water Heat Exchanger

Chilled Water Heat Exchanger Enabled	HxChWEnab
Chilled Water Heat Exchanger Command	HxChWCmd
Chilled Water Heat Exchanger Runtime	HxChWRuntime

CHWS (Chilled Water System)

Description	Point Name navName
Chilled Water Entering Temperature	HxChWETemp
Chilled Water Leaving Temperature	HxChWLTemp
Chilled Water Isolation Valve	HxChWVlvCmd
Chilled Water Circulation Pump Command	HxChWCPCmd
Chilled Water Circulation Pump Status	HxChWCPSts
Condenser Water Entering Temperature	HxCWETemp
Condesner Water Leaving Temperature	HxCWLTemp
Condesner Water Isolation Valve	HxCWVlvCmd
Condenser Circ Pump Command	HxCWCPCmd
Condenser Circ Pump Status	HxCWCPSts

HWS (Hot Water System)

Description	Point Name navName
Hot Water Flow	HWFlow
Hot Water Volume (accumulated)	HWVolume
Hot Water Supply Temp	HWSTemp
Hot Water Supply Temp Setpoint	HWSTempSp
Hot Water Return Temp	HWRTemp
Hot Water Pressure Delta	HWPressDelta
Hot Water Pressure Delta Setpoint	HWPressDeltaSp
Energy Points - Water	
Hot Water Temperature Entering	HWEtemp
Hot Water Temperature Leaving	HWLTemp
Hot Water Flow	HWFlow
Hot Water Volume (accumulated)	HWVolume
Hot Water Energy (accumulated)	HWEnergy
Hot Water Power	HWPower
Building Hot Water Loop Pumps	
Building Loop Pump Enable	HWPEnab
Building Loop Pump Command	HWPCmd
Building Loop Pump Status	HWPSts
Building Loop Pump VFD Speed	HWPVFDSpd
Building Loop Pump VFD Frequency	HWPVFDFreq
Energy Points - Electric	
VFD Energy Total (accumulated)	HWPVFDEnergy
VFD Power Total	HWPVFDPower

Domestic Hot Water

Description	Point Name navName
Water Flow	DHWFlow
Water Volume (accumulated)	DHWVolume
Supply Temperature	DHWSTemp
Supply Temperature Setpoint	DHWSTempSp
Return Temperature	DHWRTemp
DHW Building Loop Pumps	
Building Loop Pump Enable	DHWPEnab
Building Loop Pump Command	DHWPCmd
Building Loop Pump Status	DHWPSts
Building Loop Pump VFD Speed	DHWPVFDSpd
Building Loop Pump VFD Frequency	DHWPVFDFreq
Heat Exchanger	
DHW Heat Exchanger Enabled	HxDHWEnab
DHW Heat Exchanger Command	HxDHWCmd
DHW Heat Exchanger Runtime	HxDHWRuntime
DHW Water Entering Temperature	HxDHWETemp
DHW Water Leaving Temperature	HxDHWLTemp
DHW Water Isolation Valve	HxDHWVlvCmd
DHW Circulation Pump Command	HxDHWCPCmd
DHW Circulation Pump Status	HxDHWCPSts
HWS Water Entering Temperature	HxHWSETemp
HWS Water Leaving Temperature	HxHWSLTemp
HWS Water Isolation Valve	HxHWSVlvCmd
HWS Circ Pump Command	HxHWSCPCmd
HWS Circ Pump Status	HxHWSCPSts
Energy Points - Water	
Domestic Hot Water Temperature Entering	DHWEtemp
Domestic Hot Water Temperature Leaving	DHWLTemp
Domestic Hot Water Flow	DHWFlow

Domestic Hot Water

Description	Point Name navName
Domestic Hot Water Volume (accumulated)	DHWVolume
Domestic Hot Water Energy (accumulated)	DHWEnergy
Domestic Hot Water Power	DHWPower

Energy Points - Heat Recovery Water

Heat Recovery Water Temperature Entering	HRUWEtemp
Heat Recovery Water Temperature Leaving	HRUWLTemp
Heat Recovery Water Flow	HRUWFlow
Heat Recovery Water Volume (accumulated)	HRUWVolume
Heat Recovery Water Energy (accumulated)	HRUWEnergy
Heat Recovery Water Power	HRUWPower

EF (Exhaust Fans)

Description	Point Name navName
Occupancy	Occ
Exhaust Fan Enable	EFEnab
Exhaust Fan Command	EFCmd
Exhaust Fan Status	EFSts
Exhaust Damper Command (open/closed)	EFDmprCmd
Exhaust Damper Position	EFDmprPos
Exhaust Damper Status	EFDmprSts
Energy Points - Electric	
VFD Energy Total (accumulated)	EFVFDEnergy
VFD Power Total	EFVFDPower

Cooling Tower

Description	Point Name navName
Cooling Tower Enabled	CTEnab
Condenser Water Entering Temperature	CTCWETemp
Condenser Water Leaving Temperature	CTCWLTemp
Sump Temperature	CTSumpTemp
Sump Heater Command	CTSumpHtrCmd
Sump Heater Status	CTSumpHtrSts
Fan Enabled	CTFanEnab
Fan Command	CTFanCmd
Fan Status	CTFanSts
Fan VFD Speed	CTFanSpd
Fan VFD Freqency	CTFanVFDFreq
Pump Enabled	CTCPEnab
Pump Command	CTCPCmd
Pump Status	CTCPSts
Pump VFD Speed	CTCPVFDSpd
Pump VFD Frequency	CTCPVFDFreq
Energy Points - Electric	
Fan VFD Energy Total (accumulated)	CTFanVFDEnergy
Fan VFD Power Total	CTFanVFDPower
Energy Points - Electric	
Pump VFD Energy Total (accumulated)	CTPVFDEnergy
Pump VFD Power Total	CTPVFDPower