25 0000 | Integrated Automation

This standard is a baseline specification that is expected to be incorporated into all projects containing work on a building automation system. It contains the university's requirements and expectations where they exist. It is the engineer of record's responsibility to review this standard specification and expand or modify where required for their specific project. Modifications must be approved by UK Controls. Additions may need to be provided where the specification may not be all encompassing for a specific project – this specification does not include requirements for airflow measuring stations, for example.

Unless specifically noted, all standards apply to both the healthcare campus and the education campus.

Exceptions to these standards may be considered on a case-by-case basis for extraordinary projects or where value engineering is required. All deviations must be approved by the Capital Projects Project Manager and UK Controls.

Designers are encouraged to present the university with new or different systems, equipment, or materials when they may provide a better or more valuable product.

PART 1 - GENERAL

1. RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, General Mechanical Provisions and General Requirements, Division 1 Specification Sections apply to the work specified in this Section and other Sections of Division 25.
      1. Division 1 Sections relating to commissioning requirements.
      2. Division 22 Sections for plumbing equipment and systems interfaces.
      3. Division 23 Sections for mechanical equipment and systems interfaces.
      4. Division 25 Integrated Automation
      5. Division 26 Sections for electrical requirements.
2. DEFINITIONS
   A. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data and services over a network.
   B. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.
   C. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.
   D. BACnet PICS: Protocol Implementation Conformance Statement
   E. BAS: Building Automation System
   F. B-AAC: BACnet Advanced Application Controller
   G. B-ASC: BACnet Application Specific Controller
   H. MS/TP: Master-slave/token-passing, ISO/IEC/IEEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.
   I. Tier 1 Device: A control device that communicates with UK's existing Tridium servers via BACnet IP
   J. Tier 2 Device: A control device that communicates with a Tier 1 device via BACnet MS/TP
   K. VLAN: Virtual Local Area Network
3. RELATED WORK SPECIFIED ELSEWHERE:
   A. Products installed under other Division 23 Sections including but not limited to:
      1. Control valves and actuators are sized and provided under this Section, and installation is by others. Control valves are expected to generally ship from the manufacturer mated to an actuator sized and selected for the valve and service. Any control valve actuators that require field installation will be installed under this Section.
      2. Hydronic flow switches not provided by manufacturers are provided under this Section, and installation is by others.

3. Sockets, fittings, sockolets/threadolets/weldolets or equivalent, p/t ports, manual isolation valves and other in-pipe hardware required for proper hydronic sensor installation (temperature, pressure, flow, etc.) required for work under this Section are provided and installed by others. Sensor and instruments including, but not limited to: temperature sensors, pressure sensors, pressure switches and flow meters are provided under this Section. Sensor wells for instruments provided under this Section are provided under this Section.
4. Automatic control dampers, when not supplied with equipment, are sized and provided under this Section. Installation is by others. Automatic control damper actuators are sized, provided and installed under this Section.
5. Airflow measuring stations, when not supplied with equipment, are sized and provided under this Section. Installation is by others.

B. Products installed but not provided under this Section include:

1. Any manufacturer provided (under Division 23) loose interlock devices that are not excluded by the language in 1.2.A. above. For example, many packaged RTUs ship with loose sensors requiring field installation that tie into the factory installed controller and are required for proper operation.

C. Products not installed or provided, but may be integrated to under this Section include:

1. Chiller factory controls.
2. Boiler factory controls.
3. Pump skid or package controls.
4. Air-side equipment factory controls (AHU, RTU, MAU, DOAS, FCU, CRAC/CRAH, etc.) as applicable.
5. Chemical treatment equipment controls.
6. Fire alarm control panels and associated devices like smoke detectors and their associated relays.
7. Fire, smoke or combination dampers are not provided or installed under this Section. These dampers will be provided by others and will be controlled by the fire alarm system. The wiring will be performed by others, with one exception. The ATC contractor will wire all damper position indication devices to a controller for the fire, smoke or combination dampers as indicated on the Drawings and in the related Specification Sections. Additionally, where a fire/smoke damper is also used for modulating control, this contractor will wire the portion responsible for modulation.
8. Electrical system metering or monitoring.
9. Lighting control systems.

4. DESCRIPTION OF WORK

A. Furnish a Building Automation System (BAS) capable of communicating with existing University BAS servers and devices via BACnet IP. All building controllers, Application Specific Controllers (ASCs), and all inputs/outputs shall be visible across the environmental VLAN via a communication schema as defined in ANSI/ASHRAE Standard 135-2016, BACnet. This system shall communicate with the University of Kentucky Facility Management's existing BACnet head-end software using BACnet IP at the Tier 1 level and BACnet MS/TP at the Tier 2 level.

B. No gateways shall be used for communication to controllers installed under this section. BACnet MS/TP or BACnet IP shall be used for all other tiers of communication. No servers shall be used for communication to controllers installed under this section. If servers are required, all hardware and operating systems must be approved by the University's Energy Management Senior Manager and/or the Facilities Management Information Technology Manager. No Ethernet networking equipment (switches, routers, etc.) will be provided under this Section.

C. All BAS devices shall be located behind the University firewall, but outside of the Medical Center Firewall and on the environmental VLAN.

D. BACnet Protocol Implementation Conformance Statement:

1. The controls contractor shall include their BACnet PICS and BIBB statements (as described in ASHRAE 135-2001) for their BACnet Interface with their shop drawings. The interface shall comply with the following as a minimum.

   Vendor Name: Tridium, Inc.

   Product Family: Niagara Framework, including N4 Web Supervisor, JACE 9xxx at release 4.14 or greater using the most current version of JAVA or HTML 5. All control work associated with this project must be fully compatible with this version of Tridium such that all alarms, points, etc. communicate and clear alarms seamlessly with the existing system.

   Description: This product family provides bi-directional communication between the Tridium Niagara Framework and a BACnet system operating at BACnet Conformance Class 3, over Ethernet media.

   BACnet Protocols are documented in Appendices A, B & C.

E. It is the owner's intent to purchase an open system capable of being serviced and expanded by any acceptable system integrator that has and maintains certification (TCP) to work on Niagara Framework systems. The Niagara Compatibility Statement (NICS) for all Niagara Software shall allow open access and be set as follows:

   accept.station.in="*" accept.station.out="*" accept.wb.out="*" accept.wb.in="*".

   In any case, UK Controls shall maintain the right to direct contractor to modify any software license, regardless of supplier, as desired by UK Controls. The Contractor shall not install any "brand specific" software, applications or utilities on Niagara Framework based devices.

F. The BAS contractor shall provide all necessary hardware and software to meet the requirements in this Section. Provide BACnet Protocol Implementation Conformance Statement (PICS) for Windows-based control software and every controller in system, including unitary controllers. These must be in compliance with head-end systems PICS and BIBBs and attached Tridium PICS and BIBBs. Provide all hardware and software to backup, restore, troubleshoot and install system. Software, backups, unitary, and ASC files shall be delivered to UK Controls for archiving purposes.

G. Contractor shall provide all equipment, engineering and technical specialist time to check the installation required for a complete and functioning system. The contractor shall furnish and install all interconnecting system components. Components to include, but not be limited to: power line conditioners, field panels, sensors, motor starter interfaces, and any other hardware items not mentioned above but required to provide the Owner with a complete workable system.

H. Any feature or item necessary for complete operation, trouble-shooting, and maintenance of the system in accordance with the requirements of this specification shall be incorporated, even though that feature or item may not be specifically described herein. This shall include hardware and software.

I. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed especially for this project. All systems and components shall be thoroughly tested and proven in actual use.

J. It is the contractor's responsibility to ensure that the University of Kentucky Facilities Management's head-end system's (i.e. Server) licensed device/point count is increased to accommodate the number of devices and/or points that are added to fulfill the contractor's obligation to meet the requirements of the project. The server Host ID will be provided based on location of the project by Facilities Management.

K. Prepare individual hardware layout, interconnection drawings and software configuration from project design data for each system to be included in the ATC system.

L. Design, provide, and install all equipment cabinets, panels, communication cabling and all associated hardware and devices.

M. Provide and install all interconnecting cables between supplied cabinets, panels, controllers and input/output devices. Provide devices for installation by others as detailed in 3.A. above. Install devices provided by others as detailed in 3.B. above. Provide for hardware or software integration as detailed in 3.C. above.

N. Provide complete manufacturer's product data for all items that are supplied under this Section. Include vendor name of every item supplied. Any variances from this specification shall be submitted in writing during bid submission.

O. Provide supervisory specialists and technicians at the job site to assist in all phases of system installation, checkout, startup, commissioning, punch list remediation, off season testing and warranty support.

P. Provide as-built documentation, programming software for use site wide, electronic copies of all diagrams, and all other associated project operational documentation (such as technical manuals, product data and point to point checkout documentation) on approved media, the sum total of which accurately represents the final system. Electronic copies of O&M information and drawings shall be provided in .pdf format, and all drawings will be provided in .dwg format.

Q. Furnish, install, and fit-up in complete working order, with all accessories required, the automatic temperature control and monitoring systems shown on the Drawings and specified herein. The systems shall be properly connected, piped and wired in a manner conforming to the laws, ordinances and codes now in force in the Commonwealth of Kentucky.

R. Related to the alarms, the contractor is to set up the alarm programing parameters specified by the system sequences of operations. Facilities Management will be responsible for configuring the alarm names, alarm texts and enabling the alarm points.

S. All work must be coordinated and scheduled with the FM Controls group prior to any work being performed on site.

T. Space Temperature Sensors: Each terminal unit requires a space temperature sensor for operation, unless specifically indicated on the Drawings to be slaved to another unit. Slaved terminal units shall be controlled to match the CFM and discharge air temperature of the master unit. Space temperature sensor locations have been identified on the Drawings to the extent possible, but all such locations may not be shown. Provide the required space temperature sensors whether or not they are shown on the Drawings. For those space temperature sensors not shown on the Drawings, work out an acceptable location with the Architect/Engineer. No sensor covers are allowed. Additional information regarding space temperature sensor applications appears later in this document.

U. Provide DDC controls for the air terminal units including but not limited to VAV and Fan Powered Box terminal units. Provide electronic operators controlled and monitored by direct digital control systems which shall include, but not be limited to, air handling systems, pumps, terminal units, etc.

V. The control equipment shall be complete and shall include, but not be limited to, all necessary valves, damper operators, pipe, fittings, sensors, etc.

W. The BAS for this project shall be made up using standard materials, equipment and components regularly manufactured for systems of this type. The system shall be complete in every respect and shall be a functioning system.

5. QUALITY ASSURANCE

A. Installing Contractor Qualifications: Installing controls contractors must comply with the following requirements:

1. The installing systems integration contractor has been in the business of installing BACnet controls for a minimum of 5 years. Contractor shall have 3 years of installation history with the product they are submitting. In addition, the installing systems integration contractor needs to verifiably demonstrate that they have provided the controls in a minimum of (3) hospital or university renovation projects of similar size and scope where they successfully installed a BACnet system.

2. The systems integration contractor must have on staff the following number of key personnel as a minimum, each with a minimum of 5 years of related BACnet controls installation experience: Project Manager - 2, Controls Applications Engineer - 2, Programmer - 2, Installation Supervisor - 2, Controls Technician - 5.

3. Tridium Niagara N4 certified technicians are required. Contractor to have experience with successful integrations of controls with Tridium Niagara systems. Provide 3 references upon request.

4. Contractor must have a help desk operation or staff available for phone contact 24/7 for providing technical support to university staff. Call forward and emergency service numbers are not acceptable during normal business hours.

B. Codes and Standards

1. Engineer of record to provide list of currently adopted codes which are applicable to the specific project.

6. SUBMITTALS

A. Shop Drawings, Product Data, and Samples

1. Each submittal shall have a cover sheet with the following information provided: submittal ID number; date, project name, address, and title; BAS Contractor name, address and phone number; BAS Contractor project manager, and project engineer names and phone numbers. Provide brief resumes for all key contractor personnel.
2. Each submittal shall include the following information.
    a. BAS riser diagram showing all DDC controllers, network repeaters, and network wiring.
    b. One-line schematics and system flow diagrams showing the location of all control devices.
    c. Points list for each DDC controller, including: Tag, Point Type, System Name, Object Name, Expanded ID, Display Units, Controller Type, Address, Cable Destination, Module Type, Terminal ID, Panel, Slot Number, Reference Drawing, and Cable Number. The initial shop drawing submittal for review needs to include all point names meeting the naming convention outlined in this specification for UK Controls approval at the shop drawing phase prior to the contractor beginning any programming.
    d. Vendor's own written description for each sequence of operations, to include the following:
        (a) Sequences shall reference input/output and software parameters by name and description.
        (b) The sequences of operations provided in the submittal by the BAS Contractor shall represent the detailed analysis needed to create actual programming code from the design documents.
        (c) Points shall be referenced by name, including all software points such as programmable setpoints, range limits, time delays, and so forth.
        (d) The sequence of operations shall cover normal operation and operation under the various alarm conditions applicable to that system.
    e. Detailed Bill of Material list for each panel, identifying: quantity, part number, description, and associated options.
    f. Control Damper Schedules. This spreadsheet type schedule shall include a separate line for each damper and a column for each of the damper attributes, including: Code Number, Fail Position, Damper Type, Damper Operator, Blade Type, Bearing Type, Seals, Duct Size, Damper Size, Mounting, and Actuator Type.
    g. Control Valve Schedules. This spreadsheet type schedule shall include a separate line for each valve and a column for each of the valve attributes, including: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close off Pressure, Capacity, Valve CV, Calc CV, Design Pressure, Actual Pressure, and Actuator Type.
    h. Cataloged cut sheets of all equipment used. This includes, but is not limited to, the following: DDC panels, peripherals, sensors, actuators, dampers, and so forth. Cut sheets with multiple devices on them will have the pertinent material called out. This shall include manufacturer's technical product data for each control device furnished, indicating dimensions, capacities, performance and electrical characteristics, and material finishes

i. Range and scale information for all transmitters and sensors. This sheet shall clearly indicate one device and any applicable options. Where more than one device to be used is on a single sheet, submit two sheets, individually marked.

j. Hardware data sheets for all local access panels.

k. Software manuals for all applications programs to be provided as a part of the programming devices, and so forth for evaluation for compliance with the performance requirements of this Specification.

l. The controls contractor shall include their BACnet PICS and BIBB statements (as described in ASHRAE 135-2016) for each device.

m. Locations of all space, duct, and hydronic static pressure and differential pressure probes and sensors.

n. Locations of all power supplies and the circuits they are served from.

3. BAS Contractor shall not order material or begin fabrication or field installation until receiving authorization to proceed in the form of an approved submittal. BAS Contractor shall be solely responsible for the removal and replacement of any item not approved by submittal at no cost to the Owner.

4. Submittal shall have approved point names.

5. Submit software packages for FM approval after submittal approval but before installation, for the pre-commissioning meetings.

6. Long lead time products provided under this Section shall be submitted under separate cover before the complete hardware submittal is provided. These items include, but are not limited to: airflow measuring stations, control dampers, control valves, flow meters, terminal unit controllers intended for factory installation and any other materials for installation by others.

B. Maintenance Data: Submit maintenance instructions and spare parts lists for each type of control device. Include that type data, product and shop drawings in maintenance manual.

C. Operation and Maintenance Instructions

1. This contractor shall prepare an electronic Operations Manual entitled "Automatic Temperature Control and Monitoring Systems Operation and Maintenance Data." Manual shall be .pdf files with separate .pdfs for each of the items noted below.

2. Each manual shall contain the following information:

a. Name and address of Consulting Engineer, Contractor, and index of equipment, including vendor (name and address).

b. Complete brochures, descriptive data and parts list, etc., on each piece of equipment, including all approved shop drawings.

c. Complete maintenance and operating instructions, prepared by the manufacturer, on each major piece of equipment, including preventative maintenance instructions.

d. Complete shop drawing submittal on temperature and monitoring controls including control diagrams updated to reflect "as-built" conditions.

e. All wiring and component schematics necessary for Owner to troubleshoot, repair, and expand the system.

3. All manuals shall be submitted to the Engineer prior to final inspection of the building.
4. Provide a laminated copy of the as-built drawings and sequences of operations inside of each control panel that relate to each respective panel.

D. Controls Program Backup: At the end of the project, the contractor is to supply digital back-up copies of all final complete operating controls programs. These shall be delivered to UK Controls for archiving purposes.

E. UK Controls 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, databases and documentation for all configuration and programming that is generated for a given project. All required IDs and passwords for admin and programming level access to any component or software program shall be provided to UK Controls.

7. WARRANTY

A. System acceptance and the pursuant warranty is at the discretion of FM. The system, including all hardware and software components shall be warranted for a minimum period of one year, or longer depending on manufacturer warranty when the system performance is deemed satisfactory in whole by FM. The system parts will be accepted for beneficial use and placed under warranty at that time. A Certificate of Occupancy does not initiate the control system warranty. Any defects in materials and workmanship arising during this warranty period shall be corrected without cost to the Owner.

B. The BAS Contractor shall provide a five-year software maintenance agreement (SMA) on all Tier 1 controllers.

C. All applicable software as detailed in this specification should be updated by the BAS Contractor free of charge during the warranty period. This will ensure that all system software will be the most up-to-date software available from the BAS Contractor.

D. Software backups and updates will be provided to the owner at no cost during the warranty phase of the project.

8. DELIVERY, STORAGE AND HANDLING

A. Provide factory shipping cartons for each piece of equipment and control device. Maintain cartons while shipping, storage and handling as required to prevent equipment damage and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protect from weather. Stored materials will be handled per the provisions in Division 1.

PART 2 - PRODUCTS

1. DIRECT DIGITAL CONTROL SYSTEM

A. General: This specification defines the minimum hardware and performance requirements for a computer-based building automation system to be furnished and installed.

1. DIRECT DIGITAL CONTROL (DDC) EQUIPMENT

A. System Software

1. All software required for monitoring, modifying, configuring and backup for the system shall be embedded in the controller and accessible via contractor provided software or the web. This software shall allow any computer with access (and security) to the University's network to perform the work described above using a web browser or provided software. No software upgrades should be required unless provided at no additional cost to the customer.
2. The software version used for installation of any new devices must either be at the current software version used on the University Facilities Management campus at the current JAVA/HTML version or the new software at the most current JAVA/HTML version must be installed on all devices and the current system prior to the installation of the new devices. All software is to also operate on the latest version of Microsoft Windows operating system. All configuration and programming tools required for the upgraded version must be provided at the time of installation.
3. Provide a USB, standard RS-232 9 pin female, Bluetooth, RJ11, RJ12 or RJ45 connection for on-site access.

B. BACnet Conformance

1. Building Controller shall as a minimum support MS/TP and Ethernet BACnet LAN types. It shall communicate directly via these BACnet LANs as a BACnet device and shall support simultaneous routing functions between all supported LAN types. Global controller shall be a BACnet conformance class 3 device and support all BACnet services necessary to provide the following BACnet functional groups:
    a. Clock Functional Group
    b. Files Functional Group
    c. Reinitialize Functional Group
    d. Device Communications Functional Group
    e. Event Initiation Functional Group
2. Please refer to end of this section 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.
3. Standard BACnet object types supported shall include as a minimum: Analog Value, Binary Value, Calendar, Device, File, Group, Notification Class, Program and Schedule object types. Alarms should also be setup on this system with limits. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data.
4. The Building Controller shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internetwork. It must support interoperability on the campus area network and function as a BACnet Broadcast Management Device (BBMD) and/or a BACnet router. New Implementations should be capable of supporting Gigabit Ethernet, IEEE standard 802.3ab, 100 Mbps connection may still be supported, but they'll be next on the list to get treated like 10M from the perspective of the manufacturers.

C. BACnet Advanced Application Controller (B-AAC)

1. General
    a. Advanced Application Controllers are to be Tier 1 devices which communicate directly with the existing UK FM Tridium Niagra via BACnet IP.

2. Manufacturer: Subject to compliance with requirements, manufacturers offering controls that may be incorporated into the BAS system at Tier 1 BACnet IP include the following:
    a. Vykon JACE 9000
    b. Johnson Controls Facility Explorer FX-90
    c. Distech EC-BOS 9000
    d. Schneider Electric TAC I/A Series
    e. Acceptable controls manufacturers shall include any controls manufacturer which utilizes the BACnet protocol in accordance with the specification and is approved prior to bid. If the bidding manufacturer is not listed above, documentation for approval as an equal must be submitted and approved during the bidding process.
3. Application
    a. An AAC shall be provided at a minimum for each Air Handling Unit, Rooftop Unit, Primary and Secondary pumping systems, Hot Water Heating Systems, and other applications as shown on the drawings.
    b. Each floor of a building shall include a minimum of one AAC for all terminal unit Tier 2 controllers to report to.
4. Requirements
    a. Controls shall be microprocessor based, Advanced Application Controllers (B-AAC's). B-AAC's shall be based on a minimum 16 bit microprocessor working from software program memory which is physically located in the B-AAC. The application control program shall be resident within the same enclosure as the input/output circuitry which translates the sensor signals. All input/output signal conversion shall be performed through a minimum of a 10 bit A to D converter. All input points shall be universal in nature allowing their individual function definition to be assigned through the application software. All unused input points must be available as universally definable at the discretion of the owner. If the input points are not fully universal in nature, unused points must be equal in quantity between Analog Inputs and Digital Inputs.
    b. All B-AAC controllers shall have open licensing to connect to existing UK FM Tridium Niagra via BACnet/IP.
    c. Contractor shall provide a minimum of one B-AAC controller per air handling or mechanical system as shown on the drawings.
    d. The BAS contractor shall provide and field install all B-AAC's specified under this section. Mechanical equipment manufacturers desiring to provide B-AAC' type controls as factory mounted equipment, shall provide a separate bid for their products less all controls, actuators, valve assemblies and sensors, which are specified to be provided by the BAS/Temperature control contractor.
    e. All input/output signals shall be directly hardwired to the B-AAC. Troubleshooting of input/output signals shall be easily executed with a volt-ohm meter (VOM). As a result of this intent, it is specified that power line carrier systems, or other systems which command multiple outputs over a single pair of wires, shall not be utilized.

f. B-AAC's shall be in continuous direct communication with the network which forms the facility wide Building Automation System. The B-AAC's shall communicate with the B-BC at a minimum baud rate of 38400 baud.

g. Non-Volatile Memory: All control sequences programmed into the B-BC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained. Power failures shall not cause the GDC memory to be lost, nor shall there be any need for batteries to be recharged or replaced to maintain the integrity of the controller database.

h. The B-AAC shall allow for the creation of unique application control sequences. Systems that only allow selection of sequences from a library or table are not acceptable.

i. All control sequences shall be fully programmable at the B-AAC, allowing for the creation and editing of an application control sequence, while at the unit.

j. The B-AAC shall be provided with an interface port (standard RS232 data terminal port or USB port) for a laptop computer. The interface port shall allow the laptop to have full functionality as described above. From the interface port or network terminal, the laptop shall be able to directly access any B-AAC or B-ASC in the network.

k. The B-AAC shall provide LED indication of transmit/receive communications performance, as well as for the proper/improper operation of the controller itself.

l. The B-AAC shall be provided with a battery backed time clock that is capable of maintaining the time of day and calendar for up to thirty days, upon loss of power to the B-AAC, without loss of setting. The battery for the time clock shall be replaceable by the customer. The B-AAC shall be provided with integral time schedules; as a minimum, two seven day schedules with eight on/off periods per day shall be provided. Holiday override of weekly schedules shall be provided for pre-scheduling of holidays, for the year in advance.

m. To simplify controls and mechanical service troubleshooting, the B-AAC shall be capable of being mounted directly in or on the controls compartment of the air handling system. The B-AAC shall be housed in a NEMA 1 enclosure to accommodate direct mounting on the equipment to be controlled. The B-AAC shall be constructed in a modular orientation such that service of the failed components can be done quickly and easily. The modular construction should limit the quantities of printed circuit boards to a maximum of two. All logic, control system, power supply and input/output circuitry shall be contained on a single plug-in circuit board. When required to replace a printed circuit board, it shall not be necessary to disconnect any field wiring. This shall allow all controls maintenance and troubleshooting to be made while at the air handling unit. The B-AAC shall be directly wired to sensory devices, staging relays or modulating valves for heating and cooling.

n. Every controller and control panel shall be labeled with a lamicoid plate permanently secured to the device. Sticky tape or glued labels are not acceptable. The labeling shall describe the device and include related information such as MAC address, IP address, BACnet Instance numbers, etc.

o. All power feeds shall be clearly identified and shall include panel number, breaker and electrical panel location if not in the same room. Controller power will not be routed through a safety circuit.

p. For compatibility to the environment of the air handling unit, B-AAC's shall have wide ambient ratings. B-AAC's shall be rated for service from -40 DegF (Degrees Fahrenheit) to 140 DegF.

q. Contractor shall submit description of location of B-AAC's on all mechanical and air handling equipment.

5. B-AAC Naming Convention

a. See Appendix D – Device Naming Standard

D. BACnet Application Specific Controller (B-ASC)

1. General

a. Application Specific Controllers are to be Tier 2 controllers that communicate up to Tier 1 controllers via BACnet MS/TP.

2. Subject to compliance with requirements, manufacturers offering controls that may be incorporated into the work at Tier 2 BACnet MS/TP include the following:

a. Johnson Controls Facility Explorer F4-CG & CV Series

b. Distech ECB

c. Alerton VLC

d. Schneider Electric TAC I/A Series Easy Logic

e. Acceptable controls manufacturers shall include any controls manufacturer which utilizes the BACnet protocol in accordance with the specification and is approved prior to bid. If the bidding manufacturer is not listed above, documentation for approval as an equal must be submitted and approved during the bidding process.

3. Application

a. B-ASC's shall be provided for all unitary systems and terminal units such as VAV's, heat pumps, fan coil units, and other applications as shown on the plans.

b. Other equipment that may include Tier 2 controllers are VFD's and equipment with packaged controllers such as a pump skid or at heat pump with BACnet integration capabilities.

4. Requirements

a. B-ASC's shall be based on a minimum 16-bit microprocessor working from software program memory which is physically located in the B-ASC. The application control program shall be resident within the same enclosure as the input/output circuitry which translates the sensor signals. All input/output signal conversion shall be performed through a minimum of a 10-bit A to D converter.

b. Contractor shall provide a minimum of one B-ASC controller per unitary system as shown on the drawings.

c. The BAS contractor shall provide and install all B-ASC's specified under this section.

d. All input/output signals shall be directly hardwired to the B-ASC. Troubleshooting of input/output signals shall be easily executed with a volt-ohm meter (VOM). As a result of this intent, it is specified that power line carrier systems, or other systems which command multiple outputs over a single pair of wires, shall not be utilized.

e. B-ASC's shall be in continuous, direct communication with the network which forms the facility wide building automation system. The B-ASC's shall communicate with the B-AAC at a baud rate of no less than 38,400 baud.

f. Non-Volatile Memory: All control sequences programmed into the B-ASC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained. Power failures shall not cause the B-ASC memory to be lost, nor shall there be any need for batteries to be recharged or replaced to maintain the integrity of the controller database.

g. The B-ASC shall allow for the creation of unique application control sequences.

h. The B-ASC shall be provided with the ability to interface with a laptop computer. The interface port shall be provided at the wall sensor or within the unitary equipment. Connection to the wall sensor must be a standard RJ-45 or USB port.

i. Controller Location: To simplify controls and mechanical service troubleshooting, the B-ASC shall be mounted directly in the controls compartment of the unitary system. The B-ASC shall be provided with a sheet metal or polymeric enclosure that is constructed of material allowing for the direct mounting within the primary air stream, as defined by UL-465. The direct mounting shall allow all controls maintenance and troubleshooting to be made while at the unitary equipment. The B-ASC shall be directly wired to sensory devices, staging relays or modulating valves for heating and cooling.

j. For compatibility to the environment of the unitary equipment, B-ASC shall have wide ambient ratings. B-ASC's shall be rated for service from 32 DegF (Degrees Fahrenheit) to 140 DegF.

k. Contractor shall submit description of location of B-ASC's on all mechanical and unitary equipment

5. B-ASC Naming Convention

   a. See Appendix D – Device Naming Standard

F. Control Panels

1. All control panels must have a tamper switch installed that will indicate panel opening. The switch will be wired as a digital input to a controller in each respective panel.

2. All panels will be manufactured of code gauge steel. Indoor control panels will be NEMA 1 rated. All outdoor panels will be NEMA 4X rated. Control panels shall be gray in color, and all panels for a project shall be keyed alike. All control panels shall have perforated back planes.

3. Panelboard shall contain all instruments and accessories. Provide each item of equipment with an engraved nameplate. Panelboard shall be wall-mounted or stand-mounted and shall be completely enclosed.

4. As far as is practical, the control components for each system shall be grouped. Provide each group of components with identification.

5. The entire panelboard shall be pre-wired with terminal strips for power (segregated) and all inputs and outputs. All relays, switches, etc., shall be installed, furnished and wired on panelboard. Clearly mark each terminal strip as to which wire from which component is to be connected. Terminals, devices and wiring shall be uniquely labeled. Class 1 and Class 2 circuits will be segregated. Wiring troughs will be used above or below the panel to minimize excessive conductors in the panel. All wiring pathways within the panel will be enclosed in wire duct (i.e. Panduit Panduct). At least one panel per mechanical room should include a convenience RJ-45 Ethernet connection jack. Class 2 120/24V used power supplies (like Functional Devices) shall be provided with at least one three-prong outlet per panel. Control panels shall be sized to allow for at least 10% additional point capacity. 120 VAC wiring will be appropriately sized THHN. All I/O cabling will be installed as plenum rated 18 AWG jacketed cable. Analog inputs and outputs will be in shielded cable, with the shield drained to ground only at the panel. Pneumatic devices that reside in the panel will be connected from the field to a bulkhead fitting on the panel, with the device connection to the bulk-head prefabricated. Plenum rated cable ties and “sticky backs” will be used to offer a professional panel appearance. No splices are permitted. Panels shall be cleaned before turn-over. Dust, debris and wire fragments should not be present.
6. Panel-Mounted Equipment: Temperature and humidity controllers, relays, and automatic switches; except safety devices. Mount devices with adjustments accessible through front of panel.
7. Door-Mounted Equipment: Flush-mount (on hinged door) manual switches, including damper-positioning switches, changeover switches, thermometers, and gages. Flexible wire duct will be provided and installed to protect cabling to door-mounted equipment.
8. Graphics: Color-coded graphic, laminated-plastic displays on doors, schematically showing system being controlled, with protective, clear plastic sheet bonded to entire door.

G. Sensors

1. Temperature

   a. Electronic Sensors used in air ducts or liquid lines shall utilize non-adjustable thermistor sensing elements with + or -0.36˚F, accuracy and stability of at least + or -0.05˚F per year. All sensors used in liquid line shall be provided with separable stainless steel immersion wells. Immersion sensors shall protrude approximately 50% into the pipe. Heat transfer compound shall be installed on all immersion temperature sensors prior to installation in the well. Averaging sensors shall be a minimum of five (5) feet in length and shall be installed in such a manner so as to sense representative sample of the medium being controlled and shall be sized by the coil or duct area per manufacturer’s recommendation.

   b. Outside air temperature sensors shall have a minimum range of -52°F to 152°F (-46.6°C to 66.6ºC) and an accuracy of within +1ºF (0.5ºC) in this temperature range. Sunshields shall be provided for outside air sensors. Each building shall have an outdoor air temperature and humidity sensor installed, but they will be slaved as backup to a network passed sensor value as defined by UEM.

2. Humidity:

   a. Humidity Sensors: Humidity sensors shall be of the solid-state type using a capacitance sensing element. The sensor shall vary the output voltage with a change in relative humidity. Room humidity sensors shall have a minimum range of 10% to 90% +/- 2% and supply air humidity sensors shall have a range of 10% to 90% +/- 2%.

3. Equipment Operation Sensors: As follows:
    a. Status Inputs for Fans: A current sensing relay should also be provided so that the owner knows if belts are lost or fans are running backwards.
    b. Status Inputs for Electric Pumps: Differential pressure switch with adjustable range set to make at minimum flow. A current sensing relay should also be provided so that the owner knows is other problems are present.
4. Electric Pneumatic Transducers: Convert plus or minus 12-V dc pulse-width-modulation outputs (preference is 4-20mA or 0-10 Volts), or continuous proportional current or voltage to 0 to 20 psi (0 to 138 kPa). Note that all new systems are to be fully DDC. This device is only included here for interactions with existing systems.
5. Damper Position Indication: Potentiometer mounted in enclosure with adjustable crank-arm assembly connected to damper to transmit 0 to 100 percent damper travel.

H. Sensor input and output devices:
1. The following sensors and devices, or their equivalents, shall be considered acceptable. Other sensors and devices required for this specification are outlined in their respective subsystem.
2. Analog sensing elements for remote indication shall be independent of local pneumatic sensors used for local control loops.
3. System Accuracy: The system shall maintain an end-to-end accuracy for one year from sensor to operator's console display for the application specified.

STANDARD	Temperature Sensors
TYPE	Resistive
STANDARD	RTD
	2 wire configuration
	European curve, Alpha = .00385
	Ohms/Ohm/deg.C., meets DIN SID 43760
MECHANICAL	1/4" stainless steel sheath
DUCT TEMPERATURE	Standard lengths -- 5.5", 11.5" and 17.5"
	Other lengths with owner's written approval.
	Locate in central area of airstream at minimum of 18" from
	reheat coil.
	1/2" NPT mounting thread and flange and conduit connection.
	Glass encapsulated element unless otherwise approved.
THERMOWELL	Stainless steel
	Glass encapsulated element unless otherwise approved.
	3/4" process connection with drilled wells.
	1/2" NPT process connection on built-up wells.

	Insertion into measured medium - 1" + 1/2" diameter of pipe.
	Cast iron connector head - 1/2" NPT process connection and conduit connection.
	Rated thermowell pressure = 250 psi.
ELEMENT ACCURACY	Must meet .1% DIN and the DIN 43760 standard.
OVERALL ACCURACY	± 1 deg.F. General duct, space and thermowell temperatures.
	± .75 deg.F. for thermowell ele. on 4" or larger pipes.
	± .5 deg.F. for thermowell ele. on 8" or larger pipes.
OVERALL RANGE	-20% to 120% of possible operating conditions.

STANDARD	Pressure Sensor
TYPE	Electronic with LVDT element.
APPLICATION	0-10V Output (2 wire)
	Wire in conduit
	Input voltage 10-35 volts DC
	Loop resistance greater than or equal to 500 ohms
MECHANICAL	Linear variable differential transformer
	(LVDT) element
	Allowable Standard Ranges 0- 30 PSI
	0-100 PSI
	0-200 PSI
	Other ranges with Owner written approval
	1/2" NPT input thread and conduit connection.
	Provide differential inputs unless otherwise approved.
	Provide an air filter on unused differential ports.
	Provide with a NEMA 4 watertight enclosure unless otherwise approved.
	Min. rate pressure - 150% FS proof and 450 PSI static.
OVERALL ACCURACY	± 0.5% F.S. including Linearity, hysteresis and repeatability.

Accuracy Note: If pressure transducer is used to calculate flow with a pilot tube, then the accuracy of the pressure sensor should be dictated by the overall accuracy requirement of the system and would probably require a high accuracy sensor.

This section covers all new transducers provided. All new transducers provided shall be of the following type:

INPUT	OUTPUT
1. Flow Instantaneous	4-20 mA, 2 wire
2. Flow Integrated	Pulse 10 PPS Max A25
	msec open (min.) 40 msec
	closed (min.)
3. KW Instantaneous	4-20 mA, 2 wire
4. KWH - Integrated	Pulse – 10 PPS Max A25
	msec open (min.) 40 msec
	closed (min.)

4. Digital inputs from devices with isolated, dry type contacts (no grounds, no voltage) of either normally open (N.O.) or normally closed (N.C.) configuration. Live contact inputs, those that have voltage present, shall be provided with isolating devices to meet dry contact requirement.
5. Space Temperature Sensors
    a. Provide space temperature sensors that work in conjunction with the B-AAC and B-ASC terminal unit controllers. Space temperature sensors shall have visible temperature indication, setpoint indication and exposed setpoint adjustment in all areas except public spaces. Space temperature sensors are to have push buttons on the front face for adjusting the temperature setpoints.
    b. In cases where a single room sensor is to be shared by multiple controllers the slave box reheat control valves and dampers shall be individually controlled to track the discharge temperature of the master unit. The Master shall be identified locally and on the ATC head-end.
    c. An RJ-11 type connection to serial port shall allow a local portable operator or programmer's terminal to access all program blocks and attributes for complete programmability.
    d. Space Temperature Sensor Accessories
        (a) Insulating Bases: For all thermostat installations on walls bordering non-conditioned spaces or the exterior.
        (b) Thermostat Guards: Locking transparent-plastic mounted on separate base. Provide where indicated on the plans.
        (c) Adjusting Key: As required for device.
        (d) Aspirating Boxes: Where indicated for thermostats requiring flush installation.
6. Operating Temperature Range: From 20 degrees to 200 degrees F. (-29 degrees to 93 degrees C.). The occupant shall have an operation local range of 68 degrees and 74 degrees on rooms with Occupancy sensors, unless otherwise specified.

I. Carbon Dioxide Sensor:

1. 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 75 PPM, whichever is greater. Response shall be less than one minute. Input voltage shall be 20 to 30 VAC or 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.

J. Switches

1. Duct Smoke Detectors: Duct smoke detectors shall be supplied with an integral auxiliary contact to be used by the BAS Contractor to provide a digital input to the BAS.
2. Low Temperature Protection Thermostats: Shall be the manual reset type. The thermostat shall operate in response to the coldest one-foot length of the 20-foot sensing element, regardless of the temperatures at other parts of the element. The element shall be properly supported to cover the entire downstream side of the coil with a minimum of three loops. Separate thermostats shall be provided for each 25 square feet of coil face area or fraction thereof. The thermostat shall have a repeatability of +/- 10F.
3. Differential Pressure Switches: Pressure differential switches shall have SPDT change-over contact, switching at an adjustable differential pressure setpoint. The differential pressure between the two pressure connections shall deflect a spring-loaded silicon diaphragm. Switches shall be rated for 4ºF to 185ºF. Repeatability shall be better than +/- 0.01" wg between the ranges of 0.08" wg to 1.2" wg and better than 0.02" wg between the ranges of 1.2" wg to 4.0” wg.
4. Current Sensing Relays: Motor status indications, where shown on the plans, shall be provided via current sensing relays. Current sensing relays shall be self-powered and shall have selectable AC ranges of 1-6 amps, 6-40 amps and 4-200 amps. The switch output contact shall be rated for 30 VDC, 0.15 amps. Threshold setting shall be fully adjustable within the selected range and response time shall be 0.25 seconds or less. Circular window within the current sensing switch shall accept #2 wire or smaller and the window shall be a minimum of 0.510 inches diameter. Housing material shall have UL listed flame retardant properties.
5. Flow Switches: Motor status indications, where shown on the plans, shall be provided via flow switches. Flow switches shall be of the paddle type equipped with SPDT contacts to establish proof of flow. Flow switches shall be of the vapor-proof type. If installed outdoors, provide a NEMA-4 enclosure. Flow switch shall be UL listed.
6. Electric Thermostats: Thermostats shall have SPDT contacts.
7. Damper End Switches: Each end switch shall be a hermetically-sealed switch with a trip lever and over-travel mechanism. The switch enclosure shall be suitable for mounting on the duct exterior and shall permit setting the position of the trip lever that actuates the switch. The trip lever shall be aligned with the damper blade and shall directly sense damper position.

K. Dampers

1. Provide automatic control dampers as indicated, with damper frames not less than 13-gage galvanized steel. Provide mounting holes for enclosed duct mounting. Provide damper blades not less than formed 16-gage galvanized steel, with maximum blade width of 8".

2. Secure blades to 1/2" diameter zinc-plated axles using zinc-plated hardware. Seal off against spring stainless steel blade bearings. Provide blade bearings of nylon and provide thrust bearings at each end of every blade. Construct blade linkage hardware of zinc-plated steel and brass. Submit leakage and flow characteristics plus size schedule for controlled dampers.
3. Do not exceed maximum 48"x48" damper size. For sizes larger then this maximum in either dimension, use multiple dampers with a separate operator for each damper. Do not link separate dampers together.
4. For standard applications as indicated, provide parallel or opposed blade design (as selected by manufacturer's sizing techniques) with inflatable steel blade edging, or replaceable rubber seals, rated for leakage less than 10 CFM/sq.ft. of damper area, at differential pressure of 4" w.g. when damper is being held by torque of 50 inch-pounds.

L. Actuators

1. Electric Valve and Damper Motors: Size each motor to operate dampers or valves with sufficient reserve power to provide smooth modulating action or 2-position action as specified.
2. Control valves and actuators on campus chilled water systems shall be able to shut off against a 250 psig differential.
3. For reheat coils in branch ductwork and heating coils for air terminal units and fan terminal units, provide non-spring return, fully proportional valve actuators.
4. For all other applications, provide permanent split-capacitor or shaded pole type motors with gear trains completely oil-immersed and sealed. Equip spring-return motors, with integral spiral-spring mechanism. Furnish entire spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
5. Equip motors for outdoor locations and for outside air intakes with "O ring" gaskets designed to make motors completely weatherproof, and equip with internal heaters to permit normal operation at -40 degrees F. (-40 degrees C.)
6. Provide separate motor for each outside air, return air and exhaust air damper. Do not link dampers with different functions together on one damper motor.
7. Provide separate motor for each damper when overall damper size exceeds 48" in either dimension. Do not link different dampers together on one damper motor.
8. Binary backed-up motors are not acceptable.

M. Variable Frequency Drives

1. Subject to compliance with requirements, acceptable manufacturers of VFDs include, and are limited to, the following:
    a. ABB (basis of design)
    b. Yaskawa
    c. Allen Bradley

N. Miscellaneous

1. Wells for Pipe Mounted Sensor: Wells shall have minimum working pressure of 150 WOG psig. Wells shall be brass or stainless steel.

2. Lightning Protection: All electric/electronic equipment supplied must be internally or externally lightning/transient surge voltage protected on all external power feeder and input/output connections which are subject to surge voltage transients. Provide high speed clamping elements which meet IEEE. STD. 472 (SWC) on all digital or analog date channels.
3. Current Sensing Relays: Relays shall monitor status of motor loads. Switch shall have self-wiping, snap-acting Form C contacts rated for application. Setpoint of contact operation shall be field adjustable.

PART 3 – EXECUTION

1. INSPECTION:
   A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.
2. INSTALLATION OF AUTOMATIC TEMPERATURE CONTROLS
   A. General: Install systems and materials in accordance with manufacturer's instructions, reviewed shop drawings, and details shown on the Contract Drawings.
3. CONTROL WIRING
   A. Install control wiring, without splices between terminal points, color-coded. Install in neat workmanlike manner, securely fastened. Install in accordance with National Electrical Code and Division 26 specifications.
   B. Install control wiring in electrical conduit in all areas. Conceal conduit, except in mechanical rooms and areas where other conduit and piping are exposed. Conduit is to be green and minimum ¾". Label junction boxes "BAS."
   C. Connect electrical components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals according to tightening requirements specified in UL 486A.
   D. Control wiring requirements are as listed below

TAG	APPLICATION	AWG	COND	SHIELD	STRANDED	PLENUM	LOW CAP	COLOR	STRIPE
MSTP	BACNET/MSTP COM	22	3	YES	YES	YES	YES	BLUE	NONE
IO2	INPUTS	18	2	YES	YES	YES	NO	ORANGE	NONE
IO4	OUTPUTS	18	4	YES	YES	YES	NO	WHITE	NONE
H-PWR	24V POWER	18	2	NO	YES	YES	NO	BROWN	NONE

4. POWER WIRING:
   A. Provide power wiring and conduit to air terminal units (if required).

B. Furnish and install power cabling and conduit for temperature controls panels and equipment from emergency power panels. Each temperature control panel shall be connected to a separate circuit. Conduits shall connect to panels at the locations directed by the Contractor under Division 26. Final connection in the power panels shall be by Temperature Control Contractor in coordination with Division 26 Contractor.

C. Electrical power wiring and interlock wiring for all controls, signal devices, equipment, alarms, etc., shall be in accordance with diagrams and instructions from the supplier of the systems. All power and control wiring, conduit and wiring connections required for the complete installation, shall be provided by this Contractor in accordance with Division 26 requirements. Coordinate panel power requirements with Division 26 immediately after award.

D. Supervisory controls shall be on emergency power for central station equipment where possible. Tier 1 controllers shall also be on emergency power. They shall be provided with a panel mounted uninterruptable power supply (UPS) that has BACnet capability and they shall be integrated via MS/TP for monitoring purposes.

E. VFDs shall be integrated to the BAS via BACnet/MSTP for monitoring and trending. All control shall be accomplished via hardwired I/O connections for the following points: start/stop, status, speed and alarm or fault.

5. SOFTWARE PROGRAMMING

A. All software programs shall be programmed by Contractor.

B. Device and Point Naming Requirements

1. All devices and points shall be named according to the UK Controls Point Naming Standards.

2. The exact proposed device and point names shall be provided for review on the shop drawings. The contractor shall not move forward with programming until the device and point names have been reviewed and approved by UK Controls.

3. See Appendices D, E, and F.

6. PRE-COMMISSIONING MEETING

A. The BAS contractor must demonstrate to the Owner and Owner's representatives via software simulations that the proposed building automation system and control sequences will function as outlined in the contract documents prior to field implementation.

B. Once programming is complete, a virtual meeting will be conducted to demonstrate that the sequence of operations is met, and all logic safeties are correct. The meeting shall include the controls contractor’s programmer, the engineer, and UK’s controls team.

7. SYSTEM STARTUP AND ACCEPTANCE

A. Upon completion of the installation, the BAS Contractor shall start-up the system and perform all necessary testing and debugging operations.

B. An acceptance test in the presence of the Owner's representative shall be performed. The vendor shall check all sensors that exhibit any problems or faulty reading. When the system performance is deemed satisfactory in whole by FM, the system parts will be accepted for beneficial use and placed under warranty.

C. The BAS Contractor is to be available for system commissioning at the end of the installation when requested by the Engineer and/or Owner. The contractor is to also be available for seasonal commissioning, or off season testing beyond the season the system was turned over in, for the other seasons beyond the initial commissioning.

D. This Contractor shall work with the Owner (FM), who is developing the graphics, to ensure that all points report, function and alarm as required on the BACnet head-end system. The Contractor will also work with the Project Manager or UKITS to obtain all necessary IPs, Subnet Masks and Gateways. The Owner (FM) will assign all BACnet/IP instance numbers and all BACnet/MSTP network numbers for use by the Contractor. All BACnet/IP devices will report directly to the head-end system.

E. UK Controls will be performing their own complete point by point evaluation as part of this project, independently of the commissioning activity. This will occur concurrently with the Commissioning Agent during the commissioning phase of the project. Functional check sheet shall be turned over to the owner prior to the start of the warranty period. Functional check sheets shall include the name of the system controller, area served, controller ID number, individual point names per controller, field value compared to front end value, technician name and date of checkout.

8. ADJUSTMENT AND SERVICE

A. After completion of the installation, the automatic temperature control contractor shall regulate and adjust all thermostats, control valves, motors, and other equipment provided under his contract and shall place them in complete operating condition, subject to approval by the Engineer and Owner.

B. This shall include but not be limited to “tuning” of all control systems. Systems shall be tuned for decaying wave response and minimal overshoot of setpoint. Contractor is to not leave any system in an Auto-Tune mode.

C. This Contractor shall work with Balancing Contractor to provide verification of CFM reading from the DDC terminal unit controllers.

D. Final adjustment shall be performed by specially trained personnel in direct employ of manufacturer of primary temperature control system.

E. After completion of installation, perform the following:

Installation.

Check proper installation and connection of each control device.

Verify electric power.

Verify each sensor and actuator connection to field computer.

Field Computer Operation.

Point Test.

- check of wiring of each sensor and actuator end-to-end

- verify calibration of each sensor.

- verify manual operation of each actuator.

Local loop control.

- bring each local loop under control.

- check response to upset, change in setpoint.

- check full and partial load operation.

Supervisory functions.

- verify time clock schedules.

- verify reset control.

Verify communication with each field device.

- perform end-to-end sensor and actuator checks.

- verify that the database is correct.

9. DEMONSTRATION AND TRAINING

A. The BAS Contractor shall instruct the Owner's designated representatives as detailed below.

B. The duration of the instruction period shall be no less than four (4) hours for two 2-hour sessions. ***<Engineer Note: This section to be modified with each project. Discuss with UK Controls. Number of hours may be adjusted to a max of 40 depending upon the size and scope of project. For larger projects, training vouchers for instructional training at the manufacturer's facilities may be requested in lieu of on-site training.>*** These instructions are to be conducted during normal working hours at the Owner's convenience and are to be prearranged with the Owner. The owner can request this training any time within the one-year warranty period and may request any number of classes adding up to the total number of hours. The contractor shall provide an hourly unit price for additional on-site training. If the specified training hours are not used, FM reserves the right to track the unused hours and use them for training during the warranty period.

C. The instructions shall consist of both hands-on at the job site and classroom training at a classroom location on the University of Kentucky campus coordinated with the Project Manager and FM.

D. The building automation system shall be complete and operational prior to training.

E. Upon completion, the attendees shall be able to operate the system and implement system changes including start-up, boot load, add point to the data base, enter messages, and download field units.

F. Prior to the scheduling of the sessions, an agenda outlining the training topics must be submitted for approval. Agenda items shall include, but not be limited to, the following topics:

1. Explanation of control sequences. Include which sensors are used and how output device operates.
2. Explanation of control drawings and manuals, including symbols, abbreviations, and overall organization.
3. Walk-through of project to identify controller locations and general routing of network cabling.
4. Review of operation and maintenance of hardware devices including air compressor, air dryers, controllers, instruments, and sensors. Include schedule for routine maintenance.
5. Programming Application Specific Controllers
    a. Backing up and Restoring Application Specific Programming
    b. Adding/Deleting/Editing points on Application Specific controllers
    c. Troubleshooting Application Specific controllers (inputs/outputs/logic/master – slave

relationships/bus issues)

6. Programming Building Specific Controllers
    a. Backing up and Restoring Building Specific Controllers Programming
    b. Adding/Deleting/Editing points on Building Specific Controllers
    c. Troubleshooting Building Specific Controllers (inputs/outputs/logic/network issues)
7. How to use tools and cables.

Appendix A – Vykon Niagara Compatibility Statement (NICS)

Niagara Information and Conformance Statement (NICS)

OVERVIEW

Niagara includes a licensing model that provides OEMs with the ability to define the various levels and types of Niagara interoperability their products will support. The feature is referred to as the Niagara Information and Conformance Statement or NICS. There are two primary interactions that the NICS addresses – the sharing of data between stations (JACEs and Supervisors) and the ability for a tool (i.e., Workbench) to engineer a station.

The roots of the NICS concept grew from gathering and understanding the requirements of the various users of Niagara technology consisting of end users (such as building owners), partners (such as BAS OEMs) and Tridium. Here's an overview of those requirements:

End User requirements include:

- The ability to control their system and determine which contractors can bid or engineer their system
- The ability to insure they can prevent unauthorized parties from accessing the system for engineering or system changes
- The freedom to individually manage authorized parties independent of Tridium
- A methodology that is easy to understand and use

Partner requirements include:

- The ability to define the various levels and types of interoperability their products will support
- The ability to prevent unauthorized parties from accessing an installed system to make engineering changes in order to adequately manage warranty/contractual commitments
- The freedom to individually manage their own compatibility rules independent of Tridium
- A methodology that is easy to understand and use

Tridium requirements include:

- To provide a highly flexible technology solution that will enable partners to achieve their individual business and product goals
- The provide the ability to individually manage software modules that support new features and options
- To create a methodology that is easy to understand and use

ELEMENTS OF THE NICS

The NICS provides a structure (or schema) that OEMs can use to define the various levels and types of Niagara interoperability their products will support. The NICS definitions are contained in the license file which is checked by a station, or tool, when it starts up.

There are 5 simple elements to the NICS: BrandID, Station Compatibility In, Station Compatibility Out, Tool Compatibility In, and Tool Compatibility Out. These elements can be combined in a variety of ways to achieve unlimited flexibility. Let's review the details and usage of each element:

BrandID

Every licensed station and tool has a Brand Identifier (BrandID). This field holds a text descriptor that the OEM chooses as the identifier for its product line. Each station or tool can have only one BrandID entry. For example, Tridium's Vykon products have the following:

BrandID = Vykon

niagara framework®

Station Compatibility In
This field is a list of brands that this local station will allow Niagara data to come in from. Simply stated from the point of view of a JACE, "this is the list of brands that can I can accept data from". For example, Tridium's products would contain:

Station Compatibility In = All

Note: The compatibility fields can contain; a single brand "ABC", a list of multiple brands "ABC, XYZ", no brand "None" or all brands "All".

Station Compatibility Out
This field is a list of brands that this local station will allow Niagara data to be shared with. Simply stated, "This is the list of brands that I can share data with".

Tool Compatibility In
This field is a list of brands that this station will allow to be connected to it for engineering of its application. Simply stated, "This is the list of brands that can engineer me".

Tool Compatibility Out
This field is a list of brands that this tool is allowed to connect to and engineer. Simply stated, "This is the list of brands that I can engineer".

NICS EXAMPLES

This section shows samples of potential NICS that might be used by a manufacturer.

Example 1: No connectivity restrictions. There are no restrictions on which brand stations or tools can interact with the system. The station and tool NICS would be as follows:

Property	Value
STATION COMPATIBILITY IN	All
STATION COMPATIBILITY OUT	All
TOOL COMPATIBILITY IN	All
TOOL COMPATIBILITY OUT	All

Example 2: Restrictions on engineering tool access to a station. Station can interact with any brand but can only be engineered by tools from a particular brand (ABC in this example). The station and tool NICS will be as follows:

Property	Value
STATION COMPATIBILITY IN	All
STATION COMPATIBILITY OUT	All
TOOL COMPATIBILITY IN	ABC
TOOL COMPATIBILITY OUT	ABC

Example 3: Restricted system. Station can interact with only the specified brands and can only be engineered by tools from specified brands (ABC, XYZ, and DEF in this example). The station and tool NICS will be as follows:

Property	Value
STATION COMPATIBILITY IN	ABC, XYZ, DEF
STATION COMPATIBILITY OUT	ABC, XYZ, DEF
TOOL COMPATIBILITY IN	ABC, XYZ, DEF
TOOL COMPATIBILITY OUT	ABC, XYZ, DEF

Example 4: Fully restricted system. The station and tools are restricted to work only with the same brand (ABC in this example). The station and tool NICS will be as follows:

Property	Value
STATION COMPATIBILITY IN	ABC
STATION COMPATIBILITY OUT	ABC
TOOL COMPATIBILITY IN	ABC
TOOL COMPATIBILITY OUT	ABC

STATION VS. TOOL COMPATIBILITY

There are many facets to interoperability and open systems. Creating a distinction between data sharing and actual engineering of a database allows Niagara partners to achieve the optimal solution for their customers while protecting their interests. A good example is found in the increasing use of Niagara in equipment systems, a concept known as Niagara Appliance.

Having these two elements to define compatibility provides a manufacturer with the ability to enable their Niagara based products to work with other Niagara-based stations in a system, but protect their equipment system from activities that could damage it or adversely affect its operation. For example, an equipment manufacturer offering a Niagara Appliance would want that appliance to connect to any Niagara system that shares its data, but may not want anyone to be able to modify it with an engineering tool.

A TOOL FOR OWNERS

The NICS schema is an important tool for consultants, owners and operators of facilities. It enables them to specify the level of interoperability desired for their projects with a simple set of text descriptions. In this respect it can be considered similar to concepts such as BACnet™ PICS statements or BIB definitions or LONMark™ interoperability certification although it is far simpler to understand, interpret and utilize.

IT DOESN'T END WITH NICS – NIAGARA INCLUDES A COMPREHENSIVE SECURITY INFRASTRUCTURE

The NICS infrastructure provides high level, manufacturer defined, interoperability management, but it is only part of the security methodology for Niagara -based software applications and products. This is where the security infrastructure comes in.

Access to an installed system by a user or by another station is limited at the device level by security and passwords. Niagara's extensive security model provides fine grained control over access to an engineering tool, a station, and even down to individual displays and components. Please contact Tridium for detailed information on the security model.

The following is suggested language you may wish to use in writing specifications to ensure an open Niagara system:

NIAGARA INFORMATION AND CONFORMANCE STATEMENT (NICS)

The Niagara Information and Conformance Statement (NICS) for all Niagara Software shall allow open access and be set as follows: accept.station.in="*" accept.station.out="*" accept.wb.out="*" accept.wb.in="*". In any case, the end user shall maintain the right to instruct the contractor to modify any software license, regardless of supplier, as desired by the end user. The contractor shall not install any "brand-specific" software, applications or utilities on Niagara Framework-based devices unless accessible by any brand of Niagara tools.

All hardware and field-level devices installed shall not be limited in their ability to communicate with a specific brand of Niagara Framework JACE. They shall also be constructed in a modular fashion to permit the next generation and support components to be installed, in replacement of or in parallel with existing components. All controllers must be able to be programmed within the Niagara Workbench.

At the completion of the project, the owner shall be given all existing platform and station login credentials to include; super user (admin) usernames; passwords and passphrases.

TRIDIUM

Locations and customer support, worldwide

Headquarters
North America
1 804 747 4771

Support
North America & Latin America
1 877 305 1745

tridium.com

Appendix B – Tridium Niagara 4 BACnet PICS

TRIDIUM NIAGARA 4 BACNET SUPERVISOR PICS

BACnet Protocol Implementation Conformance Statement

Date: July 16, 2021
Vendor Name: Tridium
Product Name: Niagara 4 BACnet Advanced Workstation
Product Model Number: SUP
Application Software Version: 4.10.1.18
Firmware Revision: 4.10.1.18
BACnet Protocol Revision: 14

Product Description:
The Niagara4 BACnet Supervisor provides the ability to view, monitor, and control BACnet devices and objects over IP or raw Ethernet, or through a BACnet router to any BACnet media. Devices, points, schedules, alarms, and logs can be learned and managed from Niagara4. Advanced management tasks such as backup and restore and object creation and deletion are also possible with the BACnet Supervisor.

BACnet Standardized Device Profile (Annex L):

☐ **BACnet Cross-Domain Advanced Operator Workstation (B-XAWS)**
☒ **BACnet Advanced Operator Workstation (B-AWS)**
☐ **BACnet Operator Workstation (B-OWS)**
☐ **BACnet Operator Display (B-OD)**
☐ **BACnet Advanced Life Safety Workstation (B-ALSWS)**
☐ **BACnet Life Safety Workstation (B-LSWS)**
☐ **BACnet Life Safety Annunciator Panel (B-LSAP)**
☐ **BACnet Advanced Access Control Workstation (B-AACWS)**
☐ **BACnet Access Control Workstation (B-ACWS)**
☐ **BACnet Access Control Security Display (B-ACSD)** ☐ **BACnet Building Controller (B-BC)**
☐ **BACnet Advanced Application Controller (B-AAC)**
☐ **BACnet Application Specific Controller (B-ASC)**
☐ **BACnet Smart Actuator (B-SA)**
☐ **BACnet Smart Sensor (B-SS)**
☐ **BACnet Advanced Life Safety Controller (B-ALSC)**
☐ **BACnet Life Safety Controller (B-LSC)**
☐ **BACnet Advanced Access Control Controller (B-AACC)**
☐ **BACnet Access Control Controller (B-ACC)**
☐ **BACnet Router (B-RTR)**

☐ **BACnet Gateway (B-GW)**
☐ **BACnet Broadcast Management Device (B-BBMD)**
☐ **BACnet Access Control Door Controller (B-ACDC)**
☐ **BACnet Access Control Credential Reader (B-ACCR)**
☐ **BACnet General (B-GENERAL)**

Additional BACnet Interoperability Building Blocks Supported (Annex K):

Data Sharing DS-RP-A, B DS-RPM-A, B DS-WP-A, B DS-WPM-A,B DS-COV-A,B DS-COVP-B DS-V-A DS-AV-A DS-M-A DS-AM-A	**Device & Network Management** DM-DDB-A, B DM-DOB-A, B DM-DCC-A, B DM-RD-A, B DM-TS-A DM-UTC-A DM-LM-A, B DM-BR-A, B DM-R-B DM-ANM-A DM-ADM-A DM-ATS-A DM-MTS-A DM-OCD-A
Alarm & Event Management AE-N-A AE-N-I-B AE-ACK-A, B AE–INFO-A, B AE-ELV-A AE-VN-A AE-AVN-A AE-VM-A AE-AVM-A AE-AS-A AE-ELVM-A AE-ASUM-B AE-ESUM-B	**Trending** T-ATR-A T-VMMV-A T-V-A T-AVM-A T-A-A T-AMVR-A
Scheduling SCHED-VM-A SCHED-AVM-A SCHED-WS-A	**Network Management** NM-RC-B

Segmentation Capability:

Feature	Supported	Window size
Transmit Segmented Messages	yes	10
Receive Segmented Messages	yes	127

Standard Object Types Supported:

- The CreateObject and DeleteObject services are not supported, so no objects are dynamically creatable or deletable through BACnet service requests, although these objects are dynamically creatable and deletable through Niagara.
- No general range restrictions exist; however, certain specific applications may have specific range restrictions.
- All potentially available properties are listed for each object type.
- Optional properties are listed in *italics*. Not all instances support all optional properties.
- Writable properties are listed in **bold**. Any range limitations are expressed in parentheses following the property name.

Object Type	Properties	
Device	*Object_Identifier*	*Number_Of_APDU_Retries*
	Object_Name	***Time_Synchronization_Recipients***
	Object_Type	*Max_Master*
	System_Status	*Max_Info_Frames*
	Vendor_Name	Device_Address_Binding
	Vendor_Identifier	Database_Revision
	Model_Name	*Configuration_Files*
	Firmware_Revision	*Last_Restore_Time*
	Application_Software_Version	***Backup_Failure_Timeout***
	Location	*Active_COV_Subsriptions*
	Description	***UTC_Time_Synchronization_Recipients***
	Protocol_Version	*Time_Synchronization_Interval*
	Protocol_Revision	*Align_Intervals*
	Protocol_Services_Supported	*Interval_Offset*
	Protocol_Object_Types_Supported	*Backup_Preparation_Time*
	Object_List	*Restore_Completion_Time*
	Max_APDU_Length_Accepted	*Restore_Preparation_Time*
	Segmentation_Supported	*Backup_And_Restore_State*
	Max_Segments_Accepted	*Last_Restart_Reason*
	Local_Time	*Time_Of_Device_Restart*
	Local_Date	***Restart_Notification_Recipients***
	UTC_Offset	*Serial_Number*
	Daylight_Savings_Status	*Property_List*
	APDU_Segment_Timeout	
	APDU_Timeout	

Data Link Layer Options:

☒ BACnet IP, (Annex J)
☒ BACnet IP, (Annex J), Foreign Device
☒ BACnet IP, (Annex J), BACnet Broadcast Management Device (BBMD)
☒ ISO 8802-3, Ethernet (Clause 7)

Device Address Binding:

Is static device binding supported? (This is currently necessary for two-way communication with MS/TP slaves and certain other devices.) ☒Yes ☐ No

Networking Options:

☒ Router, Clause 6 – Routing configurations: BACnet/IP-BACnet/IP and EthernetBACnet/IP
☐ Annex H, BACnet Tunneling Router over IP

Character Sets Supported:

Indicating support for multiple character sets does not imply that they can all be supported simultaneously.

☒ ISO 10646 (UTF-8) ☐ IBM□/Microsoft DBCS ☒ ISO 8859-1
☒ ISO 10646 (UCS-2) ☐ ISO 10646 (UCS-4) ☐ JIS X 0280

If this product is a communication gateway, describe the types of non-BACnet equipment/networks(s) that the gateway supports:
This product supports communications between BACnet and any third-party system to which Niagara can connect. Contact Tridium for a list of supported protocols.

Appendix C – BACnet Testing Laboratories Product Listing

BACnet is a registered trademark of ASHRAE. ASHRAE does not endorse, approve or test products for compliance with ASHRAE standards. Compliance of listed products to the requirements of ASHRAE Standard 135 is the responsibility of BACnet International (BI). BTL is a registered trademark of BI.

BACnet Testing Laboratories Product Listing

This product has been tested at a qualified BACnet Testing Laboratory and found to comply with all the necessary interoperability requirements in place on the published test date. This listing represents the tested capability of the Listed Product. For information on additional functionality that was not covered in the test process, refer to the Manufacturer's PICS statement on the BI website.

Listing Information

Vendor		Listing Status
Tridium, Inc. 3951 Westerre Parkway, Suite 350 Richmond, VA 23233 USA		Listed Product
Test Requirements	BACnet Protocol Revision	Date Tested
Requirements as of July 2009	Revision 7 (135-2008)	July 2011

Product Name	Model Number(s)	Software Version
Niagara AX Supervisor with BACnet B-AWS	S-AX-AWS	3.6.35

Device Profiles

Profile	Model Numbers
BACnet Advanced Workstation (B-AWS)	S-AX-AWS

BIBBs Supported

Data Sharing	ReadProperty-A	DS-RP-A
	ReadProperty-B	DS-RP-B
	ReadPropertyMultiple-A	DS-RPM-A
	ReadPropertyMultiple-B	DS-RPM-B
	WriteProperty-A	DS-WP-A
	WriteProperty-B	DS-WP-B
	WritePropertyMultiple-A	DS-WPM-A
	WritePropertyMultiple-B	DS-WPM-B
	COV-A	DS-COV-A
	View-A	DS-V-A
	Advanced View-A	DS-AV-A
	Modify-A	DS-M-A
	Advanced Modify-A	DS-AM-A

Alarm and Event Management	Alarm and Event-Notification-A	AE-N-A
	Alarm and Event-ACK-A	AE-ACK-A
	Alarm and Event-View Notifications-A	AE-VN-A
	Alarm and Event-Advanced View Notifications-A	AE-AVN-A
	Alarm and Event-View and Modify-A	AE-VM-A
	Alarm and Event-Advanced View and Modify-A	AE-AVM-A
	Alarm and Event-Alarm Summary View-A	AE-AS-A
	Alarm and Event-Event Log View and Modify-A	AE-ELVM-A

Scheduling	Scheduling-View and Modify-A	SCHED-VM-A
	Scheduling-Advanced View and Modify-A	SCHED-AVM-A
	Scheduling-Weekly Schedule-A	SCHED-WS-A

Trending	Trending-View-A	T-V-A
	Trending-Advanced View and Modify-A	T-AVM-A
	Automated Trend Retrieval-A	T-ATR-A

Device and Network Management	Dynamic Device Binding-A	DM-DDB-A
	Dynamic Device Binding-B	DM-DDB-B
	Dynamic Object Binding-A	DM-DOB-A
	Dynamic Object Binding-B	DM-DOB-B
	Automatic Device Mapping-A	DM-ADM-A
	Automatic Network Mapping-A	DM-ANM-A
	Time Synchronization-A	DM-TS-A
	Time Synchronization-B	DM-TS-B
	UTC Time Synchronization-A	DM-UTC-A
	UTC Time Synchronization-B	DM-UTC-B
	Automatic Time Synchronization–A	DM-ATS-A
	Manual Time Synchronization–A	DM-MTS-A
	DeviceCommunicationControl-A	DM-DCC-A
	DeviceCommunicationControl-B	DM-DCC-B
	ReinitializeDevice-A	DM-RD-A
	ReinitializeDevice-B	DM-RD-B
	Backup and Restore-A	DM-BR-A
	Restart-A	DM-R-A
	Object Creation and Deletion-A	DM-OCD-A
	List Manipulation-A	DM-LM-A
	List Manipulation-B	DM-LM-B

Object Type Support

Device		

Data Link Layer Options

Media	Options
BACnet/IP (Annex J)	BBMD
Ethernet	

Networking Options

Networking Functionality	Media
Router	BACnet/IP (Annex J) – Ethernet

Character Set Support

ANSI X3.4 ISO 10646 (UCS-2)

Appendix D – Device Naming Standard

GENERAL
Naming conventions should be used on any device integrated into the PPDMCN4, CPPD, UEM, or MPPD server Tridium Supervisor. Naming conventions should be followed by UEM and vendors. Whenever possible, naming conventions should be followed at every iteration of the device. (Server - Tier 1 - Tier 2). In other words, added devices should already reflect the naming conventions in this document unless it is not possible to alter at the device level. If a Tier 1 device cannot be named to meet this standard due to manufacturer limitations approval is needed from manager, supervisor, or project manager.

PROCESS
Devices can be added to the following:
- Discovered on server (PPDMCN4, CPPD, MPPD, UEM) or JACE or BACnet controller.
- Created when building/programming a JACE or BACnet controller.

Device Tiers:
- Tier 1 devices are defined as any BAS equipment that communicates directly with a Tridium server (PPDMCN4, CPPD, MPPD, UEM) via an IP address.
- Tier 2 devices communicate to Tier 1 devices via BACnet MS/TP (or N2/LON/OBIX*). **Although some of these protocols are grandfathered in, they are no longer installed at UK.*
- Tier 3 devices are stand-alone devices that do not communicate to other Tier 1 or Tier 2 devices. If devices have BACnet MS/TP or Niagara capabilities, they cannot be Tier 3 devices. New Tier 3 devices must be approved by UK Controls.

DEVICE NAMING
Tier 1 Devices will be named in the following format:
- For Advanced Application Controllers (B-AAC)*
  BuildingName_BuildingNumber_Floor_RoomNumber_EquipShortName
  - Example:
    - PAVHA_0293_03_HA0399_AHU1

Tier 2 Devices will be named in the following format:
- For Application Specific Controllers (B-ASC)*
  - ***BuildingName_Floor_RoomNumber_EquipShortName_B-ASC Device Type with MAC address (unless integrated to Supervisor via gateway such as some Phoenix valve integrations)***
    - Examples:
      - COMBS_00_B006_AHU7_FEC14
      - CAREER_CNTR_01_RM116_VMA25 *-in this case the VMA signals it is a VAV, so it is not necessary to use VAV_VMA25.*
      - JSB_03_RM300C1_MAV – *as above, the MAV makes it clear that it is a make-up air valve. Also Integrated via gateway.*

Tier 3 Devices will be named following the same format as Tier 1 devices**.**

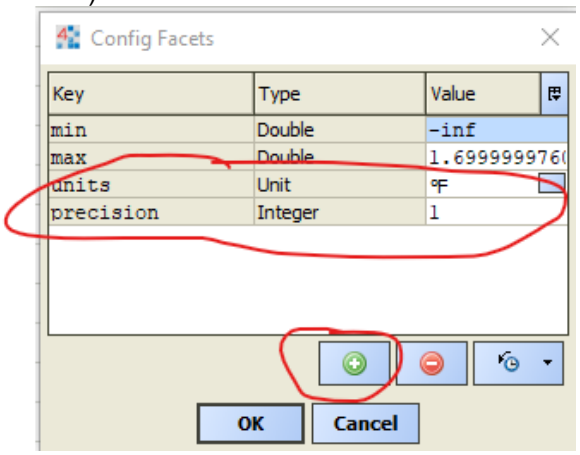
Note: Device Names should never start with a number

Appendix E – Point Naming and Facets Standard

GENERAL
Naming conventions should be used on any points integrated into the PPDMCN4, CPPD, UEM, or MPPD server Tridium Supervisor. Naming conventions should be followed by UEM and vendors. Whenever possible, naming conventions should be followed at every iteration of the point. (Server - Tier 1 - Tier 2). In other words, discovered points should already reflect the naming conventions in this document. Points should be renamed at the closest location to the edge device the point exists on. For example, if a point originates on a water softener Protonode connected via MSTP to a JCI NAE and then integrated to the PPDMCN4 server, and it isn't possible to modify the point name on the Protonode, then the point should be renamed on the NAE not the server.

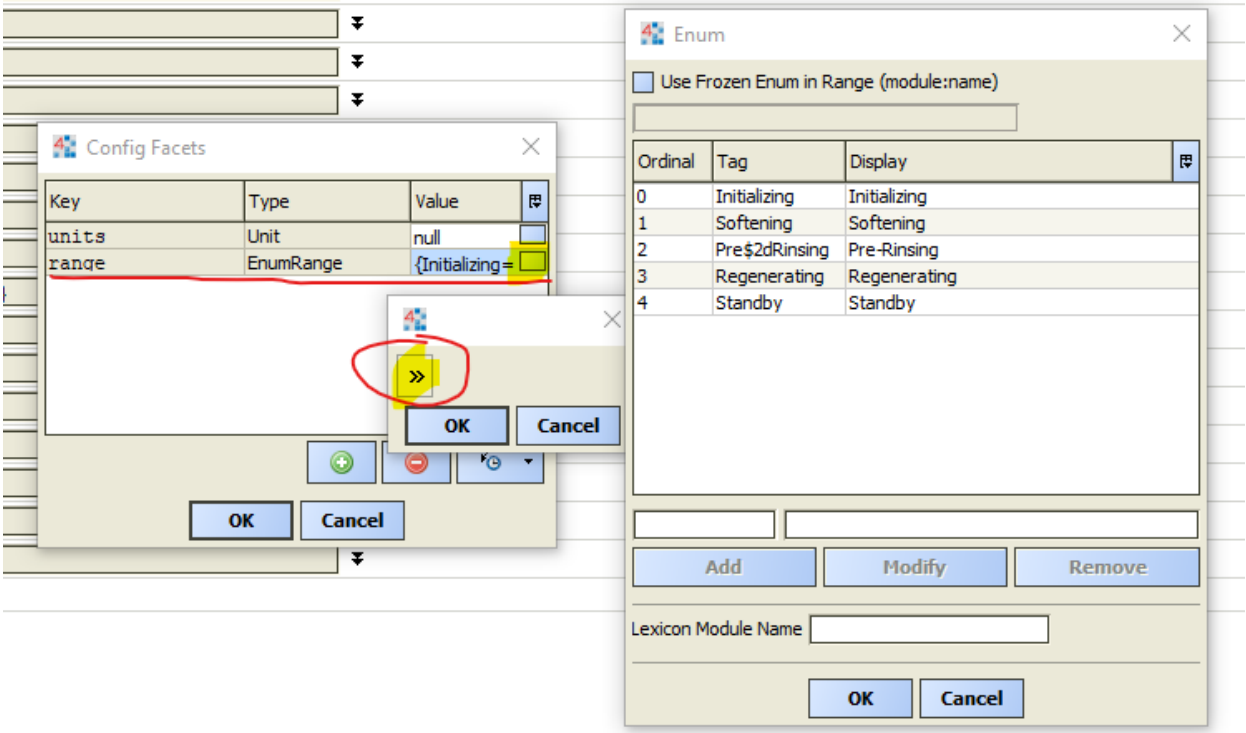
PROCESS
Points may be added in the following ways:
- Discovered on server (PPDMCN4, CPPD, MPPD, UEM) or jace from networked BAS equipment.
- Created on server or jace for applications – from palette, right-click, or copy/paste.
- Created for application or control program on any controller.

POINT FACETS
All points shall contain the proper point facet and engineered values. It is the responsibility of the integrator to ensure that these facets are correct. Points from vendors should already have the correct facets.
- Boolean point facets should not be left at true/false but rather changed to one of the following.
  - On/Off – most binary command points
  - Enabled/Disabled
  - Alarm/Normal
  - Reset/Normal
  - Occupied/Unoccupied
- Numeric points should have correct facets.
  - Common values are %, °F, cfm, in/wc, psi to name a few.
    - Celsius (°C) should only be used at the request of customer or when it can't easily be modified at edge device (such as VFD MOTOR_TEMP point).
    - Facet precision should be consistent on all points. If AHU1 has a DAT that shows 70.0 °F and the DAT_SP shows 70.00 °F. If the precision field doesn't exist, you can add (see below).



- Enumerated (Enum) points should have the range values in the facets. This is especially important on Alarm and Status points that have a large amount of options. It is the vendors responsibility to ensure that these are correct. If it is not possible to change then the vendor must

provide documentation stating what the numeric value of each selection equals so that we can enter when integrating.



- String points are rarely used and do not require facet programming.

Appendix F - Common Point Naming

This list does not attempt to cover all points that are encountered but rather the commonly used ones. If the point you are creating or integrating is not listed below, then use this list as a guideline and couple it with common sense. Point names need to be descriptive without being too long. Try and keep your point names to 20 characters or less (longer point names may end up exceeding History Name length when b-format is used - refer to SOP NA 04 for detail). No special characters are allowed except for an under-score "_". Point names must start with a letter. If in doubt, contact your Controls Supervisor, Manager, or Controls Project Manager.

Common Sensor Points	**Point Name**	**Setpoint Name**
Discharge Air Temp	DAT	DAT_SP
Mixed Air Temp	MAT	MAT_SP
Return Air Temp	RAT	RAT_ SP
Zone Temp	ZNT	ZNT_SP
Outside Air Temp	OAT	
Shared Outside Air Temp	SOAT	
Hot Water Return Temp	HWRT	HWRT_SP
Hot Water Supply Temp	HWST	HWST_SP
Chilled Water Return Temp	CWRT	CWRT_SP
Chilled Water Supply Temp	CWST	CWST_SP
Heat Exchanger Supply Temp	HXST	HXST_SP
Heat Exchanger Return Temp	HXRT	HXRT_SP
Return Air Static Pressure	RA_STATIC	RA_STATIC_SP
Supply Air Static	SA_STATIC	SA_STATIC_SP
Discharge Air Static	DA_STATIC	DA_STATIC_SP
Cooling Coil Temperature	CCT	CCT_SP
Preheat Temperature	PHT	PHT_SP
Discharge Air Flow	DA_FLOW	DA_FLOW_SP
Outside Air Flow	OA_FLOW	OA_FLOW_SP
Supply Air Flow	SA_FLOW	SA_FLOW_SP
Economizer	ECON_CMD	ECON_SP

Common ALARM Points	**Point Name**
Any Interlock Alarm (JCI)	xxx_INTRLK_ALM
Discharge Air High Pressure Alarm	DA_HI_PRESS_ALM
Discharge Air High Static Alarm	DA_HI_STAT_ALM
Discharge Air High Temp Alarm* *any other High/Low Alarms should use the same format. Ie: MAT_HI_ALM or HXST_LO_ALM or DP1_HI_STAT_ALM, etc.	DAT_HI_ALM
Discharge Air Low Pressure Alarm	DA_LO_PRESS_ALM
Discharge Air Low Static Alarm	DA_LO_STAT_ALM
Discharge Air Low Temp Alarm*	DAT_LO_ALM

Fire Alarm Status	FIRE_ALM
Low Limit Alarm / Freezestat	FREEZE_ALM
Return Air High Pressure Alarm	RA_HI_PRESS_ALM
Return Air High Static Alarm	RA_HI_STAT_ALM
Return Air Low Pressure Alarm	RA_LO_PRESS_ALM
Return Air Low Static Alarm	RA_LO_STAT_ALM
SA/DA Smoke	xx_SMOKE_ALM
Supply Air High Pressure Alarm	SA_HI_PRESS_ALM
Supply Air High Static Alarm	SA_HI_STAT_ALM
Supply Air Low Pressure Alarm	SA_LO_PRESS_ALM
Supply Air Low Static Alarm	SA_LO_STAT_ALM

Common Command points	**Point Command Name**	**Status/Feedback**	**Speed % Commands**
Supply Fan	SF_CMD	SF_STS	SF_SPD
Return Fan	RF_CMD	RF_STS	RF_SPD
Chilled Water Pump	CWP_CMD	CWP_STS	CWP_SPD
Preheat Pump	PHP_CMD	PHP_STS	PHP_SPD
Hot Water Pump	HWP_CMD	HWP_STS	HWP_SPD
Exhaust Fan	EF_CMD	EF_STS	EF_SPD
Heat Exchanger	HX_CMD	HX_STS	
Outside Air Damper (2-position)	OAD_CMD	OAD_STS	
Mixed Air Damper (2-position)	MAD_CMD	MAD_STS	
Exhaust Air Damper (2-position)	EAD_CMD	EAD_STS	
Outside Air Damper (modulating)	OAD_CMD	OAD_POS	
Mixed Air Damper (modulating)	MAD_CMD	MAD_POS	
Exhaust Air Damper (modulating)	EAD_CMD	EAD_POS	
Cooling Valve (2-position)	CWV_CMD	CWV_STS	
Heating Valve (2-position)	HWV, PHV, RHV	HWV_STS, PHV_STS, RHV_STS	
Cooling Valve (modulating)	CWV_CMD	CWV_POS	
Heating Valve (modulating)	HWV_CMD, PHV_CMD, RHV_CMD	HWV_POS, PHV_POS, RHV_POS	
Effective Occupancy	EFF_OCC		
Occupancy Override	OCC_SCHEDULE		
Occupancy Sensor	OCC_SENSOR		
Reheat Enable	RH_CMD		
Cooling Enable	CLG_CMD		
Heating Enable	HTG_CMD		

Common point name for ALL VAV's

Common points		
CLG_MAXFLOW	ZNT	EFF_OCC
CLG_MINFLOW	ZNT_SP	OCC_MODE
HTG_MINFLOW	HWV_CMD	OCC_SENSOR
DPR_CMD	DAT (duct temp sensor)	OCC_SCHEDULE (occ override)
SA_FLOW_SP	EFF_CLG_SP	
SA_FLOW	EFF_HTG_SP	
	CLG_UNOCC_SP	
	HTG_UNOCC_SP	

Common point name for UPS Bacnet points *(standard UPS is PSH600-UPS)*

Point Name	**PSH600 I/O**
USB_Connection	binaryInput:2
Line_Or_UPS	binaryInput:1
Batt_Time_Remaining	analogInput:4
Batt_Capacity	analogInput:3
Load_VA	analogInput:2
UPS_Load_Percent	analogInput:1
System_Status	device: unique #

Common point name for ALL VFD's

Point Name	**Facet**
CURRENT	In Amps
FAULT_ALM	Normal/Fault
HAND_AUTO	Hand/Auto
OUTPUT_FREQ	In Hz
OUTPUT_SPD	Percent (%)
POWER	In Kw
RUN_CMD	Run/Stop