Section 15970 - Control Systems

I. Introduction
   A. The University of Arizona employs and maintains an Energy Management Control System (EMCS) that consists of building automation, integration, and controls hardware, software, tools, and systems. The EMCS is critical to the operation of University facilities. It provides:
      a. Comfort control & automation
      b. Energy efficiency
      c. Remote monitoring and control
      d. Operational trend data for analysis
   B. This section describes Energy Management Control System and System Integration requirements for University of Arizona projects. This section also coordinates the responsibilities of the Mechanical and Electrical trade contractors pertaining to control products or systems furnished by each trade that will be integrated by this Division. See Section 15970 Appendix App-15970e-EMCS Interface Schematic, which describes EMCS networks and cabling. (App-15970f describes legacy LonWorks interface, where applicable.)
   C. It is the goal of the University of Arizona to implement an open system that will allow products from various suppliers to be integrated into a unified system in order to provide flexibility for expansion, maintenance, and service of the system. All proposals, submittals, products, and workmanship shall reflect that goal.
   D. The University of Arizona uses Smart Building Technology Standards to specify a modern, high-performance EMCS model. This section will:
      a. Communicate Smart Building Technology Standards to project managers, engineers, technicians, contractors, vendors, and service providers.
      b. Describe technology standards that facilitate simplified, automated, streamlined, scalable, repeatable, and consistent implementation of technology.
      c. Ensure that technology systems are compatible in terms of functionality, interoperability, integration, data archival and analysis, and security.
      d. Eliminate duplication of effort by leveraging infrastructure and using common standards, allowing building systems to connect to each other and to enterprise systems in a standardized manner with minimal effort.
      e. Describe processes used to plan, implement, and commission technology devices and systems in University of Arizona facilities.
   E. Systems not in the scope of Section 15970:
      a. Energy Metering – see Section 15980 for metering design specifications and requirements
      b. Security/Access Control
      c. Life Safety/Fire Alarm
      d. Elevators
      e. Digital Signage
      f. Irrigation
   F. Abbreviations:
      a. UA = University of Arizona
      b. EMCS = Energy Management Control System
      c. BAS = Building Automation System (synonymous with EMCS)
      d. DDC = Direct Digital Control
      e. GUI = Graphical User Interface
      f. ONS = University of Arizona *Smart Building Technology Device & Object Naming Standard*
      g. SOO = Sequence of Operation
      h. AHU = Air Handling Unit
      i. VFD = Variable Frequency Drive
      j. AFDD = Automatic Fault Detection and Diagnostics

II. Technology Planning
  A. The Energy Management Control System (EMCS) shall be Direct Digital Control (DDC), fully automatic, with electric and electronic components as required. Actuation shall be electronic in new or retrofit work. EMCS technology shall provide and/or support the concepts of open, distributed design, interoperability, accessibility, and security. The EMCS architecture consists of four layers:
    1. Control Layer
      a. The Control Layer is made up of building automation control devices. These devices control and monitor various equipment, such as (but not limited to) HVAC, lighting, and laboratory equipment. BACnet communications protocol shall be utilized to ensure direct interoperability between all devices within the building network. See section III.B for BACnet implementation details.
      b. This layer includes routers that convert a protocol from serial to IP (i.e.: BACnet MS/TP to BACnet/IP or Modbus RTU to Modbus TCP).
      c. Devices on this layer control the actual equipment. System design shall be capable of stand-alone operation, defined as operating the equipment in a safe and effective manner even when completely disconnected from the network. This mode of operation may not be able to achieve all aspects of the sequence of operation (SOO), but it shall still operate the equipment under a basic control scheme achievable with the local inputs and outputs available to the controller while operating under stand-alone circumstances. All control loop inputs, outputs, and logic shall reside in the same controller, allowing for stand-alone functionality. An alarm shall always be generated and sent to the EMCS monitoring system operator(s) when a controller or other networked device is not connected to the network. During stand-alone mode, controlled equipment shall continue operating as prior to the communication interruption in a manner that does not require input from remote devices. Where continuous uninterrupted operation is not desired, the equipment shall instead revert to a safe position.
      d. All equipment controllers, sensors and actuators shall be electronic, and be connected to the University of Arizona network environment through either IP or serial based (RS 485/EIA 485) network technology. Coordinate specific architecture with the University.
      e. Provide electronic speed control for variable volume systems. Electronic speed control devices shall communicate using BACnet. See Section III.B for details.
      f. Wireless technology is not allowed.
      g. System shall have a minimum of 10% capacity expansion within the current equipment. System design shall be modular to ensure future expansion capabilities, whether it be additional control/monitoring points or supervisory functions.
    2. Integration Layer
      a. The Integration Layer is made up of devices and software that use drivers to convert protocols as required to make obsolete and legacy devices on the Control Layer accessible to the Enterprise Layer. The EMCS shall provide the direct integration of standard BACnet/IP and Modbus TCP protocols. Legacy LonWorks/LonTalk/LON devices shall be supported where applicable.
      b. This layer includes gateways that translate one protocol into another (i.e.: LonTalk FTT-10 to BACnet/IP or Modbus RTU to BACnet/IP). Gateways shall not be acceptable to connect newly installed devices or products, and are reserved for connecting existing obsolete and legacy devices where applicable only.
      c. All Integration Layer devices shall be IP-based.
    3. Enterprise Layer
      a. The Enterprise Layer connects to the Control Layer either directly or through the Integration Layer. It hosts the global Graphical User Interface (GUI), trend data consolidation and visualization, programming tools, and global supervisory control.
      b. The Enterprise Layer consists of the main Graphics Server and all Tridium Niagara building-level controllers (e.g. JACE).
    4. Historian Layer
      a. The Historian Layer archives trend data collected by the system. Data may be retrieved by polling Integration Layer or Control Layer devices, or received in data exports from the Enterprise Layer.

B. EMCS technology shall be connected to or shall reside on the University of Arizona network. Ad hoc IP networks are not permitted.
   1. University of Arizona connectivity may not be available or ready for device connection at the time of controls startup during the course of a project. The controls contractor shall install a temporary IP network to support EMCS devices until University of Arizona makes the permanent network available. The controls contractor shall use 10/100 cabling that meets or exceeds University of Arizona requirements, and shall coordinate with University of Arizona to run temporary network cable to the correct IT switch locations, enabling University of Arizona to re-use the cabling. Temporary switches, including cellular modems, shall be provided and used by the controls contractor, and shall be removed by the controls contractor when any IP devices have been migrated to the University of Arizona network. All cabling shall be labeled according to University of Arizona standards.
   2. For software-only products, generally University of Arizona will supply a virtual server to host the application. Workstation software generally will not be required unless specifically noted in the scope of work, since most workstation clients will be web-based and will not require application software running on the workstation. The contractor shall coordinate with University of Arizona for provisioning of servers.
   3. In cases where an application is required to run on a workstation (such as for field configuration or programming tools), the contractor shall provide the University of Arizona with all necessary software and licenses.

C. EMCS trend data shall flow from the field devices to the Enterprise Layer as follows:
   1. For trending-capable field controllers below the Enterprise Layer, trend data shall be recorded locally in the controller, and passed to the Enterprise Layer component topologically nearest to the device where the object resides.
   2. Trend data originating from field controllers without trending capability shall be recorded directly at the Enterprise Layer component topologically nearest to the device where the object resides.
   3. Trend data recorded at field controllers or building level Enterprise Layer components shall hold a minimum of three (3) days or 500 data records for each control object, whichever is larger.

4. The system must be capable of collecting and storing trend object data for each control object in the system. All physical points, all mode points, and all active setpoints shall be trended at minimum. Refer to table:

Trend Objects	Trend Interval
temp sensor	15-min
air volume	15-min
damper command	15-min
damper position	15-min
valve command	15-min
valve position	15-min
fan command	cov
fan status	cov
compressor command	cov
compressor status	cov
compressor modulation command	15-min
compressor unloader command	cov
electric heat command	cov
electric heat modulation command	15-min
mode	cov
VFD speed command	15-min
VFD speed feedback	15-min
inlet vane command	15-min
inlet vane position	15-min

Trend Objects	Trend Interval
enthalpy/heat wheel command	cov
enthalpy/heat wheel status	cov
humidity sensor	15-min
CO2/VOC sensor	15-min
pressure sensor	15-min
temp switch	cov
pressure switch	cov
smoke detector switch	cov
pump command	cov
pump status	cov
cooling tower fan command	cov
cooling tower fan status	cov
effective temp setpoint	cov
effective humidity setpoint	cov
effective dewpoint setpoint	cov
effective enthalpy setpoint	cov
effective pressure setpoint	cov
effective air volume setpoint	cov
effective CO2/VOC setpoint	cov

   a. All static active setpoints ("effective" setpoints in the table) shall be trended COV as indicated by the table. Dynamic setpoints (setpoints reset automatically by control logic) shall be trended in 15-minute intervals.
5. Trend data that resides in or has been mapped to building level Enterprise Layer components shall be passed to the Main Graphics Server with scheduled synchronizations.
6. All products and systems provided shall be compatible with the existing enterprise server and data historian. The existing EMCS enterprise server is a Tridium-based Niagara Frameworks software product. The existing historian is Schneider Electric's Wonderware eDNA. Submit a Request For Information (RFI) for current software versions.

D. EMCS alarm data shall flow from the BACnet field devices to the Enterprise layer interface as follows:
1. Alarm Configuration:
   a. All logic to determine alarm states shall reside in the local BACnet devices.
      1. Appropriate alarm conditions, dead bands, and delays shall be used to avoid nuisance alarms.
      2. A Boolean point shall be created for each alarm condition in the local BACnet device to indicate the status of that alarm. True=Alarm, False=Normal.
   b. Alarm events shall be created in the topologically nearest component of the Enterprise layer based off the value of the alarm Boolean point.
   c. Alarm description text shall be completed to describe alarm condition.
2. An object list shall be submitted to the University of Arizona from which alarm events will be identified and classified, and then will be returned to the contractor for implementation.
3. Alarm classes shall be assigned as described in the University of Arizona BAS Alarm Guidelines.
4. Nuisance Alarms:
   a. Alarm tuning shall be performed to eliminate nuisance alarms. Nuisance alarms are defined as alarms that are triggered under conditions that are unintended, triggered under conditions that do not require attention, triggered too quickly without allowing conditions to stabilize, trigger repeatedly for the same event, or are routed incorrectly
5. Alarm Notifications:

a. Alarm management consoles:
   1. For each building, an alarm console shall be created on the Enterprise server. All alarms from the building shall be routed to this console.
   2. A Campus critical alarm console exists on the Enterprise server. Critical alarms from all buildings shall be routed to this console.

b. Email and Text Notifications:
   1. An email/text recipient shall be configured for FMIT, with contact information for each contact method required by FMIT (this may already exist). "StationAlm" alarm class events shall be routed to this email recipient.
   2. An email/text recipient shall be configured for the Control Shop, with contact information for each contact method required by the Control Shop (this may already exist). "StationAlm", "DeviceAlm", and "XXXX_CriticalAlm" alarm class events shall be routed to this email recipient.
   3. An email/text recipient shall be configured for each Control Shop technician, with contact information for each contact method required for that technician (these may already exist). Additional email recipients shall be configured for building managers or other parties that require notification. "XXXX_CriticalAlm" and "XXXX_StandardAlm" alarm class events shall be routed to the appropriate personnel for each building.

E. Equipment schedules be standardized BACnet Schedule Objects, and shall reside in the local BACnet field devices. The Enterprise user interface shall be capable of modifying, enabling, and disabling the equipment schedule objects.

III. Product Specifications

A. EMCS Layer Product Specifications:

1. Control Layer

a. All Control Layer products shall be BACnet-compliant and BTL-certified. If the project is within an existing building, then, depending on the scope of the project, the communication protocol may match existing, pending University of Arizona approval. See BACnet requirements in Section III.B.

b. Approved products:
   1. Distech Controls (BACnet)
   2. Others only with written approval
      a. Other product lines submitted for approval must have at least three separate manufacturer approved or certified service and maintenance providers with established offices in the greater Tucson metropolitan area.

c. All software and firmware for all products shall be the latest stable version available on the date of substantial completion compatible with existing University of Arizona systems and capabilities.

d. Noise, surge and spike protection requirements, at minimum:
   1. Operating Voltage: 120 VAC
   2. Clamping Voltage: 325 VAC
   3. Operating Current: 15A
   4. Peak Surge Current: 13 kA/Mode, 26 kA/Phase, 39 kA/Total
   5. Operating Frequency: 60 Hz
   6. EMI Attenuation: > 40 dB
   7. Modes of Protection: Line-to-Neutral, Line-to-Ground, Neutral-to-Ground
   8. Status Indication
   9. Vibration-resistant Screw Terminal Connections
   10. Terminals must accept up to 14 AWG
   11. Operating Temperature: -40°C to +85°C

e. All EMCS devices controlling major equipment shall be provided with surge protection as outlined above.

f. Memories shall be non-volatile, or unit shall hold memory up to 30 days minimum on backup batteries.

g. All CV and VAV terminal unit controls shall be DDC application-specific type (B-ASC) for new building construction and retrofit work.

h. All control valves with a nominal opening diameter of 2" and smaller shall be ball valves, except for steam which shall be globe valves. Valves greater than 2" shall be globe valves.
i. Use Fisher 92B steam pressure reducing valve with the appropriate pilot.
j. Use manual-reset freeze stats.
k. Humidity sensors:
    1. Input Voltage Range: 6 to 30 VDC
    2. RH Range: 3% RH to 95% RH
    3. Accuracy: ±2% RH
    4. RH Signal Output: 4 to 20mA for 0 to 100% RH
    5. Repeatability: ±1% RH
    6. NEMA 4 enclosure
l. Monitor all central utilities and emergency systems from a local and remote location. See Section 15980 for metering details and requirements.
m. Required Control Objects:
    1. Niagara 4 Jace or BACnet router(s) required based on existing network architecture, (coordinate with UA BAS shop for existing architecture)
    2. Chilled water flow (gpm), totalized energy (btu)
    3. Chilled water header differential pressure (psig)
    4. Heating Hot water flow in GPM, totalized energy in btu's
    5. Domestic Hot water flow in GPM totalized in btu's
    6. Domestic water totalized in gallons
    7. Electric use totalized in kW hrs
    8. real time demand in kW
    9. Individual equipment power and energy use where required by University of Arizona
    10. Chilled water supply and return pressure and temperatures
    11. Steam pressures
    12. Domestic water pressures
    13. Hot water supply and return pressure and temperatures
    14. Status of equipment pumps and drives
    15. Change of set point capability for all variable frequency drives
    16. Provide HVAC equipment greater than 1 HP with time scheduling capability via EMCS
    17. Reset of hot water supply temperatures
    18. Chiller operational status, run times, pressures and temperatures
    19. Cooling tower operational status and temperatures
    20. Report of any EMCS component failures on critical equipment as required by University of Arizona
    21. Emergency generator-run time, load, kW, kVA
    22. Alarms as specified in other sections
    23. All control objects specified or suggested by the sequence of operations for each piece of equipment or system
n. Individual Unit Characteristics:
    1. Air Handling Unit fan status, start/stop, and fan speed (where applicable)
    2. Supply air, return air, outside air and mixed air temperatures
    3. Return air and outside air relative humidity
    4. Demand reset of hot and cold decks (based on zone terminal unit demand)
    5. Economizer control (enthalpy-based)
    6. Chilled water return temperature control
    7. Lighting controls (where specified)
    8. Occupancy reset of temperature and system shutdown (scheduled and/or via sensors)
    9. Filter differential pressure indication
    10. Space humidity status and reset when specified
    11. High-limit humidity control (dehumidification mode)
    12. Status of hot and cold duct static pressure
    13. Demand reset of duct static pressure (based on zone terminal unit damper positions)

14. Active control strategy for maintaining ventilation and indoor air quality requirements (e.g.: CO_2 sensing, outdoor air flow measurement)

o. Terminal Unit Characteristics:
   1. Adjustment of flow setpoints (min and max)
   2. Override of temperature setpoint
   3. Occupied and Unoccupied set points for flow and temperature
   4. Graphical thermostat with occupied setpoint, user single point adjustable from 70-75
   5. Adjustable dead-band
   6. Discharge air temperature
   7. Valve position
   8. % cooling load
   9. % heating load
   10. Current air volume set point
   11. Current air volume
      a. For dual-duct terminal units, provide airflow monitoring stations on both hot and cold inlet ducts, at a minimum.

p. Provide an outdoor air station at each AHU that measures temperature and relative humidity. (This station will be used for all reset and AHU mode decisions, i.e.: economizer, dehumidification.) This station must be installed in a location that will not be affected by influences other than actual ambient air conditions, such as exhaust air, radiant heat from nearby objects, reflected radiant heat, evaporation, vandalism, or other confounding factors.

q. Provide airflow measuring stations as required. Provide Ebtron Gold air flow measuring stations.

r. All control valves and isolation valves are to be located outside the Air Handler enclosure (not in the airstream).

s. Chilled water control valves to fail to “open” position. Hot water control valves to fail to “closed” position.

t. Provide adequate space to install all control valves with stems in the vertical position without exception.

u. Provide adjustable static pressure safety switch to shut down VFD controlled fans.

v. Identify all controls and wiring within pertinent control panel and provide control system drawing framed under Plexiglass or laminated on inside of panel door.

w. Provide alarms for critical control objects & conditions. Alarms shall be annunciated at the enterprise server. While other alarms may be required or specified, standard alarms shall include (where applicable):
   1. Command failure (where status is available):
      a. Fans
      b. Pumps
      c. Equipment
   2. Excessive deviation from setpoint:
      a. Supply air temperature
      b. Space temperature
      c. Building static pressure
   3. High temperature limit:
      a. Heating hot water
      b. Chilled water
      c. Domestic hot water
   4. Low temperature limit:
      a. Heating hot water
      b. Chilled water
      c. Domestic hot water
      d. Mixed air temperature
   5. Equipment fault:
      a. VFD fault
      b. Photovoltaic inverter fault
      c. Chiller fault
      d. Boiler fault

e. Generator fault
f. Refrigeration unit fault

6. Safety devices
   a. Filter status switch
   b. Low temperature detector (freeze stat)
   c. High static pressure switch
   d. Flood/moisture sensor
   e. Condensate pan float switch
   f. Smoke/fire alarm
   g. Occupant panic button
   h. Refrigerant detector
   i. Hazardous gas level
7. Laboratory environment
   a. Room pressurization error
   b. Space temperature high/low
   c. Space humidity high/low
   d. Exhaust system fault
   e. Fume hood control fault

x. PID Loop Tuning Requirements:

1. Definitions:
   a. Process variable (Pv): the system parameter the loop is designed to control (i.e.: temperature, pressure, etc.)
   b. Control variable (Cv): the means of affecting the Process variable (i.e.: valve, damper, VFD, etc.)
   c. Setpoint (Sp): the desired value of the Process variable
   d. Error: the difference between the Setpoint and the Process variable
   e. PID: Proportional, Integral, and Derivative mathematical terms
      i. P calculates the response for current error
      ii. I calculates the response for historical error
      iii. D calculates the response based on rate of change
   f. Bias: Used in P-only loop controllers, Bias compensates for steady-state error
   g. Deadband: defines a Pv range within which the Cv will not be adjusted by the PID controller
2. Specific commissioning tasks:
   a. Identify required control loops and loop variables.
   b. Tune all loop controllers.
   c. Review data showing Pv maintained at Sp.
   d. Review data showing system startup & stabilization.
   e. Review data of system upset & recovery.
   f. Document results.
3. Methods of performance:
   a. Pv, Cv, Sp, PID gains, Deadband, and Error properties shall only be visible and adjustable within the controller. These properties shall also be visible and adjustable while the loop is active.
   b. Separate PID terms shall be used for different modes of operation (i.e.: heating, cooling, economizer) to avoid linearity issues; each mode shall be tuned individually.
   c. Loop controller shall use P, I.
      i. D, Bias, and Deadband as-needed to provide control within the required parameters.
      ii. Ramp times for fans shall be a minimum of 3 mins or 180s.
   d. Loop control shall display:
      i. Stability: the Pv shall be maintained in a stable state.
      ii. Setpoint tracking: the Pv shall match the Sp, reducing Error to within the acceptable range (see below).
   e. Loop control shall not display:
      i. Hunting/oscillation:

a. Patterns of hunting or oscillation shall not be exhibited by the loop controller.
b. Hunting is defined as a change of more than 5% in 5 minutes

ii. Excess Error:
a. Temperature Control: Error must be < 2°F of setpoint
b. Humidity Control: Error must be < 10% of setpoint
c. Static Pressure Control: Error must be < 0.10" WC of setpoint
d. Hydronic Pressure Control: Error must be < 5 PSI of setpoint
e. Air Volume Control: Error must be < 10% of setpoint
f. Hydronic Volume Control: Error must be < 10% of setpoint

iii. Gross overshoot:
a. Upon Sp change or load upset, Pv shall not be allowed to overshoot Sp by +/-10% of stated Pv range.

iv. Excessive Cv action:
a. When Pv is stable, Cv shall adjust no more than 5% per minute (total action in both directions).

v. Sluggishness:
a. Upon equipment startup, the loop controller must bring Pv to stable control within the allowable Error within 20 minutes.
b. Upon Sp change or load upset, the loop controller must return Pv to stable control within the allowable Error within 5 minutes.

4. Documentation and reporting criteria for each control loop shall be provided by contractor:
a. Identify parameters:
i. Control Loop Identifier and equipment served
ii. Pv object & Pv range
iii. Cv object & Cv range
iv. Sp object & Sp range
v. PID terms & values
vi. Bias term & value (if applicable)
vii. Deadband (if applicable)
b. Data graph of loop behavior on startup for each applicable mode:
i. Graph must show actual data of:
a. Initial conditions: Equipment off, Cv in safe position
b. Equipment Start: Sp value, Cv action, Pv response
c. End conditions: Stable Pv within allowable Error
d. Time elapsed between Initial and End conditions
c. Data graph of upset & recovery under load for each applicable mode:
i. Graph must show actual data of:
a. Initial conditions: Stable Pv within allowable Error
b. Upset: Sp change (10% of Pv range) and Cv action
c. End conditions: Stable Pv within allowable Error
d. Time elapsed between Initial and End conditions

2. Integration Layer
a. Integration Layer products shall be Tridium Niagara-based technology. See Niagara requirements in Section III.C.
b. Approved Products:
1. Niagara 4-based products (only Open Niagara 4 products)
c. All software and firmware for all products shall be the latest version available at the date of substantial completion compatible with University of Arizona systems and capabilities.

3. Enterprise Layer
    a. The University of Arizona operates and maintains an integrated open-protocol environment that allows products from various suppliers to be integrated into a unified system in order to provide flexibility for expansion, maintenance, and service of the system.
    b. EMCS and GUI software (Enterprise Software) shall provide an essential window into the open environment, serving as the primary user interface for all open-protocol systems. This Enterprise Software will be used by all vendors providing the University of Arizona with open-protocol products and systems. All software and firmware for all products shall be the latest version available at the date of substantial completion.
    c. The Enterprise Software shall be installed in a University of Arizona-provided virtual environment. Minimum and recommended system requirements shall be provided by the contractor.
    d. The Enterprise Software shall be a BACnet Client, and shall be capable of performing the functions of a BACnet Advanced Workstation (B-AWS). The software shall be capable of simultaneously supporting BACnet/IP communications on several different UDP ports and networks.
    e. Enterprise Software functionality requirements:
        1. The Enterprise Software shall have the ability to collect data for any property of any object and store this data for future use. The Enterprise Software shall also be configured to archive trend data collected by devices supervised by the Enterprise Software.
        2. All log data shall be available to the user in the following data formats:
            a. Table (HTML)
            b. Graph (HTML)
            c. Comma separated values (CSV) export
        3. The building controls graphical user interface (GUI) shall be web-based and hosted on the University of Arizona Niagara Enterprise Server. See Appendix App-15970b Graphical User Interface (GUI) Standards for detailed GUI requirements.
        4. Event Alarm Notification
            a. The Enterprise Software shall be configured to generate alarms for Enterprise Software and BAS device errors, and other conditions that may lead to outages, failures, performance issues, or trend data loss.
            b. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:
                1. To alarm
                2. Return to normal
                3. To fault
            c. Create a minimum of eight of alarm classes for the purpose of routing types and or classes of alarms, i.e.: supervisory, EMCS device failure, security, HVAC, Fire, etc. Submit alarm classes to University of Arizona for approval.
            d. Provide routing of alarms by class, object, group, or node. Provide alarm escalation functionality.
            e. Provide alarming for all IP-connected BAS devices.
            f. Alarms shall be annunciated via email to one or more recipients.
            g. The following shall be recorded by the Enterprise Software for each alarm (at a minimum):
                1. Time and date
                2. Location
                3. Equipment/Device
                4. Acknowledge time, date, and user who issued acknowledgement.
                5. Number of occurrences since last acknowledgement.
            h. A log of all alarms shall be maintained by the Enterprise Software and shall be available for review by the user group.
                1. Provide features to allow filtering/routing of alarms by user defined parameters.

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

i. Alarms shall be created to notify operators of operating conditions that require immediate corrective response only. Conditions that do not warrant immediate, specific action shall not have alarms associated. Alarm event notification shall include information to indicate the specific action that is required.
j. Nuisance alarms, defined as false and/or repetitive notifications where no immediate corrective response is required, shall be reconfigured in a manner that eliminates false/repetitive alarms while preserving functionality required to alert University of Arizona operators of alarm circumstances that require attention.

5. Provide and maintain an Audit Log that tracks all operator activities that are performed on the Enterprise Software system. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. For each log entry, provide the following data:
   a. Time and Date
   b. User ID
   c. Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.
6. The Enterprise Software shall be configured to automatically and regularly backup its configuration database. The database shall be backed up based on a user-defined time interval to itself and a remote server.
   a. Copies of the current configuration database and the most-recently-saved database shall be stored in the Enterprise Software. The age of the most recently saved database is dependent on the user-defined database save interval. The last three (3) backups shall be retained.
   b. The Enterprise Software shall be configured to collect and store copies of the configuration backup for each of the devices it supervises.
7. A standard library of objects, templates, and GUI clip-art shall be included for development and setup of application logic, user interface displays, system services, graphics, and communication networks.

4. Historian Layer
   a. Accessibility
      1. Historian must support users via web-based user interface (UI). Users may include internal University of Arizona staff and external service providers.
      2. All software and firmware for all products shall be the latest version available at the date of substantial completion.
      3. System must provide users the ability to extract and download raw data in an open format (CSV), allowing data users to evaluate data within Excel or other software.
      4. UI must be remotely-accessible via methods approved by the University.
      5. Historian must be capable of "pushing" data to data clients both within and outside of the University of Arizona network (in open formats like CSV or via an open API). This may include scheduled exports of data to a File Transfer Protocol (FTP) site, or scheduled database synchronization.
      6. Historian database (DB) must be openly accessible to other third-party data clients and tools. This will allow other future tools to connect directly to the DB. (For example, tools like Microsoft Excel or Tableau can connect directly to a SQL DB, eliminating the need to extract, download, and import data. DB must support similar connectivity.)
      7. UI web server(s) must be capable of redundancy. This helps ensure availability of the resource.

b. Data Model
    1. Data from various sources must be normalized under a common data model (schema). All data entries must include:
        a. Date/time stamp in standard format
        b. Object name
        c. Value
        d. Engineering units
            i. any unit codes must be decoded into English text
        e. Object status (normal = 1/failed = 0, where available)
            i. Normal = 1
            ii. Failed = 0
            iii. Object status should be incorporated into recorded value by dividing the value by the status:
                a. 72^0F {ok} = 72/1 = 72
                b. 72^0F {fail} = 72/0 = nan (not-a-number)
                c. 72^0F {fail} = 72/0 = null
            iv. Values recorded for failed objects shall be distinguishable from valid values.
        f. System must be capable of receiving/retrieving data from various sources (Niagara^{AX}, Niagara^4, BACnet Trend Objects, SQL, JSON, etc.).

c. Engineering
    1. Database shall be distributable across disks, servers, and data centers, and logically optimized for network efficiency.
    2. Database shall be open-protocol or open API to accommodate future needs and applications.
    3. Database shall have configurable redundancy features.
    4. Database shall be repairable and upgradable without causing system downtime.
    5. Disaster recovery (DR) options shall be outlined for system and data. DR setup shall be supported by vendor as-required to facilitate DR implementation and testing.

d. Maintenance
    1. Operational uptime for the system must be 99.9% (8 hours of downtime allowable annually)
    2. System or accessibility downtime caused by data storage failure must be 0 minutes.
    3. Support and development resources must be available in the marketplace.
    4. Maintenance and support must be transition-able to University of Arizona.

e. Security
    1. System software must meet University of Arizona security requirements.
    2. System must be capable of granting data access permissions to users and user-types on a per-facility and per-user basis.
    3. System must be hardened for security.

B. BACnet Implementation & Deployment Specifications
    1. BACnet Definitions
        1. BACnet: ANSI/ASHRAE Standard 135-2012
        2. BACnet Device Types:
            a. BACnet Router (B-RTR): A device that connects two BACnet networks, permitting information exchange between them. All devices providing BACnet router service must support registering as a foreign device with a BBMD.
            b. BACnet Building Controller (B-BC): A general-purpose, field-programmable

device capable of carrying out a variety of building automation and control tasks. Typically controls major equipment and/or provides supervisory control.
   c. BACnet Advanced Application Controller (B-AAC): A fully-programmable controller.
   d. BACnet Application Specific Controller (B-ASC): A controller intended for use in a specific application with limited programmability. Typically controls minor equipment such as VAV terminal units.
   e. BACnet Smart Sensor (B-SS): A simple sensing device intended for a specific application.
   f. BACnet Smart Actuator (B-SA): A simple control device intended for a specific application.
   g. BACnet Advanced Work Station (B-AWS): Used to monitor the performance of a system and to modify parameters that affect the operation of a system.
   h. BACnet Operator Work Station (B-OWS): Used for monitoring and basic control of a system.
   i. BACnet Operator Display (B-OD): A basic operator interface with limited capabilities.
   j. BACnet Gateway (B-GW): A device that connects a BACnet network to a dissimilar network or device, permitting information exchange between them.
   k. BACnet Broadcast Management Device (BBMD): A device that propagates BACnet broadcast services from one network to another network.
3. BACnet Client: A BACnet device requesting information from and/or sending supervisory commands to a BACnet Server or BACnet Servers.
4. BACnet Server: A BACnet device that responds to requests and/or supervisory commands from a BACnet Client device.
5. BACnet Interoperability Building Blocks (BIBBs): Standard technical functionality blocks used to describe the capability of a device to interact with BACnet services. Each BIBB has a client version (A) and a server version (B). A single BACnet device can support both A and B versions of a BIBB.
6. BACnet Protocol Implementation Conformance Statement (PICS): Document that describes in technical detail the BACnet implementation applied to a device, including which BACnet Interoperability Building Blocks (BIBBs) apply to the device.
7. Native-BACnet: A controller that uses BACnet as the primary communication protocol, and does not require the use of a gateway or translator to be BACnet-compliant.
8. BACnet Testing Laboratory (BTL): A laboratory that tests and certifies BACnet devices for conformance to the BACnet standard.
9. Bounded/Unbounded: An *unbounded* broadcast refers to a BACnet broadcast that is sent to all BACnet device IDs on the entire internetwork. A *bounded* broadcast is sent only to a subset of device IDs. Unbounded confirmed broadcast messages can result in BACnet storms. Bounded confirmed broadcast services mitigate the risk of storms by reducing the scope of the communications to only those devices that are specified, which limits the number of potential responses.

b. Documenting BACnet in Proposals, Submittals, and As-Built Records
1. Clear communication regarding BACnet is essential. Therefore, all documentation and literature shall refer to BACnet topics and concepts using standardized terminology. Refer to *ANSI/ASHRAE Standard 135* for proper terms.
2. Any documentation that does not meet the terminology requirements or fails to include the required information will be rejected.
3. All approved BAS system submittals shall include all pertinent information relating to BACnet including:
   a. Controller schedule including all BAS controllers to be used; include an electronic spreadsheet including:
      i. Controller name/description
      ii. Manufacturer
      iii. Model number
      iv. Software Version
      v. Firmware Version
      vi. BACnet device type (i.e.: B-BC, B-AAC, B-ASC, etc.)
      vii. BACnet network type (BACnet/IP or BACnet MS/TP)

viii. Location (room number or description of installation location)
ix. Controlled Equipment
x. MS/TP network(s) supported (where applicable)
xi. Host controller (for MS/TP devices, where applicable)

b. BAS architecture diagram specific to the planned installation (no generic diagrams) including:
i. Logical network topology for all networks
ii. Nomenclature to identify each device and network matching nomenclature in controller schedule

c. Product data sheets for all products provided
d. Operation & Maintenance manuals for all products provided
e. Technical manuals for all products provided
f. BACnet PICS for each product included in design
g. Device and object names shall conform to Appendix App-15970a *Smart Building Technology Device & Object Naming Standard* (ONS).
h. Request for information (RFI) regarding IT and BACnet parameters required for configuration of devices. Logical diagram and controller schedule must be updated incorporating network configuration information and re-submitted for approval.

4. All accepted BAS system as-built documentation shall include all pertinent information relating to BACnet including:
a. Submittal schedules, diagrams, and drawings updated with IT and BACnet parameters obtained from University of Arizona.
b. Updated architecture diagram including IT network details and BACnet parameter details.

5. PICS shall include at minimum:
a. BACnet Standard Application Services Supported: This table confirms the BACnet services supported by the device.
b. Standard Object Types Supported: This table lists the device's supported object types. It also indicates if the object is dynamically creatable, dynamically delete-able, optional supported properties, and writable properties.
c. Data Link Layer Options: Describes the network types supported for communications, e.g., Ethernet, IP, or MS/TP.
d. Special Functionality: Describes any special exceptions the device may have to the BACnet protocol in order to perform any specific functions.
e. Property Range Restrictions: Indicates, among other things, the number of characters allowed for the various text properties, such as Object_Name and Description.
f. The project technical specifications should act as the submittal review criteria. The information provided by the PICS should be compared to the technical specifications to ensure the device will function in the system as intended by the design.

c. BACnet Services
1. Normal Services (directed to a specific BACnet device or devices)
2. Broadcast Services (directed to any/all BACnet devices)
a. *Who-is?*
i. The *Who-is?* service is to be used in limited ways to avoid BACnet storms:
1. Unbound discovery is prohibited; use bounded *Who-is?* messages to limit responses.
2. *Who-is?* shall not be required for daily operation of the BAS or integration system; *Who-is?* is a discovery tool only. System devices are required to cache device discovery information and use directed communications to achieve interoperation.
3. Any system or device incapable of controlling and/or disabling *Who-is?* broadcast services it is capable of initiating will not be accepted.

b. *Who-has?*
i. The *Who-has?* service shall not be used in normal day-to-day operation;

system devices are required to cache object locations and use directed communications to achieve interoperation.

1. A device may use *Who-has?* to initially gain access to a network object, but thereafter this information shall be cached.
2. System devices shall not re-issue *Who-has?* on a return from power failure or other system disruption. Device or system backups shall retain cached object locations. *Who-has?* is permitted only in cases of programming changes.
3. The system must be capable of disabling the *Who-has?* service.
4. The system must be capable of configuring the *Who-has?* service to limit and bound its use.
5. Any system or device incapable of controlling and/or disabling *Who-has?* broadcast services it is capable of initiating will not be accepted.

c. Time synchronization
   i. The *Time-sync* broadcast service must be configurable; only bounded time broadcasting is permitted. Directed *Time-sync* communications is preferred.
d. Broadcasting on IP Networks
   i. General Broadcasting Guidelines:
      1. Broadcast services of any kind must not be used except where absolutely necessary.
      2. Where broadcast services are used, testing must be performed to ensure that the broadcasts and/or the responses do not cause system instability or loss of performance.
      3. Unbounded broadcast services are strictly prohibited. Any system that requires the use of unbounded broadcast services, or is unable to be configured to use bounded broadcast services, shall not be accepted.
e. Multicasting
   i. Systems that require multicasting will not be accepted.
f. BBMDs
   i. Systems that require BBMDs will not be accepted. The use of BBMDs, where that functionality might be desirable, shall be regulated by the University of Arizona. Any device capable of BBMD functionality must have that functionality disabled until University of Arizona expressly approves in writing the functionality for each specific device.
g. Foreign Devices
   i. BBMD-capable devices must also support foreign device registration.

d. BACnet Devices
   1. All BACnet devices shall be BTL-certified.
   2. BACnet networks:
      a. The following controllers shall be BACnet/IP:
         i. B-RTR
         ii. B-AWS
         iii. B-OWS
         iv. B-GW
      b. BACnet MS/TP is permitted for the following controllers:
         i. B-ASC
         ii. B-SS
         iii. B-SA
         iv. B-OD
         v. B-BC
         vi. B-AAC
      c. BACnet/Ethernet is not permitted, and this functionality must be disabled prior to connection to any University of Arizona network.
      d. ARCNET is not permitted, and this functionality must be disabled prior to connection to any University of Arizona network.
      e. LonWorks-protocol devices are in no way compatible with BACnet devices.

LonWorks/LonTalk/LON is not permitted.

f. Proprietary protocols are not permitted.

g. Wireless protocols are not permitted except with express permission from University of Arizona. Where permitted:

i. WiFi 802.11

1. WPA2 encryption shall be supported and implemented

h. BACnet devices and networks must be configured optimally for high-performance and low response latency. Serial networks (MS/TP) must be sized to perform without latency issues, regardless of the traffic imposed on them to support control, monitoring, and trending functions.

3. Required BIBBs (see following tables):

a. Refer to the tables below:

b.

Alarm and Event Management											
NAME	TITLE	B-AWS	B-OWS	B-RTR	B-GW	B-BC	B-AAC	B-ASC	B-SA	B-SS	B-OD
AE-ACK-A	Acknowledgement	●	●			●	●				●
AE-ACK-B	Acknowledgement					●	●				
AE-ASUM-A	Alarm Summary	●	●				●				●
AE-ASUM-B	Alarm Summary					●	●				
AE-ESUM-A	Enrollment Summary	●	●			●	●				
AE-ESUM-B	Enrollment Summary					●	●				
AE-INFO-A	Information	●	●			●	●				●
AE-INFO-B	Information					●	●				
AE-LS-A	Life Safety	●	●								
AE-LS-B	Life Safety										
AE-N-A	Alarm and Event Notification	●	●			●	●				
AE-N-E-B	Notification – External Device					●					
AE-N-I-B	Notification – Internal					●	●				
AE-VM-A	View and Modify Some Parameters	●	●								
AE-AVM-A	View and Modify All Parameters	●									
AE-VN-A	Notification - View Some Info	●	●								
AE-AVN-A	Notification - View All Info	●									
AE-ELVM-A	Event Log - View and Modify	●									

Data Sharing											
NAME	TITLE	B-AWS	B-OWS	B-RTR	B-GW	B-BC	B-AAC	B-ASC	B-SA	B-SS	B-OD
DS-COV-A	Change of Value					●	●				
DS-COV-B	Change of Value					●	●				
DS-COVP-A	Change of Value – Property										
DS-COVP-B	Change of Value – Property										
DS-COVU-A	Unsolicited COV					●	●				
DS-COVU-B	Unsolicited COV					●	●				
DS-RP-A	Read Property	●	●			●	●				●
DS-RP-B	Read Property	●	●		●	●	●	●	●	●	
DS-RPC-A	Read Property Conditional										
DS-RPC-B	Read Property Conditional										
DS-RPM-A	Read Property Multiple	●				●	●				
DS-RPM-B	Read Property Multiple	●				●	●	●			
DS-WP-A	Write Property	●	●			●	●				●
DS-WP-B	Write Property		●		●	●	●	●	●		
DS-WPM-A	Write Property Multiple	●									
DS-WPM-B	Write Property Multiple					●	●				
DS-V-A	Read Commonly Used Properties	●									
DS-V-B	Read Commonly Used Properties										
DS-AV-A	Read Any Standard Property	●									
DS-AV-B	Read Any Standard Property										
DS-M-A	Modify Commonly Used Properties	●									
DS-M-B	Modify Commonly Used Properties										
DS-AM-A	Modify Any Standard Property	●									
DS-AM-B	Modify Any Standard Property										

Device Management											
NAME	TITLE	B-AWS	B-OWS	B-RTR	B-GW	B-BC	B-AAC	B-ASC	B-SA	B-SS	B-OD
DM-ADM-A	Discover All Objects in Any Device	●	●								
DM-ANM-A	Discover all Devices on the Network	●	●								
DM-BR-A	Backup and Restore	●									
DM-BR-B	Backup and Restore					●	●	●			
DM-DCC-A	Communication Control	●									
DM-DCC-B	Communication Control					●	●	●			
DM-DDB-A	Dynamic Device Binding	●	●			●	●				
DM-DDB-B	Dynamic Device Binding	●	●			●	●	●	●	●	
DM-DOB-A	Dynamic Object Binding					●	●				
DM-DOB-B	Dynamic Object Binding	●	●			●	●	●	●	●	
DM-LM-A	List Manipulation	●									
DM-LM-B	List Manipulation					●	●				
DM-OCD-A	Object Creation and Deletion	●									
DM-OCD-B	Object Creation and Deletion					●	●				
DM-PT-A	Private Transfer										
DM-PT-B	Private Transfer										
DM-R-A	Restart	●									
DM-R-B	Restart					●					
DM-RD-A	Reinitialize	●									
DM-RD-B	Reinitialize					●	●	●			
DM-TM-A	Text Message										
DM-TM-B	Text Message										
DM-TS-A	Time Synch – Local Time	●	●			●					
DM-TS-B	Time Synch – Local Time				●	●	●				
DM-UTC-A	Time Synch – UTC	●	●			●					
DM-UTC-B	Time Synch – UTC				●	●	●				
DM-VT-A	Virtual Terminal	●	●								
DM-VT-B	Virtual Terminal										

Network Management											
NAME	TITLE	B-AWS	B-OWS	B-RTR	B-GW	B-BC	B-AAC	B-ASC	B-SA	B-SS	B-OD
NM-CE-A	Connection Establishment			●							
NM-CE-B	Connection Establishment			●							
NM-RC-A	Router Configuration	●									
NM-RC-B	Router Configuration			●							

Network Security											
NAME	TITLE	B-AWS	B-OWS	B-RTR	B-GW	B-BC	B-AAC	B-ASC	B-SA	B-SS	B-OD
NS-ED	Supports Encryption										
NS-KS	Key Server										

Scheduling											
NAME	TITLE	B-AWS	B-OWS	B-RTR	B-GW	B-BC	B-AAC	B-ASC	B-SA	B-SS	B-OD
SCHED-A	Scheduling	●	●								
SCHED-B	Scheduling										
SCHED-VM-A	View and Modify	●	●								●
SCHED-VM-B	View and Modify										
SCHED-AVM-A	Create, View, and Modify	●	●								
SCHED-AVM-B	Create, View, and Modify										
SCHED-ELVM-A	View and Modify Event Log	●									
SCHED-ELVM-B	View and Modify Event Log										
SCHED-E-A	Scheduling - External	●									
SCHED-E-B	Scheduling - External					●	●				
SCHED-I-A	Scheduling - Internal	●									
SCHED-I-B	Scheduling - Internal					●	●				
SCHED-WS-A	Weekly Schedule										
SCHED-WS-B	Weekly Schedule										

Trending											
NAME	TITLE	B-AWS	B-OWS	B-RTR	B-GW	B-BC	B-AAC	B-ASC	B-SA	B-SS	B-OD
T-ATR-A	Automated Trend Retrieval	●									
T-ATR-B	Automated Trend Retrieval					●	●				
T-V-A	Display Trend Values	●	●								
T-V-B	Display Trend Values										
T-AVM-A	Modify All Trend Configuration	●									
T-AVM-B	Modify All Trend Configuration										
T-VMT-A	View and Modify Trends	●	●			●	●				
T-VMT-E-B	View and Modify Trends External					●					
T-VMT-I-B	View and Modify Trends Internal					●	●				

e. BACnet Gateways (B-GW)
   1. BACnet gateways are approved for use to connect to existing obsolete and legacy devices only. Any other use must be individually and expressly approved in writing by RFI to University of Arizona for each specific application and instance.
   2. BACnet gateways shall not be used to connect new non-BACnet controllers or other devices unless specifically approved in writing by RFI to University of Arizona.
   3. Where possible/available, when BACnet gateways are used, they shall be configured to facilitate all available BACnet functionality. Devices connected using a gateway shall support the following BIBBs at minimum: DS-RP-B, DS-WP-B, DM-DDB-B, DM-DOB-B, DM-DCC-B, DM-RD-B. Objects made available using a gateway shall support the following BIBBs at minimum: DS-RP-B, DS-WP-B (DS-WP-B where “write” function applies).
   4. Any device or network connected to the BACnet internetwork via a BACnet gateway is considered part of the BACnet internetwork, and all requirements that apply to the BACnet internetwork extend to the devices and networks connected via BACnet gateways. High-performance communications and interoperability is required, and BACnet gateway solutions shall meet these requirements.

f. BACnet MS/TP to IP Routers (B-RTR)
   1. Any router or other device that supports one or more BACnet MS/TP networks shall support "BACnet IP, (Annex J), Foreign Device"

g. BACnet Parameters
   1. BACnet network configuration parameters must be configurable.
   2. BACnet network configuration parameters include:
      a. Device ID

b. Network Number
c. UDP port
d. BBMD feature settings (disabled unless specifically permitted by University of Arizona)

3. BACnet network configuration parameters shall be obtained from University of Arizona
   a. BACnet parameters are managed by University of Arizona.
4. Automatically-generated BACnet network configuration parameters must be configured to avoid duplication of object, device, or network instances. Automatically-generated BACnet parameters must be capable of being manually configured; devices that only support automatically-generated BACnet parameters are not permitted.

h. IT Network
1. TCP/IP network configuration parameters will be obtained from University of Arizona:
   a. IP address
      i. University of Arizona currently uses IPv4 addressing.
   b. Subnet mask
   c. Default gateway
   d. DNS
      i. University of Arizona currently does not support DNS.
2. Ports
   a. BACnet UDP port will be obtained from the University of Arizona.
   b. Other ports, when required for BAS operation (non-BACnet TCP or UDP ports), must be submitted for approval.
3. Physical infrastructure
   a. All IP network cabling and cabling installation shall meet or exceed University of Arizona specifications and standards. Cabling shall be installed from EMCS devices to locations designated by University of Arizona as managed IP switch locations (data closets). All IP cabling shall be installed with adequate service loops in designated IP switch locations to facilitate connection to University of Arizona IP switches regardless of IT rack or switch installation configuration.
   b. Separate networks for EMCS devices shall not be permitted; the University of Arizona IT infrastructure shall be leveraged to support EMCS devices.
   c. All end devices must connect directly to a University of Arizona managed IP switch; no unmanaged switches or hubs shall be permitted except for temporary service until the permanent IP network is functional. Temporary IP network equipment shall be removed and devices migrated to the University of Arizona IP network when permanent IP network is ready.

i. BACnet Implementation
1. During the execution phase of the project, coordination with the University is required to avoid or plan for potential system or network disruption. A risk and impact assessment must be performed prior to any activity that might disrupt existing system functionality. System outages must be planned three (3) weeks prior to work being performed.
2. Activities that may impact existing system performance include (but are not limited to):
   a. Adding a new controller to the network
   b. Removing a controller from the network
   c. Re-addressing existing controllers
   d. Modifying existing programming
   e. Changing device BBMD settings
   f. Altering router tables
   g. Altering BBMD tables
   h. Altering foreign device settings
3. Where possible when adding new devices, the new internetwork segment(s) shall be isolated and screened for proper configuration prior to being added to the existing internetwork.
4. After new devices, networks, programming modifications, or configuration settings have been added to the existing network, network diagnostics must be performed and documented to ensure that the changes have not adversely affected the system. Any changes found to be having negative effects shall be reported to University of Arizona, and immediately reverted until such time that the issue can be resolved. Resolution of the issue shall be coordinated with University of Arizona to minimize the impacts to

facility operations.

5. BACnet Features:
    a. Required fields for BACnet devices:
        i. Object Name
            1. Object Name shall be named according to the Object Naming Standard
        ii. Location
            1. Location field shall, at minimum, include room number where the device is located
        iii. Description
            1. Description field shall be used to identify the mechanical or other equipment served by the device
        iv. Vendor Name
        v. Vendor Identifier
        vi. Model Name
        vii. Firmware Revision
        viii. Application Software Revision
    b. Required fields for BACnet objects:
        i. Object Name
            1. Object Name shall be named according to the Object Naming Standard
        ii. Object Type
        iii. Description
            1. Description field shall include text describing the object
        iv. Device Type
            1. The Device Type field shall identify the type of sensor connected
        v. Units
            1. Engineering units shall be standard BACnet units

j. BACnet Commissioning & Acceptance
    1. BACnet Parameter Commissioning
        a. To ensure that all BACnet parameters have been configured correctly, each new device must be certified to have the parameters submitted and approved prior to project execution. Additionally, the BACnet internetwork must be free from errors; after all work has been completed, the vendor must submit a diagnostic report that reflects a properly-functioning BACnet internetwork.
        b. BACnet PICS must be submitted for each device model supplied as part of the project. All new devices must be BTL-certified.

k. BACnet Device & Network ID Standards
    1. BACnet Device Object ID Parameters:
        a. Description:
            i. BACnet permits the interconnection of up to 4,194,303 devices.
            ii. Each device is referenced by its device Object_ID property.
            iii. Each device shall have a value for the Object_ID property that is unique across University of Arizona buildings, including existing devices.
            iv. No device shall have an Object_ID with an instance number less than 1000.
            v. No device shall have an Object_ID with an instance number greater than 3,999,999.
            vi. Device Object_ID parameters shall be obtained from University of Arizona.
    2. BACnet Network Number Parameters:
        a. Description:
            i. The BACnet permits the interconnection of up to 65,535 networks.
            ii. Each network must have a Network Number that is unique across University of Arizona buildings, including existing networks.
            iii. No network shall have a Network Number less than 1000.
            iv. Network Number 65,535 shall not be used.
            v. Network Number parameters shall be obtained from University of Arizona.

3. BACnet MS/TP MAC Addressing:
    a. Master devices use token-passing.
    b. Slave devices reply to requests only. They do not support the *Who-is?* service, and therefore cannot be automatically discovered.
    c. MS/TP (Master Slave/Token Passing) addressing consists of 256 (0-255) addresses:
        i. 0 shall be reserved for the BACnet Router (B-RTR) serving the MS/TP segment.
        ii. 1-127 may be used for master or slave devices.
        iii. 128-254 are reserved for slave devices only.
        iv. 255 is reserved for broadcasting.
    d. MAC addresses shall be obtained from University of Arizona.
    e. MS/TP networks shall be limited to approximately 30 slave devices to prevent network latency.
    f. MAC addresses on a network shall be consecutive starting with 0 (B-RTR). (Some products reserve addresses 0, 1, 2 & 3. In cases like this, the addresses must be as nearly consecutive as possible.)
    a. The "Max Master" parameter for all applicable devices associated with an MS/TP network shall be set to the address of the highest-addressed master device.

C. Integration Implementation & Deployment Specifications
1. 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, the owner shall maintain the right to direct contractor to modify any software license, regardless of supplier, as desired by the owner.
2. All hardware and field level devices installed, (i.e.; ASCs, PDUs), for the project shall not be limited in their ability to communicate with a specific brand of Niagara Framework device.
3. The Contractor shall also provide the owner with Admin role login in credentials and the passphrase so that the owner may have full access to all Niagara Framework products installed.
4. Niagara 4:
    a. Only "Open" Niagara 4 products will be accepted, where "Open" refers to interoperability with other "Open" Niagara 4 products/drivers/tools/software/etc., regardless of supplier. Proprietary versions of Tridium-based Niagara 4 products will not be accepted.
5. All Niagara 4 software licenses shall have the "accept.station.in=*"; "accept.station.out=*" and "accept.wb.in=*" and "accept.wb.out=*" section of the software licenses.Niagara 4:
    a. Only "Open" Niagara 4 products will be accepted, where "Open" refers to interoperability with other "Open" Niagara^4 and Niagara^{AX} products/drivers/tools/software/etc., regardless of supplier. Proprietary versions of Tridium-based Niagara 4products will not be accepted.
6. Where integrating to an EMCS system or device that does not conform to Appendix App-15970a *Smart Building Technology Device & Object Naming Standard* (ONS), the standard shall be applied to all devices and objects mapped or defined in the integration system.
7. Integration Minimum Requirements
    a. All available objects in the legacy system shall be mapped to the integration system.
    b. Mapped objects shall be named according to the Object Naming Standard.
    c. Mapped objects must refresh at least every 15 seconds; stale values are not acceptable.
    d. Mapped objects that are not updating shall show stale and/or failed status when the target object or device is not responding.
    e. Mapped Object Functionality:

1. Mapped objects shall be read-able and writable directly from the integration system interface according to object functionality:
    a. Binary inputs shall be mapped read-only.
    b. Binary outputs shall be mapped read/write.
    c. Binary variables shall be mapped read/write.
    d. Analog inputs shall be mapped read-only.
    e. Analog outputs shall be mapped read/write.
    f. Analog variables shall be mapped read/write.
    g. Multi-state inputs shall be mapped read-only.
    h. Multi-state outputs shall be mapped read/write.
    i. Multi-state variables shall be mapped read/write.
2. Mapped objects shall return to automatic control when released from override in the integration system. Any point command override imposed from either the native system or the integration system shall be indicated in the integration interface and be able to be released from the integration system.
3. Control logic in the integration system shall be capable of commanding objects in the integrated system.

f. Integrated devices that are not communicating with the integration system shall indicate a fault that can be used to generate an alarm.

An Alarm Class named “DeviceSts” shall be created, and an alarm shall be generated in that alarm class for each device upon device communication failure (when the device is “down”).

D. Configuration and Programming Tools
1. Contractor shall provide all software (including any licensing required), hardware (special cables, operator terminals, etc.), and administrator access privileges to allow full configuration, programming, and administration of all system components and devices provided. University of Arizona has a limited ability to support different products and tools. Therefore, only certain products and tools shall be accepted. These include:
    a. Trane
        1. Tracer TU for Programmable Controllers Service Tool
    b. Schneider Electric
        1. Automation Server
            a. Locally-hosted web server with programming & configuration utility
    c. Tridium Niagara-based Workbench variants (only Open Niagara versions are accepted)
        1. Distech Controls EC-Net4 Workbench
            a. EC-Configure EC-Net4 Wizards
            b. EC-*gfx*Program Graphical Programming Interface
        2. Honeywell Controls
            a. WEBs-AX Workbench
        3. Vykon Controls
            a. Niagara^{AX} Workbench
                i. BACnet OWS & AWS
                ii. VykonPro Tools
    d. Delta Controls ORCAview OWS Software
        1. Requires hardware USB key
2. All software and/or firmware shall be of latest revision available (at substantial completion). The software shall be provided with a license that never expires.
3. Configuration and programming tools shall be provided for any EMCS product provided to the University of Arizona as part of any project. Tools must enable trained controls technicians to:

a. Back up & restore controller configuration and programming database
b. Add/remove/edit control points from controller database
c. Add/remove/edit controller programming (control logic)
d. Add/remove/edit schedules, trends, alarms, etc.
e. Manage and configure devices
f. Configure device IP network configuration
g. Configure device BACnet network configuration

4. Server-based tool software:
   a. Where applicable and required by University of Arizona, tools shall be installed on servers provided by University of Arizona.
5. Workstation-based tool software:
   a. Where applicable and required by University of Arizona, tools shall be installed on workstation computers provided by the University. In cases where tools are being installed on remote workstations, laptops, or notepad computers, appropriate cables, converters, etc. required to connect the tool computer to supported controllers shall be provided.

IV. Execution

A. Submittals:

1. Submittals provided must meet requirements outlined in any/all contract or specification documents pertaining to the project, and for the evaluation of the technology systems proposed shall also include at minimum:
   a. Device schedule in electronic spreadsheet format (use template available from University of Arizona, Appendix App-15970d Device Schedule Template), including:
      i. Device name/description
      ii. Manufacturer
      iii. Model
      iv. Device type (BACnet device type)
      v. Network type (B/IP or MS/TP)
      vi. Software revision
      vii. Firmware revision
      viii. Location (room number)
      ix. Controlled equipment
      x. MS/TP network(s) supported (number of MS/TP networks supported)
      xi. Host controller (BACnet router for MS/TP devices)
      xii. Columns reserved for University of Arizona-assigned:
         a. IP Address
         b. Subnet mask
         c. Default gateway
         d. BACnet UDP
         e. BACnet Device ID
         f. BACnet Network Number
         g. BACnet BBMD authorization
         h. BACnet MS/TP Address (MAC address)
   b. Device technical data, technical manuals, and IT security hardening guide
   c. Device BACnet PICS for each BACnet-compliant device
   d. Description of BACnet implementation, including diagrams and technical information regarding the specific requirements and limitations of the implementation
   e. Floor plan drawings indicating the location of each device
   f. Riser diagram(s)
   g. Network topology diagram(s)
      i. Include a schedule of BACnet Networks with a column reserved for University of Arizona-assigned BACnet Network Numbers.
   h. Data flow diagram describing interoperability between proposed system(s) and other building systems, including integration, data collection, user interface, enterprise servers (with the understanding that the product may be hosted by enterprise server products from

other vendors), etc.
i. Sequence of Operations (SOO) to be used in creation of control logic.
j. Request for information (RFI) requesting University of Arizona-supplied IT, BACnet, and other required parameters
k. Design engineer contact information for proposed system
l. Technical contact information for the proposed products

B. Technology Deployment
1. Devices shall not be added to the network until TCP/IP and BACnet parameters have been confirmed in coordination with the designated University of Arizona representative.
2. Any device causing or thought to be causing network disruption shall be removed from the network until such time that the contractor can determine the cause of the issue and provide resolution.
3. The contractor bears the responsibility of providing, configuring, and deploying network (IP and BACnet) devices in a manner conducive to a properly operating, error-free network.

C. Networking
1. Physical Networks
a. Cabling
i. Refer to University of Arizona guidelines for cabling specifications and installation guidelines (for 10/100/1000 and fiber-optic cabling). To avoid duplication of effort, all cabling shall be compliant with and installed according to University of Arizona standards. Coordinate with University of Arizona to identify locations of University of Arizona network switches (existing or future), risers, raceways, and cabling trays. Refer to University of Arizona design if available, and install cabling in a manner to avoid duplication of work where possible.
ii. Provide adequate cabling service loops to allow University of Arizona to re-terminate cabling to patch panels.
iii. Label cables according to University of Arizona standards. Provide labels that will stay securely affixed and legible throughout the construction process.
iv. All work shall comply with codes and standards applicable to each type of work through the course of this contract.
v. Conduit or other appurtenances that are required by University of Arizona (regardless of codes or standards) shall be provided and installed by cabling installer. At minimum, cabling shall be installed in conduit in all mechanical and electrical rooms, and in unfinished warehouse or storage spaces. Exposed cabling in these areas is not permitted, regardless of the presence of existing exposed cabling.
vi. Core-drilling and other cabling pathway-creating activities shall be included where necessary. All penetrations shall meet code requirements.
b. Network Hardware
i. All IT network hardware components shall be provided, installed, and configured by University of Arizona. Temporary IT network hardware shall be supplied by contractor as needed to maintain project schedule, and shall be removed when the University of Arizona network is ready and in coordination with University of Arizona.
ii. Enclosures intended for the installation of University of Arizona network hardware components may be installed by other contractors under the direction of University of Arizona or authorized representatives.
iii. Absolutely no network routers, switching, wireless, or other hardware shall be connected to the University of Arizona network without the express and specific permission of University of Arizona. Contractor may connect devices to a temporary network to meet project schedule and milestones.
iv. Absolutely no cellular modems or other wireless access devices shall be connected to the EMCS or other building systems unless prior written permission is obtained from University of Arizona. Any cellular modems or other wireless access devices shall be removed from the system prior to connecting the system to the University of Arizona network. Cellular modems or other devices that would circumvent University of Arizona IT security shall be removed prior to connection to the University of Arizona network.
c. Device Hardening
i. Utilize a hardening guide and industry best practices when configuring any building technology device. All unused or unnecessary ports shall be disabled or closed, passwords shall meet or exceed complexity requirements, and network communication should be encrypted where possible. Policy techniques such as the *principle of least*

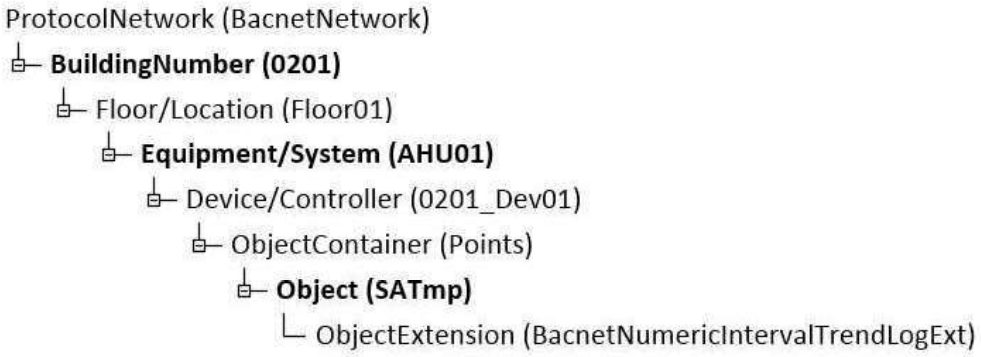
privilege (POLP) and *separation of duties (SoD)* shall be implemented where possible. Default credentials for any device shall be disabled and replaced with user-specific administrative credentials for contractor technicians and University of Arizona technicians. Other less-privileged user accounts may be added also. The University of Arizona system administrators shall be given access privileges greater than or equal to any other user account on the system prior to connection to the University of Arizona network. The system administrator may immediately restrict vendor and other user access according to the *principle of least privilege (POLP)* for the remainder of the project. Refer to *NIST SP800-123* for hardening guidelines.

D. Object Naming Standard (ONS) (Appendix App-15970a)

1. The University of Arizona *Smart Building Technology Device & Object Naming Standard* (ONS) is intended to standardize the names of EMCS, Lighting, Metering, and other building control and monitoring objects. Systems must support at least thirty-character object names, and object names must never exceed thirty-five (35) characters.
2. The ONS shall be used to create all object and device names, without exception. The Standard is described in the ONS document available from University of Arizona. Objects include:
   a. Device (controller, equipment, smart sensor – any device that has a BACnet Device ID)
   b. Control points
   c. Schedule objects
   d. Calendar objects
   e. Trend objects
   f. Event Enrollment objects
   g. Notification Class objects
   h. Command objects
   i. File objects
   j. Graphic files
   k. Reports
   l. Any BACnet-discoverable object
   m. Any object mapped to the integration device/system
   n. Any object created in the integration device/system
3. It is the contractor's responsibility to obtain the ONS document prior to implementation of any project.
4. All object naming shall be submitted to University of Arizona for review and approval prior to implementation – any system objects implemented prior to University of Arizona approval shall be corrected by the vendor at no additional cost to University of Arizona.
5. Any control object or point required by the controls application that is not represented in this standards document shall be submitted to University of Arizona via RFI. A response will be generated identifying the name that should be used for the application. If the supplied name is not currently represented in the standard document, it may be added by University of Arizona.
6. It is understood that the object names for some products cannot be modified – so-called "canned-application" controllers. These object names shall be proposed with an indication that the controller cannot be customized. This information may be used in conjunction with other information as part of the vendor selection criteria.
7. Refer to the ONS document for object naming guidelines. The specifications and instructions in that document are part of this general controls specification.

E. Integration

1. University of Arizona has selected Niagara Framework products to create a standardized integration environment to host the standardized graphical user interface (GUI).
   a. Niagara 4 hardware products are the current standard for integration of obsolete, legacy, proprietary, LonWorks, and Modbus devices. Niagara^4 hardware products may be accepted where they are compatible with existing enterprise systems.
   b. Niagara 4 software products are the current standard for enterprise software. Niagara^4 software products may be accepted where they are compatible with existing enterprise systems.
   c. All Niagara products shall be "Open" as defined in section III.C.
2. The integration shall be logically organized in a hierarchy as follows:



Boldface names shall conform to ONS guidelines and shall be used to comprise the names of Trend Objects using B-formatting as follows:

%parent.parent.parent.parent.parent.parent.name%_%parent.parent.parent.parent.name%_% parent.name%Td

The entire name shall not exceed 35 characters, as per the ONS.

3. Variations on the hierarchy shall be in keeping with the design intent; poorly organized hierarchy shall be rejected. Additional layers should be avoided.
4. BACnet Trend Objects shall be integrated from control devices for data upload and archival. Where the underlying system does not support BACnet Trend Objects, BACnet Trend Objects (or Niagara Network history extensions, depending on the application) shall be created.
5. BACnet Schedule Objects shall be integrated from control devices. Where the underlying system does not support BACnet Schedule Objects, BACnet Schedule Objects (or Niagara Network schedule objects, depending on the application) shall be created to manage equipment schedule functions. The enterprise server global calendar shall be referenced in schedule objects as appropriate for the application.

F. Graphical User Interface (GUI) Standards

1. All graphical user interface (GUI) pages shall be created using standard templates provided to the contractor by the University upon request. The templates are Niagara-based. Completed GUI pages shall include all of the types of information and features included in the templates, and shall not deviate from the template format. Page hierarchy, organization, and linking shall resemble existing examples.
2. Standard templates shall be requested for each individual project to ensure that the latest version of the templates are used for each project.

G. Technology Commissioning

1. In addition to any mechanical, electrical, or other building systems commissioning process included as part of the project, Technology Commissioning shall be performed to ensure that devices and systems have been deployed according to University of Arizona standards. This commissioning process covers:
   a. IP network configuration
      i. The IP configuration of each IP device shall match University of Arizona-supplied settings.
   b. BACnet network configuration
      i. The BACnet configuration of each device shall match University of Arizona-supplied settings.
   c. Product type application review
      i. Devices shall reside on the correct network type depending on the device type.
   d. Object Naming verification
      i. System objects shall be named according to the ONS.
   e. Integration organization review
      i. Integration of control devices and objects shall be logically organized, properly identified, and display functionality consistent with University of Arizona expectations.
   f. Documentation/literature review
      i. As-built documentation
      ii. Product data sheets

iii. Product installation, operation, and maintenance manuals
iv. Product/system technical literature
v. Configuration and programming guides/manuals
vi. Network security hardening guide
vii. Highest-level access credentials
viii. Complete configuration and programming backups for all devices

H. As-Built Documentation

1. The as-built shall contain, at minimum, all information included in the submittal, corrected to reflect the actual installation at the completion of the project.
   a. The SOOs shall be included in the as-built and also provided in RTF format

I. Integration with Automatic Fault Detection and Diagnostics (AFDD)

1. Contractor will coordinate with University of Arizona Facilities Management to implement onboarding of all new BAS systems into the third-party AFDD system currently in use.
2. Onboarding onto the AFDD should occur as soon as permanent power, reliable internet connectivity and BAS network architecture at the IP level is complete. Ad hoc internet connectivity can be used until permanent UArizona networking is complete, so long as all device IP addresses will remain the same after connection to the UArizona network.
3. As part of preparation for AFDD onboarding, the Contractor will be responsible for the following:
   a. Ensure all device IP and MAC addresses are programmed per the BacNet Device Schedule submitted by the project team and approved by University of Arizona Facilities Management.
   b. Install the latest version of the nHaystackService on all JACEs in the building.
   c. Coordinate with University of Arizona Facilities Management to establish user credentials for the AFDD vendor for access.

Respond to any requests for clarification from the AFDD vendor during the onboarding process, as requested through University of Arizona Facilities Management.

End of Section 15970

University of Arizona
Facilities Management
Building Automation

Smart Building Technology Device & Object Naming Standard

Standardized device & object naming convention for Building Automation Systems

THE UNIVERSITY OF ARIZONA

Smart Building Technology Device & Object Naming Standard for Building Automation Systems

Appendix App-15970a

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SHEET TITLE & NUMBER:
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Device & Object Naming Standard

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Smart Building Technology Device & Object Naming Standard for Building Automation Systems

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INTRODUCTION

This University of Arizona Smart Building Technology Device & Object Naming Standard (ONS) is intended to standardize the names of EMCS, Lighting, Metering, and other devices and control objects. Character limitations vary between EMCS products.

The provided diagrams are intended to aid the technician in finding the appropriate names for each object. The diagrams show generic HVAC, lighting, metering, and other equipment containing control points and objects, some of which may or may not be present in a particular application.

All device and object naming shall be submitted to University of Arizona for review and approval prior to implementation – any system objects implemented prior to approval shall be corrected by the vendor at no additional cost to the University.

Any control object or point that is not represented in this standards document must be submitted via RFI. A response will be generated identifying the name that should be used for the application. If the supplied name is not currently represented in the standard document, it may be added.

It is understood that the object names for some products cannot be modified – "canned-application" controllers. These object names shall also be submitted with an indication that the controller cannot be customized.

Object Units Descriptions

Object units are suggested in parentheses, such as: (°F)

For analog points, the engineering units are provided. Engineering units are standardized, and UA FM should be consulted where the standard units are inappropriate for the measurement or application.

Generally, analog outputs are expressed in percent (%, or pct). For valves and dampers, %open/%closed is used. 0% open would indicate that the control object is closed. 100% open would indicate that the control object is open. For mixing dampers, diverting valves, face/bypass dampers, etc., see unit indications where objects are found in diagrams in this document.

Binary outputs are generally expressed with (Off/On). Other binary units are provided depending on the application. The order of the state text labels is determined by the default position of the device. For example, a damper that is normally closed would use the units (Closed/Open), whereas a damper that is normally open would use (Open/Closed).

PROCESS

This Object Naming Standard (ONS) is implemented according to the following process:

1) Engineer automation system to understand what objects are required.
2) Using the ONS document (this document), identify and document the standardized names for the control objects and devices.
3) Submit the proposed names to University of Arizona.
4) Receive comments back, correct errors, and resubmit. Repeat process until all issues are resolved.
5) Object naming is approved by University of Arizona.
6) Implement names in EMCS database and programming.

Failure to follow and complete these steps in order may result in substantial re-work by and at the expense of the EMCS contractor.

SCOPE

This ONS covers all BACnet-discoverable devices and objects. These include:

- AI, AO, AV, BI, BO, BV, MO, & MV point types
- Calendar objects (Cldr)
- Schedule objects (Sched)
- Trend Log objects (Td)
- Event Enrollment objects (Evt)
- Notification Class objects (Not)
- File objects (File)
- Command objects (Bcmd)
- Devices

This Standard also covers all points, registers, etc. (objects) that are mapped using a driver, integration device, or system (such as Niagara Frameworks), and any additional objects created in the integration device or system. For example, registers mapped from a 3rd-party Modbus device to a EMCS controller using a driver must be named using this Standard.

UNDERSTANDING THE STANDARD

In order to properly implement this ONS, it is important to understand the goal it is intended to accomplish, the design philosophy of the naming system, and the methodology used to meet those goals.

GOAL:
Ensure that EMCS devices and objects are named in a manner that enables any user of the system or system data to instantly identify the device or object and understand the function of system objects, whether they are sensors, actuators, schedules, trend logs, etc. A user can be a human operator, but it can also be a computer that stores or processes information from the system.

PHILOSOPHY:
To allow a human to instantly identify a device or object simply by reading the name, at minimum the name must indicate which building it is in, what equipment or system it is associated with, what type of object it is, and what it does. These parts of the name must be human-readable using standardized abbreviations. These standardizations allow an operator or analyst to read, search, sort, group, and filter objects with ease.

A computer interpreter of a name would be able to use the building and equipment/system indications to group objects. To make the function of an object clear to a machine, the object type/function portion of the name is composed of standardized "camel-cased" abbreviations that a computer can break apart and use to automatically apply metadata tags. These tags allow applications, such as analytics engines or CMMS, to interpret information directly from the EMCS or from a trend archive and create actionable responses and outputs.

METHODOLOGY:
To create names that are both human-readable and machine-readable, the structure and abbreviations of the names are standardized. Each name has three parts separated by underscores: Building Number, Equipment Designator, and Object Name. (See the "ANATOMY" page for technical details on structure standardization.) Building Numbers are provided by University of Arizona in accordance with a pre-existing numbering system. The Equipment Designator is a free-form field; the mechanical drawings equipment schedule can be used as a guide. The Object Name is a camel-cased, standardized name for the object.

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Smart Building Technology Device & Object Naming Standard for Building Automation Systems

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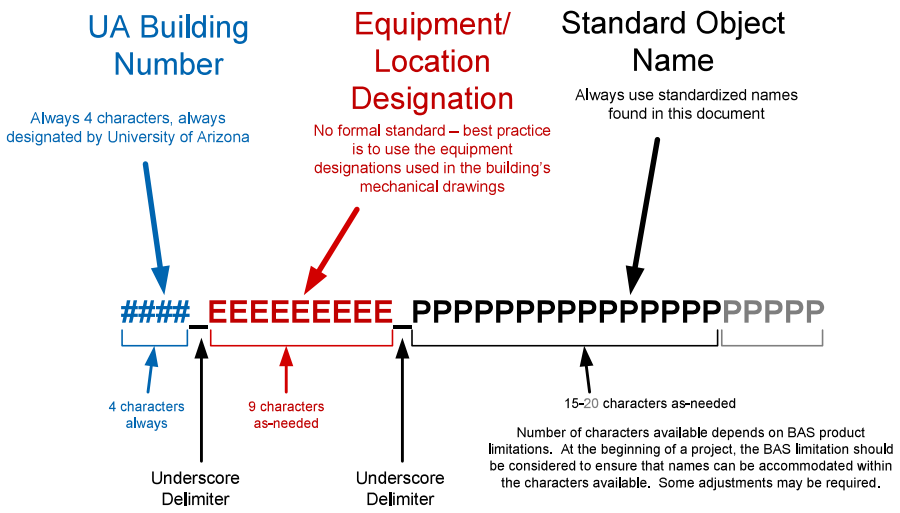
INTRO

Object Name Anatomy

Building_Equipment_Object



See ABRV page for Standard Point Name abbreviations.

TYPICAL CONVENTIONS

SUFFIXES:

Ena
Usually applied to BV objects. An "Ena" point indicates that conditions have been met to allow a device to be commanded, but is not the actual command. Examples:

CHWSysEna	HHWSysEna
BlrEna	EconEna

Cmd
Usually applied to BO and AO objects, and sometimes BV and AV objects also. A "Cmd" point commands something – starts a motor, modulates a valve, etc. Examples:

SFCmd	ChlrCmd
MADmprCmd	BlrCmd
CCVlvCmd	CTDivVlvCmd

Sts
Usually applied to BI objects. Corresponds to the "Cmd" point. This is the actual status of the thing. Examples:

SFSts	ChlrSts
SFVFDSts	CHWPmpSts

Pos
Applied to AI objects, "Pos" is feedback from a device such as a valve or a VFD. Corresponds to "Cmd" in the case of a valve or damper, or "Spd" in the case of a VFD. Examples:

CCVlvPos	CTFPos
MADmprPos	SashPos

Sp
Applied to AV objects, "Sp" is shorthand for Setpoint. Used to indicate the setpoint that corresponds to a control variable.
Examples:

SATmpSp	CHWSTmpSp
SAStPrsSp	HWSFlwRatSp
CHWSysOATmpEnaSp	

Alm
Usually applied to BI or BV objects. "Alm" should only be used on objects that have a corresponding event notification. Examples:

BlrAlm	MATmpAlm
LowTempAlm	DAStPrsAlm
FireAlm	ServiceAlm

Td
Applied to the end of an object name to indicate that it is the trend object associated with the control point object.
Examples:

SATmpTd	SFStsTd
CCVlvCmdTd	MATmpSpTd

Sched
Applied to schedule objects.
Examples:

AHU01_Sched	IceSys_Sched
CHW_Sched	EF01_Sched

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ANATOMY

Standard Point Name Abbreviations

A
Alm = Alarm (Off/On)
Aux = Auxilliary
AFMS = Air Flow Measuring Station
Avg = Average
Adj = Adjustment
A = Phase A
AppPwr = Apparent Power (kVA)
Ats = Automatic Transfer Switch
Auto = Automatic
B
Batt = Battery
B = Phase B
Btn = Button
Buzz = Buzzer
Blr = Boiler
Bstr = Booster
Btu = British Thermal Units
Base = Baseline
Bb = Baseboard
Bldg = Building
Byp = Bypass
C
Cmd = Command (Off/On)
CC = Cooling Coil
Cd = Condenser
Cond = Conditioning
Cmp = Compressor
CO2 = Carbon Dioxide
CD = Cold Deck
Clg = Cooling
Coeff = Coefficient
CdPan = Condenser Pan
Chlr = Chiller
Ctrl = Control
Cur = Current
Cap = Capacity
CHW = Chilled Water
CHWR = Chilled Water Return
CHWS = Chilled Water Supply
Cir = Circulation
CT = Cooling Tower
CDW = Condenser Water
CDWR = Condenser Water Return
CDWS = Condenser Water Supply
C = Phase C
Cnd = Condensate
Chg = Change
Cfctr = C-factor
Comb = Combiner
CtRatio = Current Transformer Ratio
D
DirNorm = Direct Normal
DA = Unit Discharge Air
Dew = Dewpoint (°F)
Dmd = Demand
Dmp = Damper
Db = Deadband
Dif = Differential
DCV = Demand-Controlled Ventilation
Det = Detector
Dly = Delay
Dis = Discharge
DHW = Domestic How Water
Div = Diverting
DW = Domestic Water

Standard Point Name Abbreviations

E
EA = Exhaust Air
Econ = Economizer
Ena = Enable
EF = Exhaust Fan
Eff = Effective
Enrg = Energy (kWh)
Enth = Enthalpy
Ent = Entering
Ev = Evaporator
Eject = Ejection
EVID = Electric Vehicle Identification
F
Fault = Fault
Freq = Frequency
Flw = Flow
FByp = Face/Bypass
Frst = Frost
Fast = Fast Fan Speed
Pos = Speed Control Feedback (%)
Flt = Filter
G
GH = Gas Heater
Glb = Global
Gly = Ethylene Glycol
Gen = Generator
H
Hand = Manual
HC = Heating Coil
HD = Hot Deck
Hi = High
High = High Fan Speed
HL = High Limit
HOA = Hand/Off/Auto
Hor = Horizontal
HPrs = High-Pressure
Hr = Hour
Ht = Heating
Htg = Heating
Hum = Humidifier
HW = Hot Water
HWR = Hot Water Return
HWS = Hot Water Supply
HX = Heat Exchanger
I
IAQ = Indoor Air Quality, Air Quality
Inlet = Fan Air Inlet
Irrad = Irradiance
Iso = Isolation
Ind = Indicator
Inf = Infectious
In = Input
Inv = Inverter
K
Kfctr = K-factor
L
Lck = Lockout
Ldlg = Lead/Lag
Lnk = Link
Lvr = Louver
LL = Line-to-Line
LL = Low Limit
LN = Line-to-Neutral
LPrs = Low-Pressure
Lmt = Limit
Lvg = Leaving
Lo = Low
Low = Low Fan Speed

Standard Point Name Abbreviations

M
MA = Mixed Air
Man = Manual
Mod = Modulation, Modulating
Mode = Mode
Max = Maximum
Min = Minimum
Med = Medium Fan Speed
Mf = Manifold
MPrs = Medium-Pressure
MU = Make-Up
N
Neg = Negative
Neut = Neutral
O
OA = Outside Air
Occ = Occupied
Offst = Offset
Ovrd = Override
Out = Output
Oper = Operation, Operator
OAF = Outside Air Fan
OT = OverTime
P
PC = Pre-Cool
PH = Pre-Heat
Par = Parallel
Pmp = Pump
Pri = Primary
Perf = Performance
PhsRev = Phase Reversal
POA = Plane of Array
Precip = Precipitation
Prev = Previous
Pro = Protective
PtRatio = Potential Transformer Ratio
PwrFct = Power Factor
Pls = Pulse, Pulses
Pos = Position (%), Positive
Prs = Pressure (psi, inWC)
Pwr = Power (kW)
R
RA = Return Air
RelHum = Relative Humidity (%)
RnTm = Run Time (hours)
Rst = Reset
Rev = Reversing
RF = Return Fan
RH = Re-Heat
Rng = Range
RstH = High End of Reset Scale
RstL = Low End of Reset Scale
Rcv = Recovery, Recovered
Rec = Recovery
Rfg = Refrigerant
Rej = Rejection, Rejected
Req = Required
Rev = Reversing
Rat = Rate
Rm = Room
RctPwr = Reactive Power (kVAR)
Rly = Relay
RelPwr = Real Power (kW)
Rem = Remaining
RO = Relay Output

Standard Point Name Abbreviations

S
Serial = Serial Number
SA = Supply Air
Smk = Smoke
Sp = Setpoint
Spd = Speed Control Command (%)
Sts = Status (Off/On)
SF = Supply Fan
Stg = Stage
Sw = Switch
Snsr = Sensor
Slow = Slow Fan Speed
Stby = Standby
Stm = Steam
Sec = Secondary
Seq = Sequence
Ser = Series, Service
Strts = Starts
SqFt = Square Feet
Str = Strainer
Snw = Snow, Snow-melt
Sup = Supply
T
Trk = Tracking
THD = Total Harmonic Distortion
Tons = Tons of Refrigeration
Tot = Total
Tm = Time
Tmp = Temperature (°F)
Tmr = Timer (s)
Td = Trend
U
Uoc = Unoccupied
Unbal = Unbalanced
UTC = Universal Time Clock
Usr = Zone Occupant
V
Vib = Vibration
VAC = Volts Alternating Current
VDC = Volts Direct Current
VFD = Variable Frequency Drive
Vlt = Voltage
Vel = Velocity
Vent = Ventilation
Vlv = Valve
VOC = Volatile Organic Compounds
Vol = Volume
W
Warn = Warning
Wh =Wheel
Wtr = Water
Z
Zn = Zone

Standard Engineering Units & Unit Abbreviations

Temperature: Degrees Fahrenheit (°F)
Water Pressure: Pounds per Square Inch (psiG)
Water Pressure Differential: Pounds per Square Inch Differential (psiD)
Air Pressure: Inches of Water Column (inWC, "WC)
Air Pressure Differential: Inches of Water Column Differential (inWCD, "WCD)
Relative Humidity: Percent (%)
Modulating Command = Percent (%open/ %closed)
Time: Seconds (s)
Minutes (m)
Hours (h)
Water Volume: Gallons (Gal)
Natural Gas Volume: Cubic Feet (CF)
Hundred Cubit Feet (CCF)
Thousand Cubit Feet (MCF)
Thermal Energy: British Thermal Unit (BTU)
Thousand BTU (MBTU)
Million BTU (MMBTU)
Tons of Cooling (Tons)
Electrical Power (real): Watt (W)
Kilowatt (kW)
Megawatt (MW)
Gigawatt (GW)
Electrical Energy (real): Watt-hour (Wh)
Kilowatt-hour (kWh)
MW-hour (MWh)
Electrical Power (apparent): Volt-amperes (VA)
Kilovolt-amperes (kVA)
Electrical Energy (apparent): Volt-ampere-hour (VAh)
Kilovolt-ampere-hour (kVAh)
Electrical Voltage: Direct Current Volts (VDC)
Alternating Current Volts (VAC)
Millivolts (mV)
Electrical Current: Amperes (A)
Milliamps (mA)
Carbon Dioxide (CO2): Parts per Million (ppm)
Carbon Monoxide (CO): Parts per Million (ppm)
Volatile Organic Compound (VOC): Parts per Million (ppm)
Air Flow Volume: Cubic Feet per Minute (cfm)
Air Flow Velocity: Feet per minute (fpm)

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DRAWN BY: Mike Grush
JOB NUMBER: 200762-001
REV. DATE: **04/17**

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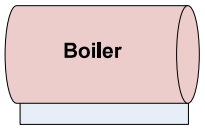
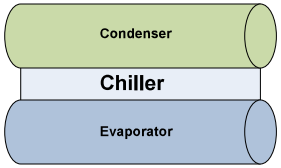
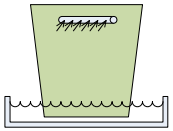
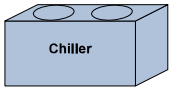
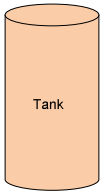
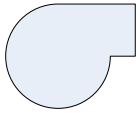
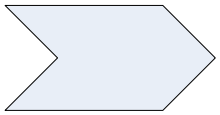
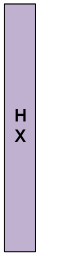
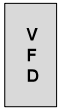
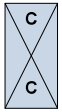
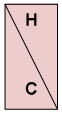
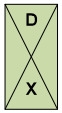
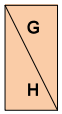
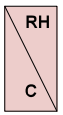
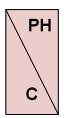
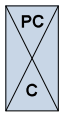
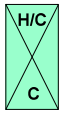
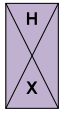
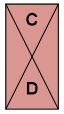
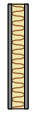
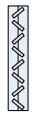
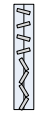
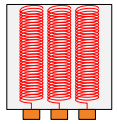
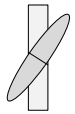
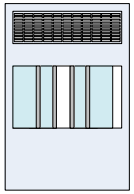
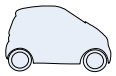
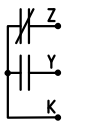
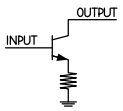
ABRV

	Boiler
	Water-Cooled Chiller
	Cooling Tower
	Air-Cooled Chiller
	Storage Tank
	Fan or Pump
	Ductwork

	Air-to-Air Heat Exchanger
	Coil
	Variable Frequency Drive
	DX Compressor
	Cooling Coil
	Heating Coil
	DX Coil
	Gas Duct Heater
	Reheat Coil

	Pre-Heating Coil
	Pre-Cooling Coil
	2-Pipe Heating/ Cooling Coil
	Heat Exchanger Coil
	Condenser Coil
	Air Flow Measuring Station
	Filter
	Control Damper
	Face/Bypass Damper

	Electric Duct Heater
	Terminal Unit Damper
	Lab Fume Hood
	Water-to-Water Heat Exchanger
	Electric Vehicle
	Pulse Output
	Open Collector Output
	Electric Meter
	Gas Meter
	Water Meter

	Thermal Energy Meter
	Wireless
	Electric Meter
	Electric Meter
	Fuse
	Reversing Valve
	3-Way Valve
	2-Way Valve
	Damper Actuator
	Solenoid Valve
	Direct-Expansion Valve
	Strainer
	Air Temperature Duct Sensor
	Static Air Pressure Duct Sensor
	Relative Humidity Duct Sensor
	Air Quality Duct Sensor

	Averaging Duct Temperature Sensor
	Averaging Duct Temperature Switch
	Duct Smoke Detector
	Well Temperature Sensor
	Hydronic Pressure Sensor
	Hydronic Pressure Differential Sensor
	Hydronic Flow Sensor
	Air Pressure Differential Switch
	Air Pressure Differential Switch
	OSA Temperature Sensor
	OSA Relative Humidity Sensor
	OSA Air Quality Sensor
	Pyranometer

	Weather Station
	Space Temperature Sensor
	Space Relative Humidity Sensor
	Space Air Quality Sensor
	Space Occupancy Sensor
	Lighting Load
	Lighting Level
	Wall
	Air Pressure Differential Sensor
	Calendar
	Schedule
	Refrigerant

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STATUS: Version 3

DRAWN BY: Mike Grush

JOB NUMBER: 200762-001

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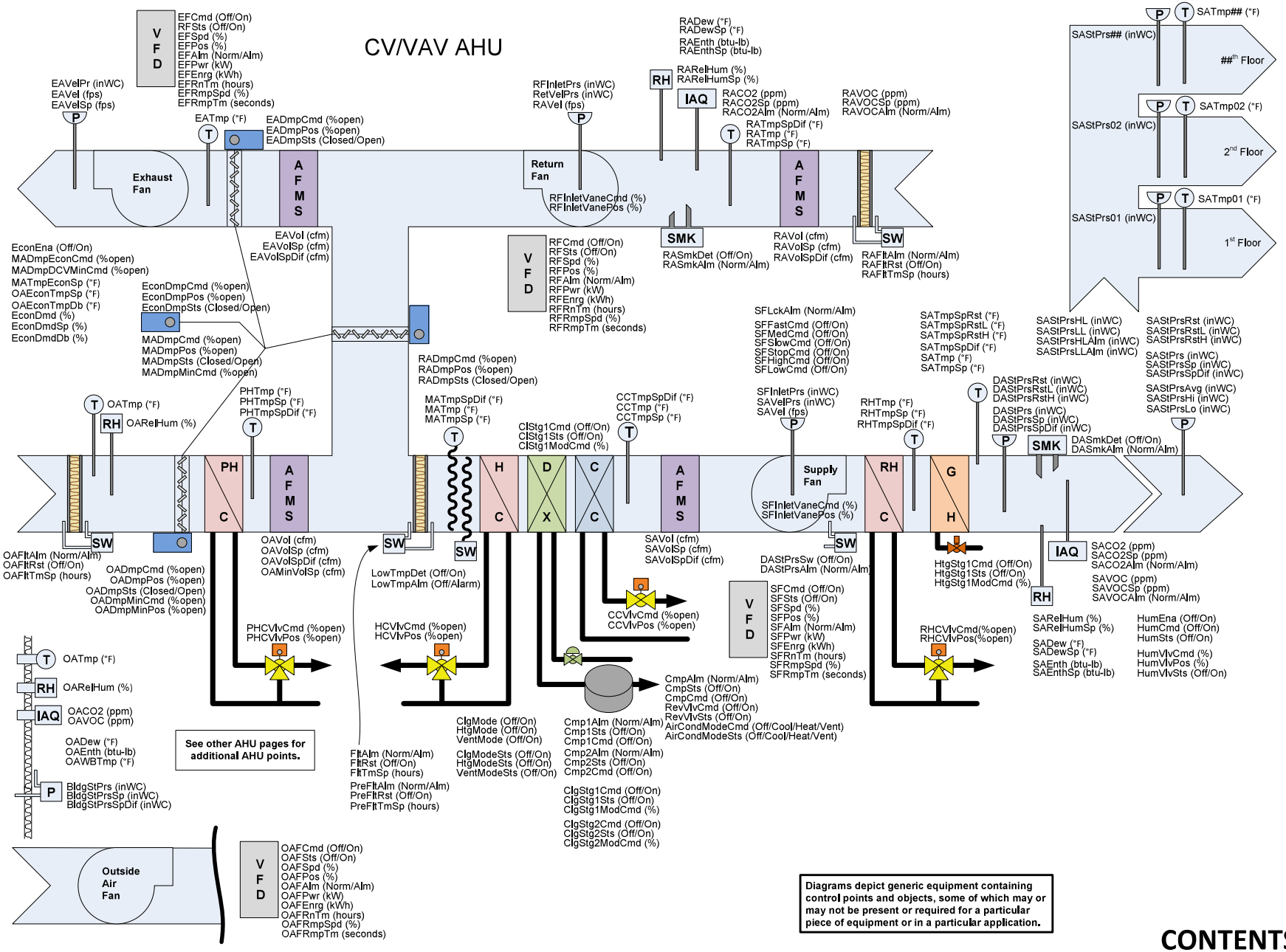
LEGEND



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AHUVAV

AHU Control Parameters

Equipment Enable

SysEna (Off/On)
Ena (Off/On)

Occupied Mode

OccCmd (Occ/Uoc)
OccSts (Occ/Uoc)
EffOcc (Occ/Uoc)

Override Mode

OvrdCmd (Off/Ovrd)
OvrdSts (Off/Ovrd)
ManOvrdCmd (Off/Ovrd)
ManOvrdSts (Off/Ovrd)
OvrdTmSp (sec, min, hours)
OvrdTmr (sec, min, hours)
OvrdCnt (count)

Overtime Hours

OTOccCmd (Occ/Uoc)
OTOccSts (Occ/Uoc)
OTOccTm (hours)

Misc

StartDelay (sec)
AuxContact (Off/On)
RemoteSp (use applicable units)

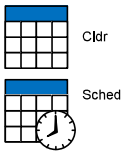
Equipment Runtime

Ideally equipment runtime objects should use hours for the engineering units and should not refer to the units in the name. However, where multiple objects are used to express runtime for a single piece of equipment with different time units, the following names should be used (SFRnTm is used as an example):

SFRnTm (hours)
SFRnTmSec (seconds)
SFRnTmHr (hours)
SFRnTmDay (days)

Equipment Schedule

SchedCmd (Off/On)
SchedSts (Off/On)
SchedEna (Off/On)



Cooling/Heating/Ventilating

ClgEna (Off/On)
ClgEnaSp (°F)
ClgDmd (Off/On)

HtgEna (Off/On)
HtgEnaSp (°F)
HtgDmd (Off/On)

VentEna (Off/On)

Lockout Points

ClgLckCmd (Off/On)
ClgLckSts (Off/On)
ClgLckTmpSp (°F)
ClgLckTmpDb (°F)

HtgLckCmd (Off/On)
HtgLckSts (Off/On)
HtgLckTmpSp (°F)
HtgLckTmpDb (°F)

StmLck (Off/On)
RHtLck (Off/On)
PHtLck (Off/On)

Warm-Up/Cool-Down Modes

CoolDnMode (Off/On)
CoolDnCmd (Off/On)
CoolDnSts (Off/On)
CoolDnSATmpSp (°F)
CoolDnRmTmpSp (°F)

WarmUpMode (Off/On)
WarmUpCmd (Off/On)
WarmUpSts (Off/On)
WarmUpSATmpSp (°F)
WarmUpRmTmpSp (°F)

Uoccupied Modes

UocLLEna (Off/On)
UocLLCmd (Off/LL)
UocLLSts (Off/LL)

UocHLEna (Off/On)
UocHLCmd (Off/HL)
UocHLSts (Off/HL)

Alarm/Safety Objects

UnitAlm (Norm/Alm)
ServiceAlm (Norm/Alm)
FaultAlm (Norm/Alm)

SmkAlm (Norm/Alm)
FireAlm (Norm/Alm)
ShutdownRelay (Off/On)

FltAlm (Norm/Alm)
FltRst (Off/On)
FltTmSp (hours)
FltTm (hours)

PreFltAlm (Norm/Alm)
PreFltRst (Off/On)
PreFltTmSp (hours)
PreFltTm (hours)

LowTmpAlm (Off/Alarm)

Loop Control Objects

Loop control variables, where they are being assigned using system objects, should use the following names:

[process]LpPv (use process variable units)
[process]LpCv (use control variable units)
[process]LpSp (use process variable units)
[process]LpPGain (pgain)
[process]LpIGain (igain)
[process]LpDGain (dgain)
[process]LpErr (use process variable units)
[process]LpTm (sec)
[process]LpBias (use control variable units)
[process]LpDb (use process variable units)
[process]LpCvHL (use control variable units)
[process]LpCvLL (use control variable units)

Example using a simple Supply Air Temperature control loop controlling a Cooling Coil Valve:

SATmpLpPv (°F) ...or SATmp (°F)
SATmpLpCv (%) ...or CCVlvCmd (%open)
SATmpLpSp (°F) ...or SATmpSp (°F)
SATmpLpPGain (pgain)
SATmpLpIGain (igain)
SATmpLpDGain (dgain)
SATmpLpError (°F)
SATmpLpTm (sec)...or 1
SATmpLpBias (%) ...or 50
SATmpLpDb (°F)
SATmpLpCvHL (%) ...or 100
SATmpLpCvLL (%) ...or 0

Example using a Temperature control loop controlling a Cooling Coil Calve and a Heating Coil Valve, with multiple temperature inputs and set-points depending on mode:

TmpLpPv (°F) ...SATmp during Occ, RATmp during Uoc
TmpLpCv (null) ...Cv controls CCVlvCmd & HCVlvCmd
TmpLpSp (°F) ...SATmpSp during Occ, RATmpSp during Uoc
TmpLpPGain (pgain)
TmpLpIGain (igain)
TmpLpDGain (dgain)
TmpLpError (°F)
TmpLpTm (sec) ...or 1
TmpLpBias (null) … or 0
TmpLpDb (°F)
TmpLpCvHL (null) ...100, 0 through 100 is for the cooling coil valve
TmpLpCvLL (null) …-100, 0 through -100 is for the heating coil valve

Optimal Start Stop (OSS)

OSS Objects (SSTO/SSTOCO)	OSS Objects (Zone Optimization)
OptStZn (null)	OptStClgSp (°F)
OptStMode (null)	OptStHtgSp (°F)
OptStNextStrtTm (min)	OptStDesOper (null)
OptStNextStopTm (min)	OptStEffClgSp (°F)
OptStErlyStrtTm (min)	OptStEffHtgSp (°F)
OptStLateStrtTm (min)	OptStMode (null)
OptStNextOccTm (min)	OptStLastMode (null)
OptStErlyStopTm (min)	OptStNextMode (null)
OptStLateStopTm (min)	OptStNextOccTmr (min)
OptStNextUocTm (min)	OptStNextOccTm (min)
OptStAdjStrtTm (min)	OptStNextStrtTmr (min)
OptStAdjStopTm (min)	OptStNextStopTmr (min)
OptStSeason (Summer/Winter)	OptStNextStopTm (min)
OptStZnTmp (°F)	OptStNextStrtTm (min)
OptStOATmp (°F)	OptStNextUocTmr (min)
OptStClgSp (°F)	OptStNextUocTm (min)
OptStClgCoeff1 (hours)	OptStOATmp (°F)
OptStClgCoeff2 (hours)	OptStOATmpStop (°F)
OptStClgCoeff3 (hours)	OptStOATmpStrt (°F)
OptStClgCoeff4 (hours)	OptStOccClgSp (°F)
OptStHtgSp (°F)	OptStOccHtgSp (°F)
OptStHtgCoeff1 (hours)	OptStLastOccTm (min)
OptStHtgCoeff2 (hours)	OptStPhase (null)
OptStHtgCoeff3 (hours)	OptStStopDrtn (min)
OptStHtgCoeff4 (hours)	OptStStopMode (null)
	OptStStopTm (min)
	OptStStrtDrtn (min)
	OptStStrtMode (null)
	OptStStrtTm (min)
	OptStStopTmpDif (°F)
	OptStStrtTmpDif (°F)
	OptStStopTGTmp (°F)
	OptStStrtTGTmp (°F)
	OptStAdjStrtTm (min)
	OptStAdjStopTm (min)
	OptStUocClgSp (°F)
	OptStUocHtgSp (°F)
	OptStUocTm (min)
	OptStZnTmp (°F)
	OptStZnTmpStop (°F)
	OptStZnTmpStrt (°F)

Diagrams depict generic equipment containing control points and objects, some of which may or may not be present or required for a particular piece of equipment or in a particular application.

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AHUMISC

Zone Control

Zn##OccCmd (Off/On)

Zn##EffTmp (°F)
Zn##EffSp (°F)
Zn##OccClgSp (°F)
Zn##OccHtgSp (°F)
Zn##UocClgSp (°F)
Zn##UocHtgSp (°F)
Zn##StbyClgSp (°F)
Zn##StbyHtgSp (°F)

T
Zn##Tmp (°F)
Zn##TmpSp (°F)

RH
Zn##RelHum (%)
Zn##RelHumSp (%)
Zn##Enth (btu-lb)
Zn##EnthSp (btu-lb)
Zn##Dew (°F)
Zn##DewSp (°F)

IAQ
Zn##CO2 (ppm)
Zn##CO2Sp (ppm)
Zn##CO2Alm (Norm/Alm)
Zn##IAQAlm (Norm/Alm)
Zn##VOC (ppm)
Zn##VOCSp (ppm)
Zn##VOCAlm (Norm/Alm)

See other AHU pages for additional AHU points.

General Zone Management

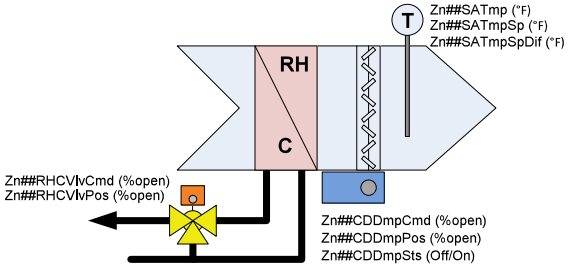
ZnDmpMax (%open)
ZnDmpMin (%open)
ZnDmpAvg (%open)

ZnHDDmpMax (%open)
ZnHDDmpMin (%open)
ZnHDDmpAvg (%open)

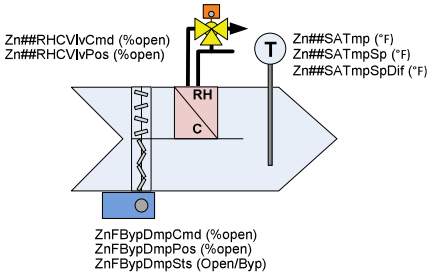
ZnCDDmpMax (%open)
ZnCDDmpMin (%open)
ZnCDDmpAvg (%open)

ZnRHCVlvMax (%open)
ZnRHCVlvMin (%open)
ZnRHCVlvAvg (%open)

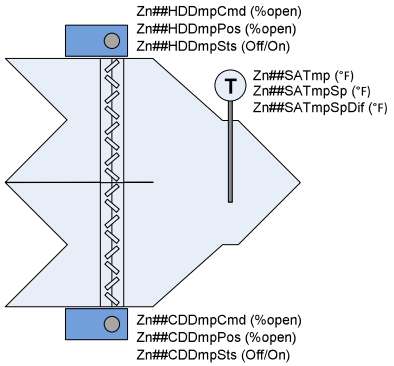
Single-duct Zone Damper



Face/Bypass Zone Damper



Dual-duct Zone Dampers



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DRAWN BY: Mike Grush
JOB NUMBER: 200762-001
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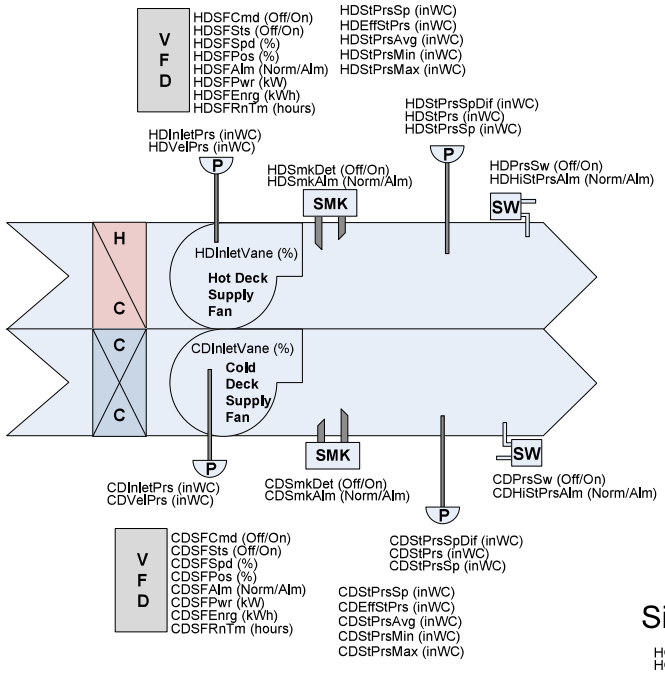
AHUMZ

Dual Supply Fan Dual Duct AHU



AHU Control Parameters

Unit Control Points

ManOvrdCmd (Off/On)
ScheduleCmd (Off/On)
ScheduleSts (Off/On)
OccCmd (Occ/Uoc)
OvrdCmd (Off/Ovrd)
OccSts (Occ/Uoc)
EffOcc (Occ/Uoc)
OTOcc (Occ/Uoc)
OTOccTm (hours)

NightLLCmd (Off/LL)
NightHLCmd (Off/HL)
ClgEna (Off/On)
ClgDmd (Off/On)
HtgEna (Off/On)
HtgDmd (Off/On)
RemoteSp (use applicable units)
StartDelay (sec)

Miscellaneous Points

AuxContact (Off/On)
ShutdownRelay (Off/On)
UnitAlm (Norm/Alm)
ServiceAlm (Norm/Alm)
SmkAlm (Norm/Alm)
FireAlm (Norm/Alm)

Lockout Points

ClgLckCmd (Off/On)
ClgLckSts (Off/On)
ClgLckTmpSp (°F)
ClgLckTmpDb (°F)
HtgLckCmd (Off/On)
HtgLckSts (Off/On)
HtgLckTmpSp (°F)
HtgLckTmpDb (°F)
StmLck (Off/On)
RHLck (Off/On)
PHLck (Off/On)

See other AHU pages for additional AHU points.

Zone Control Setpoints

OccCmd (Occ/Uoc)
UocOvrdCmd (Uoc/Ovrd)
OvrdTimeSp (hours)

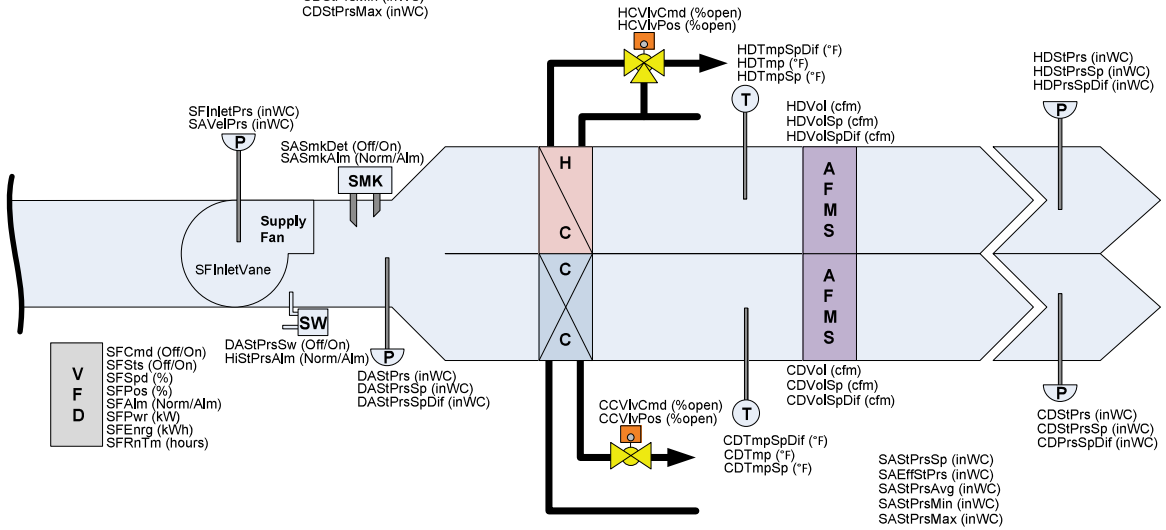
T — Tmp (°F), TmpSp (°F)

EffTmp (°F)
EffSp (°F)
OccClgSp (°F)
OccHtgSp (°F)
UocClgSp (°F)
UocHtgSp (°F)
StbyClgSp (°F)
StbyHtgSp (°F)

UsrSpAdjEna (Off/On)
UsrSpAdjRng (°F)
UsrSpAdjHL (°F)
UsrSpAdjLL (°F)
UsrSpAdj (°F)
EffUsrSp (°F)
OccSnsrSts (Off/On)

MinClgVolSp (cfm)
MaxClgVolSp (cfm)
MinHtgVolSp (cfm)
MaxHtgVolSp (cfm)
MinTotVolSp (cfm)
MaxTotVolSp (cfm)
AirFlowPct (%)
AirFlowPctSp (%)
OccAirVolSp (cfm)
UocAirVolSp (cfm)
HDDuctArea (sqft)
HDVolCoeff (coeff)
CDDuctArea (sqft)
CDVolCoeff (coeff)

Single Supply Fan Dual Duct AHU



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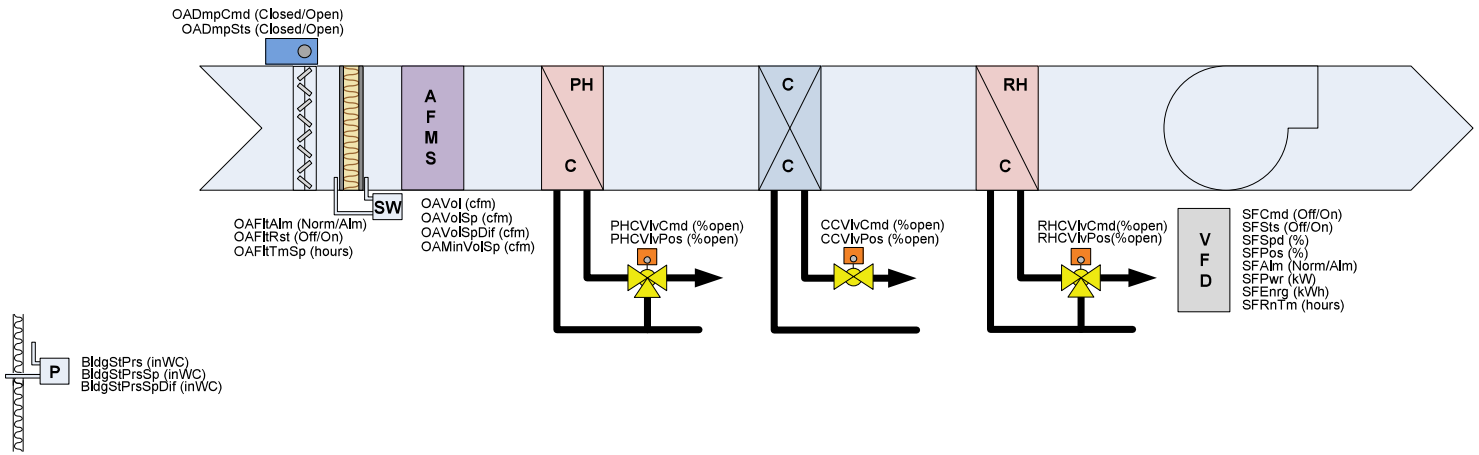
AHUDD

OSA AHU/MUA AHU



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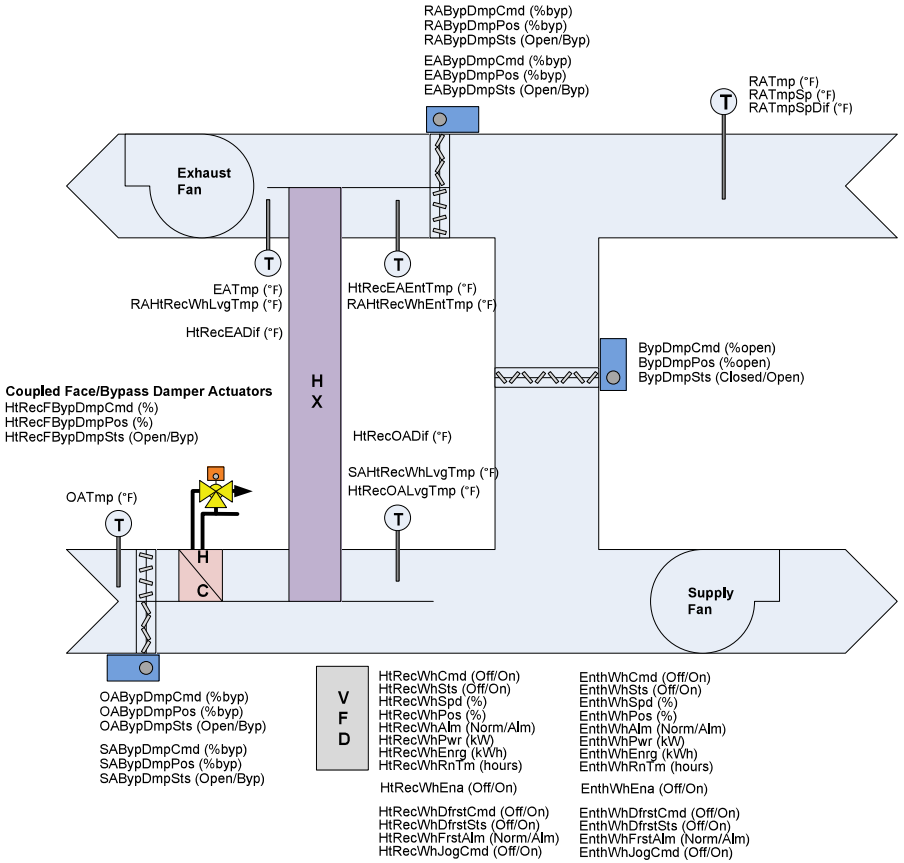
SHEET TITLE & NUMBER:

AHUOA

Air-to-Air Heat Recovery



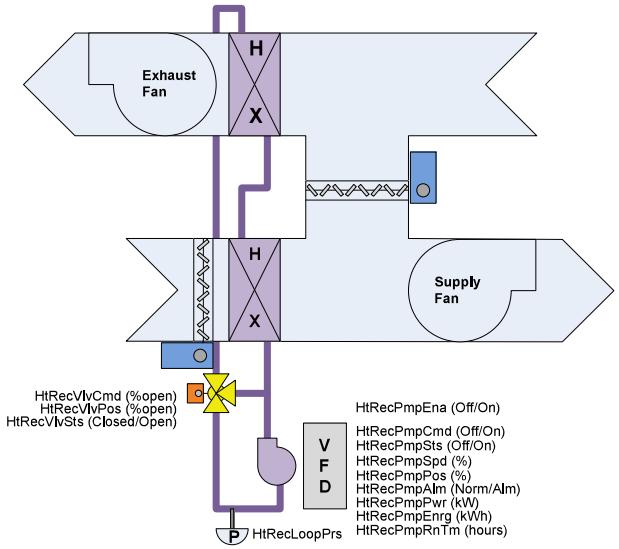
Heat Recovery Control Points

HtRecEna (Off/On)
HtRecMode (Recover/Reject)
HtRcvMode (Off/On)
HtRejMode (Off/On)
HtRecDif (°F)
HtRecDifSp (°F)
HtRecovered (btu)
HtRejected (btu)
HtRecEff (%)
HtRecEffBase (%)

HtRcvModeSp (°F)
HtRejModeSp (°F)
HtRcvModeDb (°F)
HtRejModeDb (°F)
HtRecOATmpSp (°F)
HtRecOATmpDb (°F)
HtRecDifSp (°F)
HtRecDifDb (°F)

FrstAlm (Norm/Alm)

Hydronic Heat Recovery



See other AHU pages for additional AHU points.

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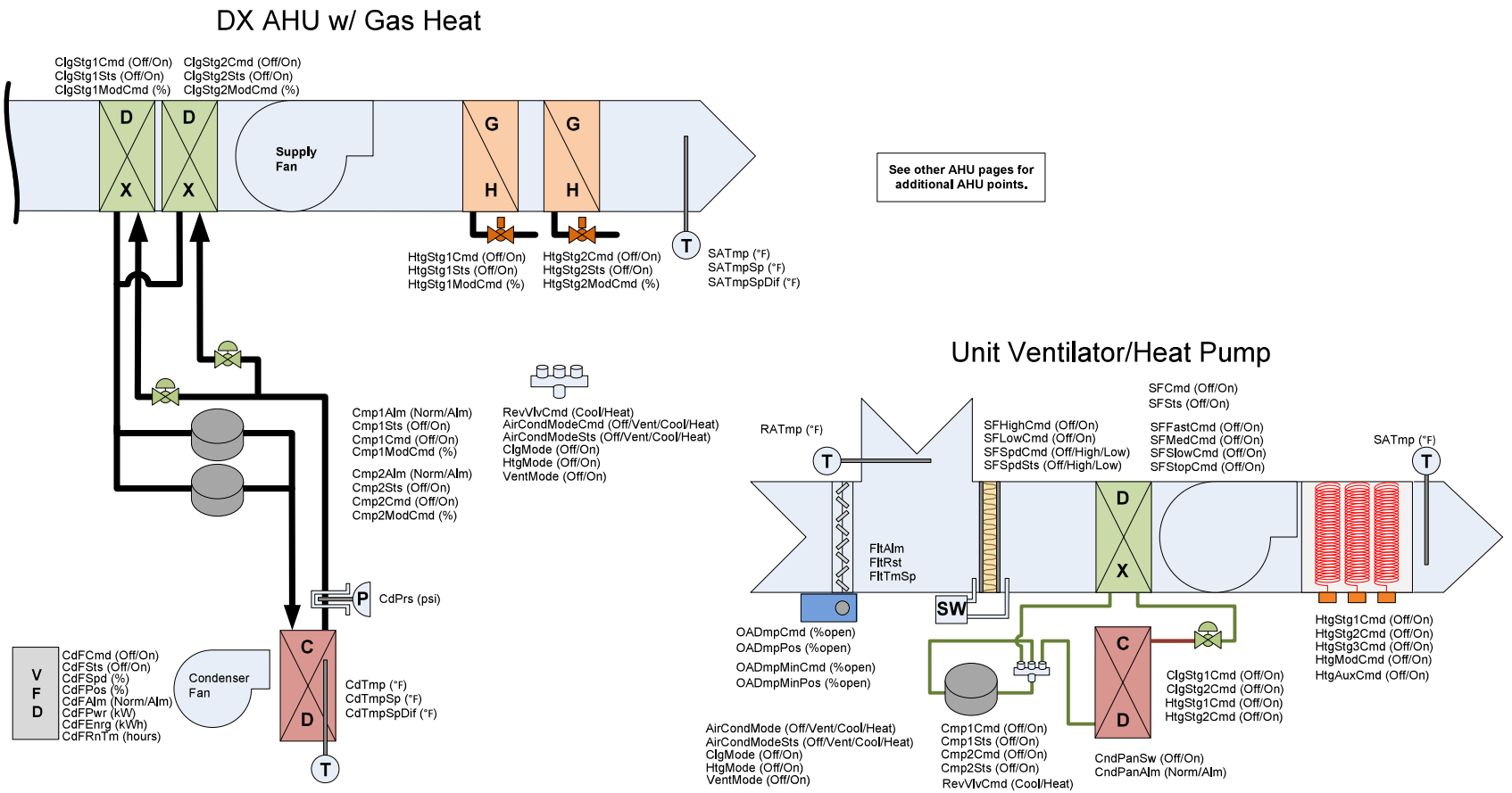
AHUHXR



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AHUDX

Zone/Terminal Unit Control Setpoints

OccCmd (Occ/Uoc)
UocOvrdCmd (Uoc/Ovrd)
OvrdTimeSp (hours)

OccRmTmpSp (°F)
UocRmTmpSp (°F)

EffRmTmp (°F)
EffRmTmpSp (°F)
OccClgSp (°F)
OccHtgSp (°F)
UocClgSp (°F)
UocHtgSp (°F)
StbyClgSp (°F)
StbyHtgSp (°F)

UsrSpAdjEna (Off/On)
UsrSpAdjRng (°F)
UsrSpAdjHL (°F)
UsrSpAdjLL (°F)
UsrSpAdj (°F)
EffUsrSp (°F)
OccSnsrSts (Off/On)

T
RmTmp (°F)
RmTmpSp (°F)

RH
RmRelHum (%)
RmRelHumSp (%)
RmEnth (btu-lb)
RmEnthSp (btu-lb)
RmDew (°F)
RmDewSp (°F)

IAQ
RmCO2 (ppm)
RmCO2Sp (ppm)
RmCO2Alm (Norm/Alm)
RmIAQAlm (Norm/Alm)
RmVOC (ppm)
RmVOCSp (ppm)
RmVOCAlm (Norm/Alm)

AirCondModeCmd (Cool/Heat)
AirCondModeSts (Cool/Heat)
ClgModeSts (Off/On)
HtgModeSts (Off/On)
StbyModeSts (Off/On)

MinClgVolSp (cfm)
MaxClgVolSp (cfm)
MinHtgVolSp (cfm)
MaxHtgVolSp (cfm)

OccAirVolSp (cfm)
UocAirVolSp (cfm)

EffAirVolSp (cfm)

AirFlowPct (%)
AirFlowPctSp (%)

DuctArea (sqft)
VolCoeff (coeff)

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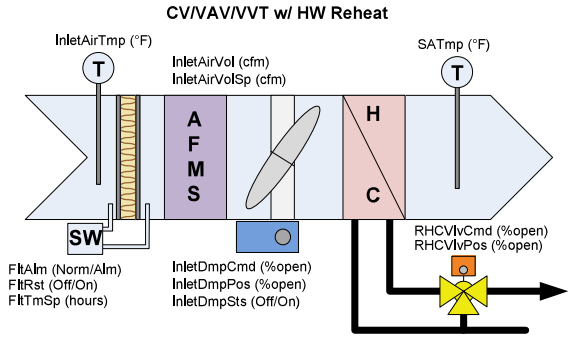
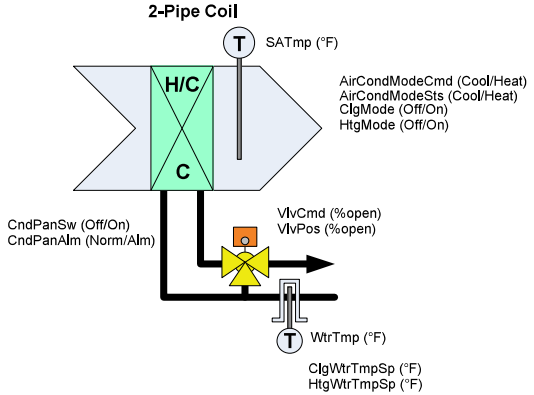
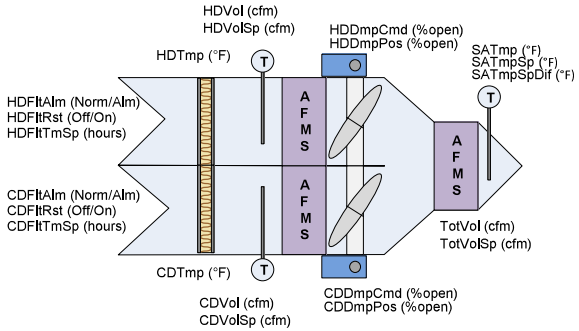
ZONE





Dual-Duct Terminal Unit



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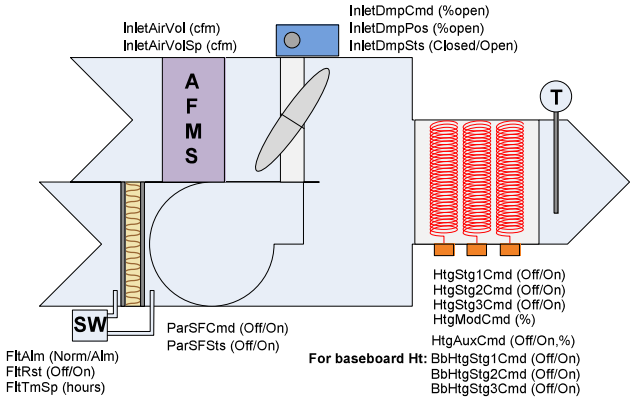
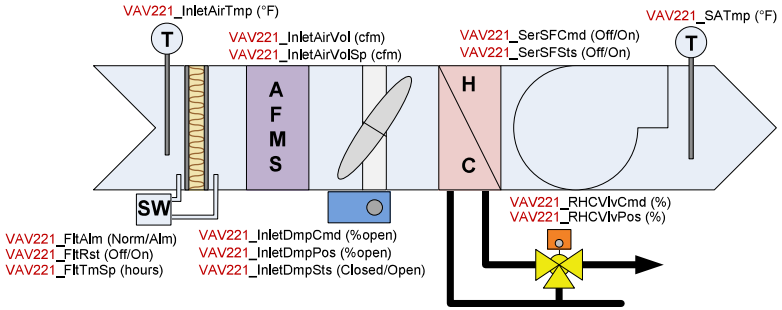
VAV CV VVT

VAV w/ Parallel Fan & Electric Reheat

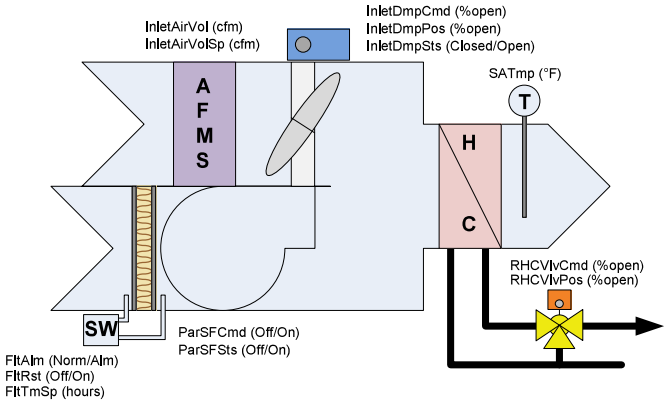


VAV w/ Series Fan & HW Reheat

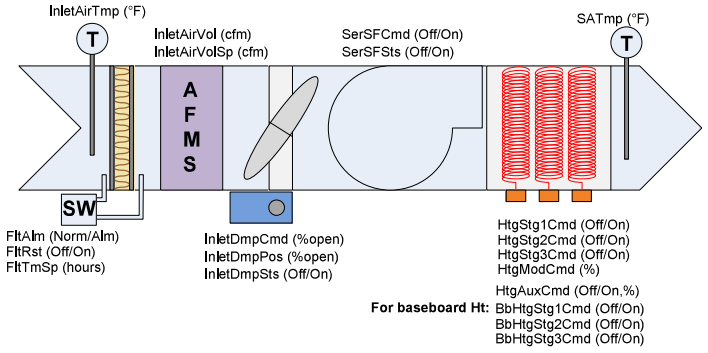
In this example, "VAV221_" is the equipment designator.



VAV w/ Parallel Fan & HW Reheat



VAV w/ Series Fan & Electric Reheat



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FTU

Fan Coil Unit Control Setpoints

OccCmd (Occ/Uoc)
UocOvrdCmd (Uoc/Ovrd)
OvrdTimeSp (hours)

OccRmTmpSp (°F)
UocRmTmpSp (°F)

EffRmTmp (°F)
EffRmTmpSp (°F)
OccClgSp (°F)
OccHtgSp (°F)
UocClgSp (°F)
UocHtgSp (°F)
StbyClgSp (°F)
StbyHtgSp (°F)

UsrSpAdjEna (Off/On)
UsrSpAdjRng (°F)
UsrSpAdjHL (°F)
UsrSpAdjLL (°F)
UsrSpAdj (°F)
EffUsrSp (°F)
OccSnsrSts (Off/On)

T
RmTmp (°F)
RmTmpSp (°F)

RH
RmRelHum (%)
RmRelHumSp (%)

RmEnth (btu-lb)
RmEnthSp (btu-lb)

RmDew (°F)
RmDewSp (°F)

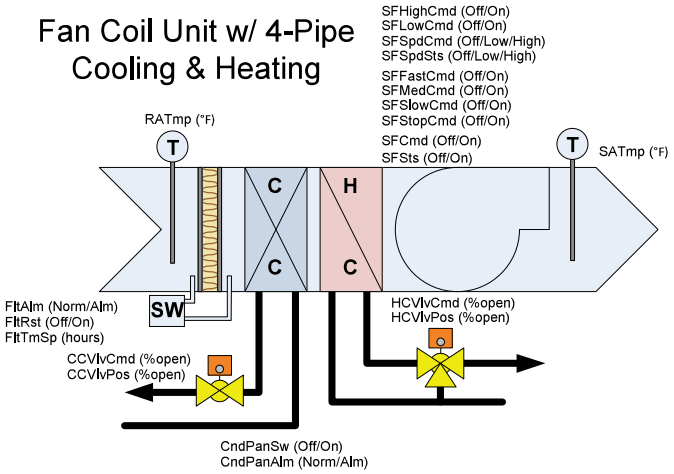
IAQ
RmCO2 (ppm)
RmCO2Sp (ppm)
RmCO2Alm (Norm/Alm)

RmIAQAlm (Norm/Alm)

RmVOC (ppm)
RmVOCSp (ppm)
RmVOCAlm (Norm/Alm)

AirCondModeCmd (Cool/Heat)
AirCondModeSts (Cool/Heat)
ClgModeSts (Off/On)
HtgModeSts (Off/On)
StbyModeSts (Off/On)

Fan Coil Unit w/ 4-Pipe Cooling & Heating



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FCU

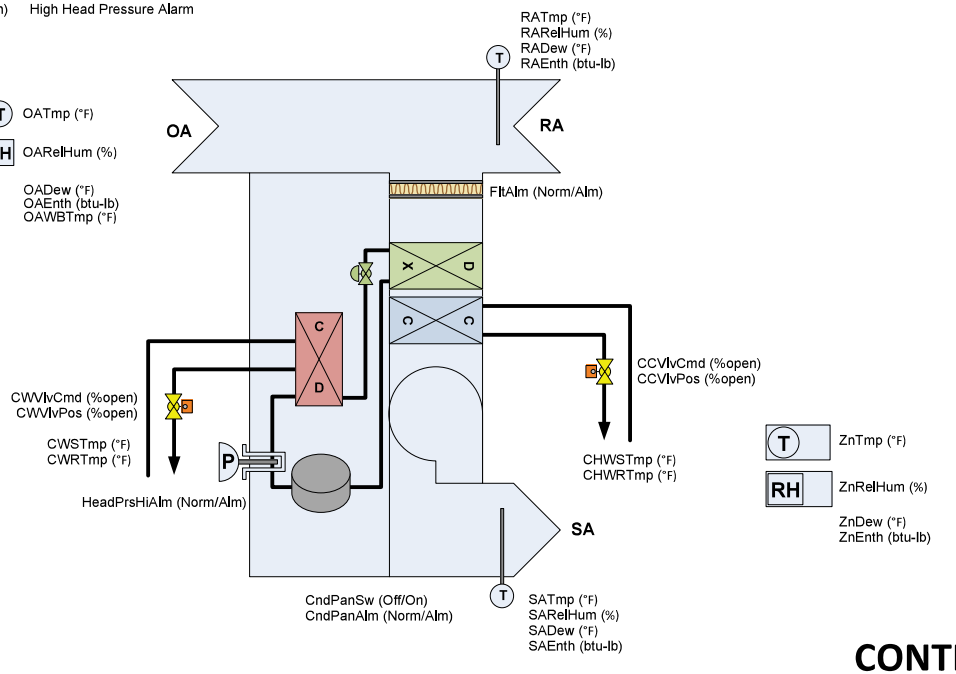
General Objects	Description
UnitStartCmd (Off/On)	Unit On/Off Command
SysSts (varies)	System Status
SysOpState (varies)	System Operating State
AutoMode (Manual/Auto)	System Operating State
Shtdn (Off/On)	Unit Shutdown
Stby (Off/On)	Unit Standby
SATmp (°F)	Supply Air Temperature
RATmp (°F)	Return Air Temperature
OATmp (°F)	Outside Air Temperature
ZnTmp (°F)	Zone Air Temperature
SARelHum (%)	Supply Air Relative Humidity
RARelHum (%)	Return Air Relative Humidity
OARelHum (%)	Outside Air Relative Humidity
ZnRelHum (%)	Zone Relative Humidity
SADew (°F)	Supply Air Dew Point Temperature
RADew (°F)	Return Air Dew Point Temperature
OADew (°F)	Outside Air Dew Point Temperature
ZnDew (°F)	Zone Air Dew Point Temperature
CHWSTmp (°F)	Chilled Water Supply Temperature
CHWRTmp (°F)	Chilled Water Return Temperature
CWSTmp (°F)	Condenser Water Supply Temperature
CWRTmp (°F)	Condenser Water Return Temperature
CHWFlwSw (Off/On)	Chilled Water Flow Switch
CWFlwSw (Off/On)	Condenser Water Flow Switch
CHWFlwRat (gpm)	Chilled Water Flow Rate
CWFlwRat (gpm)	Condenser Water Flow Rate
FanSts (Off/On)	Fan Status
CCVlvPos (%)	Chilled Water Valve Position
CWVlvPos (%)	Condenser Water Valve Position
CmpSts (Off/On)	Compressor Status
PmpSts (Off/On)	Pump Status
ClMode (Off/On)	Cooling Mode
HtMode (Off/On)	Heating Mode
DehumMode (Off/On)	Dehumidification Mode
HumMode (Off/On)	Humidification Mode
EconMode (Off/On)	Economizer Mode
ActCapPct (%)	Active Capacity Percentage
ZnEnth (btu-lb)	Zone Enthalpy
SAEnth (btu-lb)	Supply Air Enthalpy
RAEnth (btu-lb)	Return Air Enthalpy
OAEnth (btu-lb)	Outside Air Enthalpy

Set Points	Description
ZnTmpSp (°F)	Zone Temperature Set Point
ZnDewSp (°F)	Zone Dew Point Temperature Set Point
ZnRelHumSp (%)	Zone Relative Humidity Set Point
ZnEnthSp (btu-lb)	Zone Enthalpy Set Point

Faults	Description
GeneralFlt (Off/On)	General Fault
CHWVFlt (Off/On)	Chilled Water Control Valve Failure
PwrFlt (Off/On)	Ext Power Source Failure
TmpFlt (Off/On)	Temperature Control Sensor Issue
AirFlwFlt (Off/On)	Airflow Sensor Issue
SATmpFlt (Off/On)	Supply Air Sensor Issue
RATmpFlt (Off/On)	Return Air Sensor Issue
ZnTmpFlt (Off/On)	Ext Air Sensor Issue
OATmpFlt (Off/On)	Outside Air Sensor Issue
RARelHumFlt (Off/On)	Return Air Relative Humidity Sensor Issue
FanFlt (Off/On)	Fan Failure
CmpFlt (Off/On)	Compressor Failure
FireAlm (Norm/Alm)	External Fire Alarm Contacts
ExtDmpPosFlt (Off/On)	External Air Damper Position Issue
WtrLeakFlt (Off/On)	Water Leakage Detector Sensor Issue

Warnings	Description
MaintDue (Off/On)	Maintenance Due
ServiceReq (Off/On)	Service Required
SATmpHi (Off/On)	Supply Air Over Temperature
SATmpLo (Off/On)	Supply Air Under Temperature
RATmpHi (Off/On)	Return Air Over Temperature
RATmpLo (Off/On)	Return Air Under Temperature
ZnTmpHi (Off/On)	Ext Air Sensor Over Temperature
ZnTmpLo (Off/On)	Ext Air Sensor Under Temperature
RADewHi (Off/On)	Return Air Dew Point High
RADewLo (Off/On)	Return Air Dew Point High
RARelHumHi (Off/On)	Return Air Relative Humidity High
RARelHumLo (Off/On)	Return Air Relative Humidity Low
ZnDewHi (Off/On)	Zone Dew Point High
ZnDewLo (Off/On)	Zone Dew Point Low
ZnRelHumHi (Off/On)	Zone Relative Humidity High
ZnRelHumLo (Off/On)	Zone Relative Humidity Low
CHWSTmpHi (Off/On)	Supply Chilled Water Over Temp
ExtTmpHi (Off/On)	Ext Over Temperature
WtrUdrFlrFlt (Off/On)	Water Under Floor
SmokeAlm (Norm/Alm)	Smoke Alarm
FltAlm (Norm/Alm)	Filter Alarm
HeadPrsHiAlm (Norm/Alm)	High Head Pressure Alarm

CRAC Unit



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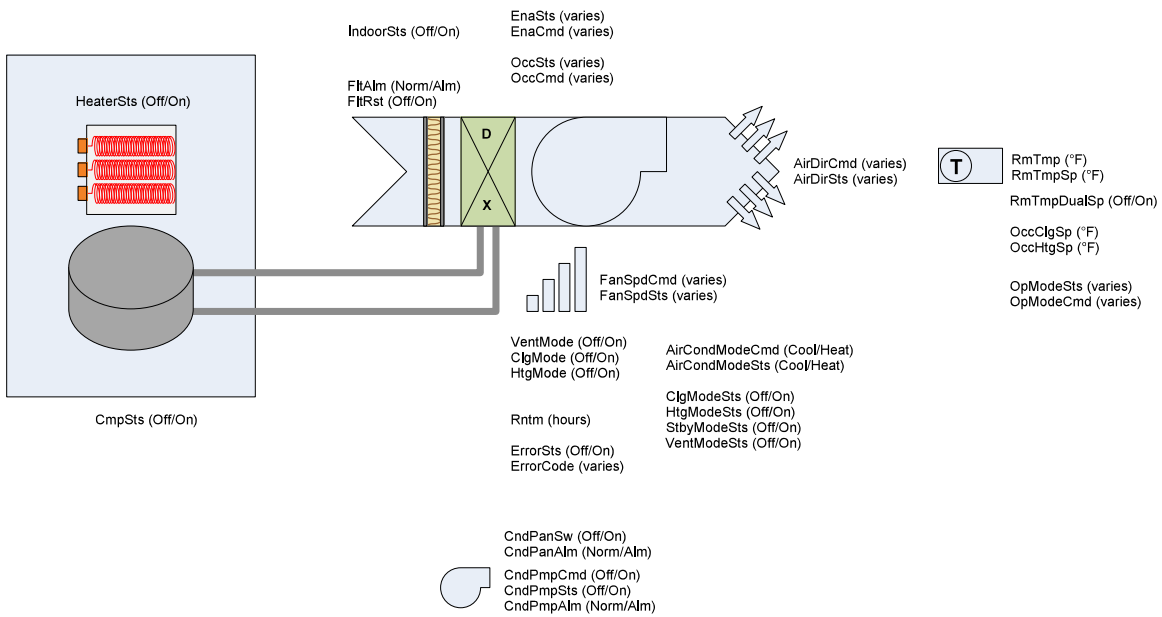
CRAC



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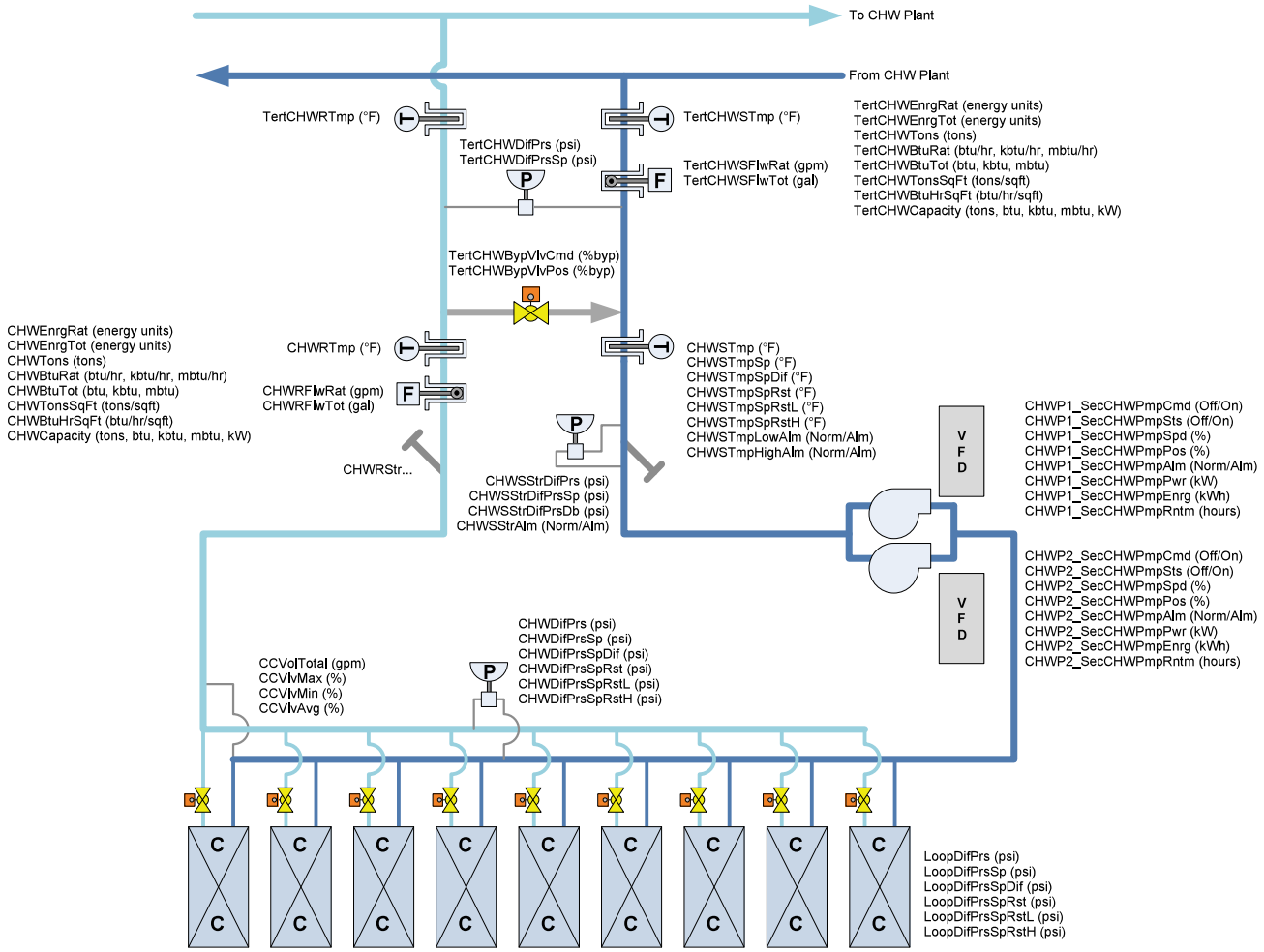
VRV

Tertiary CHW



See other CHW pages for additional CHW points.

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CHW TER

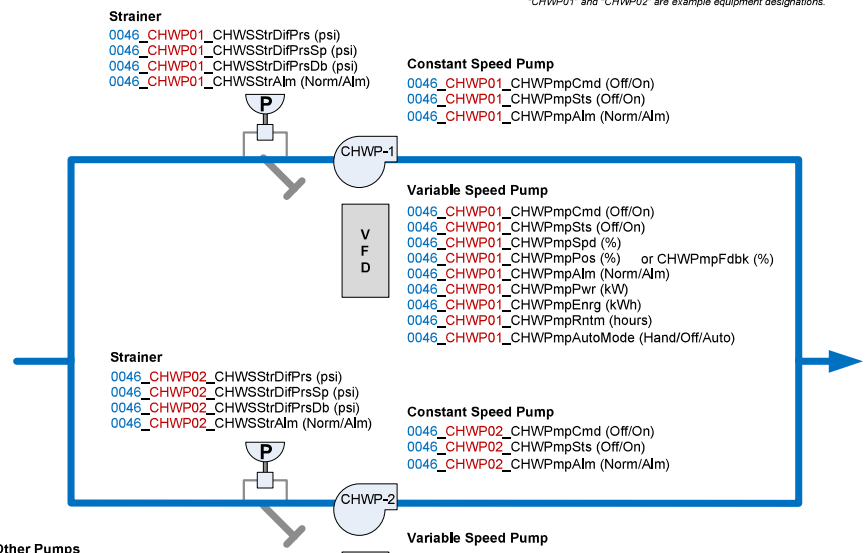
Pump Control Objects

CHWPmpSeq (seq)
CHWPmpRotCmd (Off/On)
CHWPmpRotSchedCmd (Off/On)
CHWPmpLeadEna (Off/On)
CHWPmpLagEna (Off/On)
CHWPmpEna (Off/On)
CHWPmpCmd (Off/On)
CHWPmpSts (Off/On)

CHWPmpRotSched

Pump Objects Example

"0046" is an example building number.
"CHWP01" and "CHWP02" are example equipment designations.



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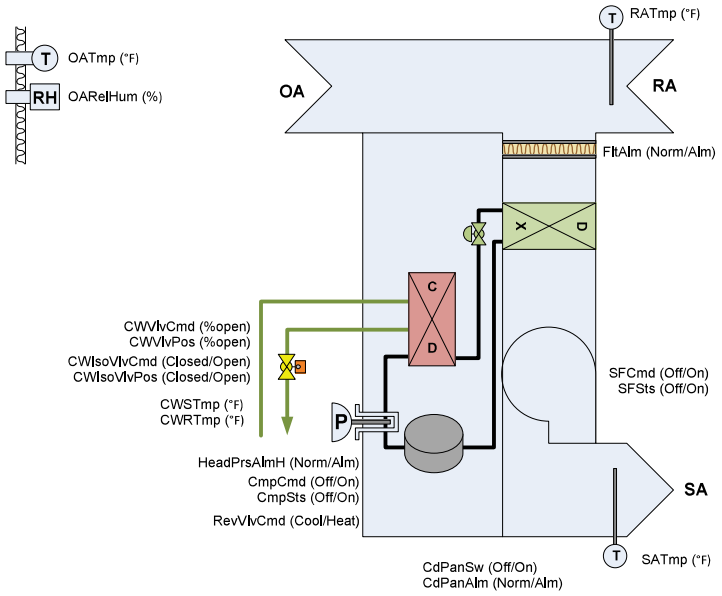
PMP

Water Source Heat Pump



Room Control Setpoints

OccCmd (Occ/Uoc)
UocOvrdCmd (Uoc/Ovrd)
OvrdTimeSp (hours)

OccRmTmpSp (°F)
UocRmTmpSp (°F)

EffRmTmp (°F)
EffRmTmpSp (°F)
OccClgSp (°F)
OccHtgSp (°F)
UocClgSp (°F)
UocHtgSp (°F)
StbyClgSp (°F)
StbyHtgSp (°F)

UsrSpAdjEna (Off/On)
UsrSpAdjRng (°F)
UsrSpAdjHL (°F)
UsrSpAdjLL (°F)
UsrSpAdj (°F)
EffUsrSp (°F)
OccSnsrSts (Off/On)

AirCondModeCmd (Cool/Heat)
AirCondModeSts (Cool/Heat)
ClgModeSts (Off/On)
HtgModeSts (Off/On)
StbyModeSts (Off/On)
VentMode (Off/On)

T
RmTmp (°F)
RmTmpSp (°F)

RH
RmRelHum (%)
RmRelHumSp (%)

IAQ
RmCO2 (ppm)
RmCO2Sp (ppm)
RmCO2Alm (Norm/Alm)
RmIAQAlm (Norm/Alm)
RmVOC (ppm)
RmVOCSp (ppm)
RmVOCAlm (Norm/Alm)

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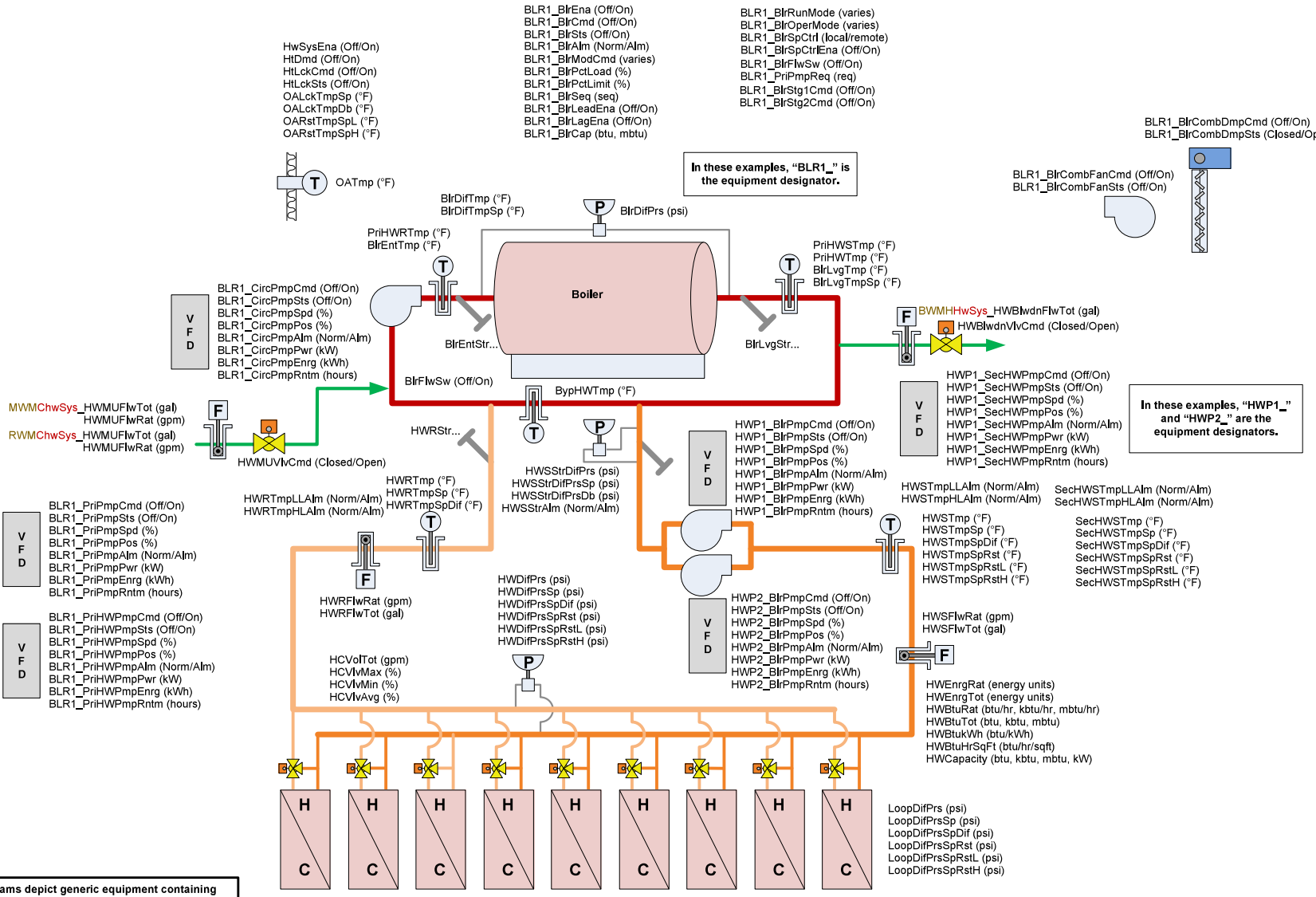
WSHP



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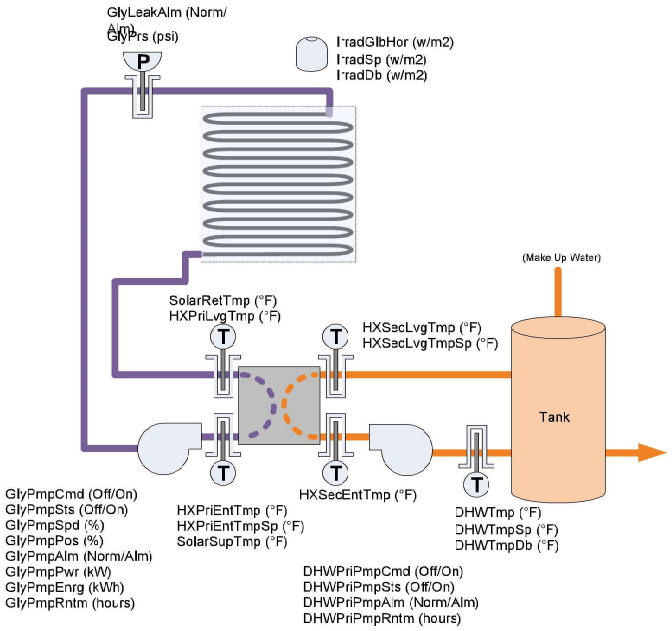
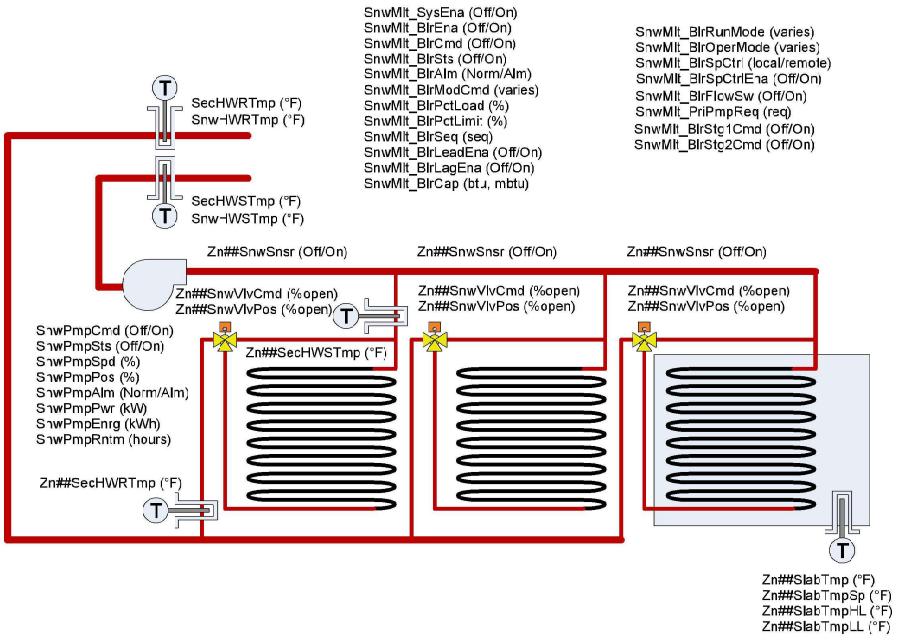
HWS

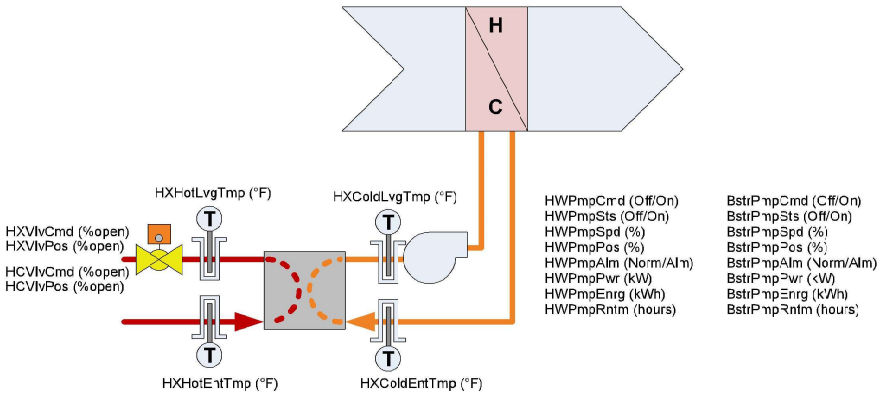
Solar Thermal Hot Water



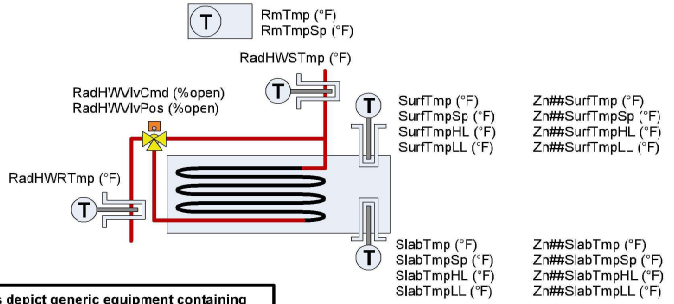
Snow Melt System



HW HX & Booster Pump



Radiant Floor Heat



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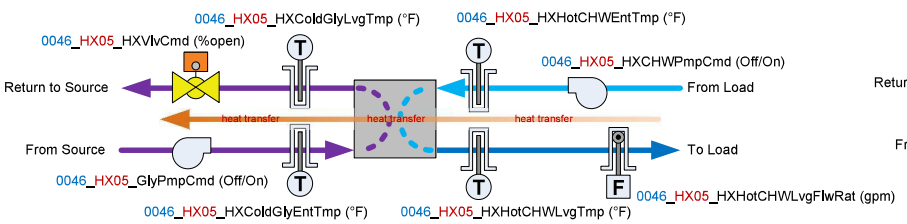
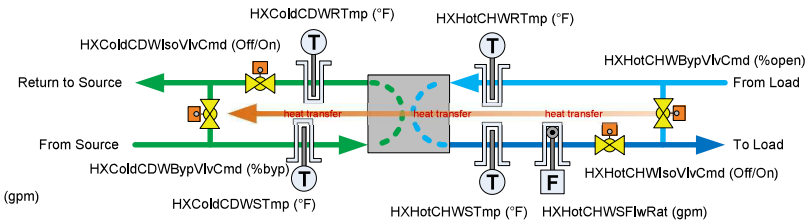
HWS2

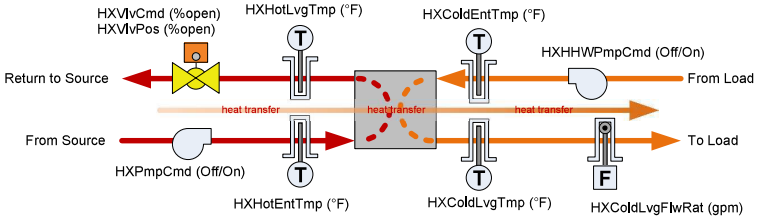
Glycol Cooling Application



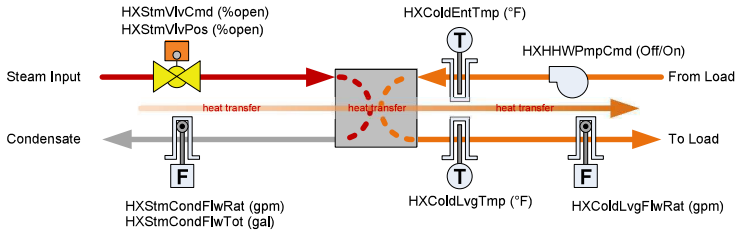
Free-Cooling Condenser Water Application



Hot Water Heating Application



Steam/Hot Water Heating Application



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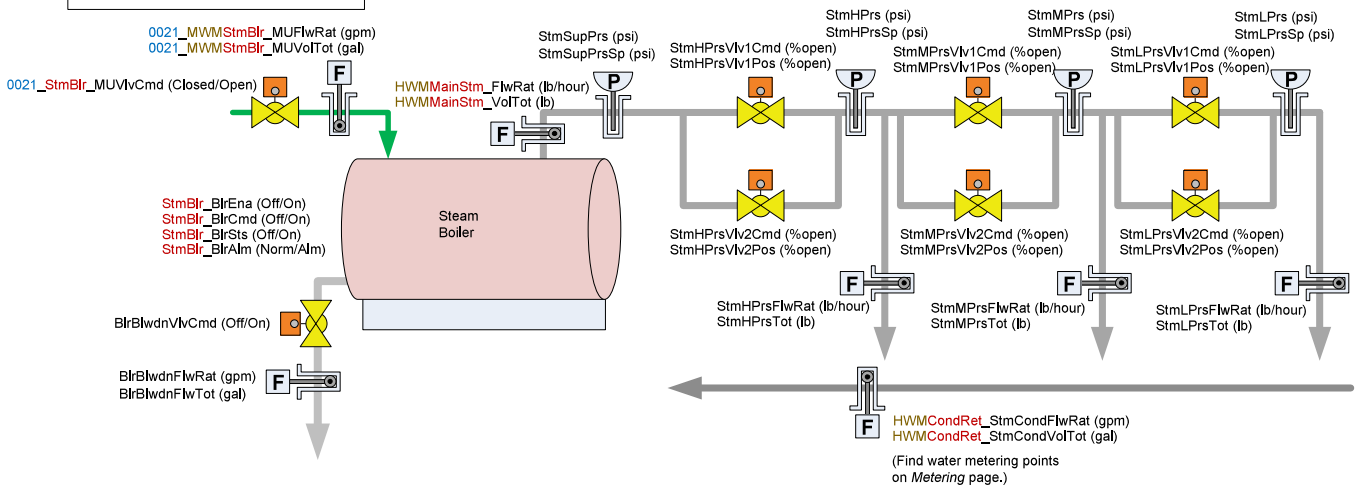
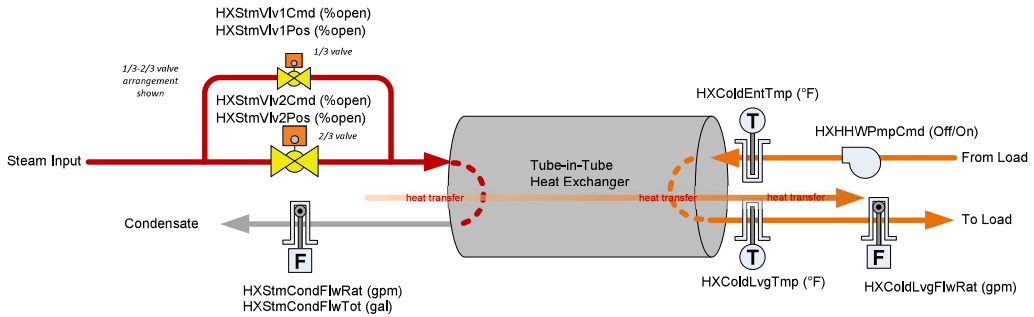
HX

In this example, "0021_" is the building number. The meter is a make-up water meter for the steam boiler.

Steam Reduction Station





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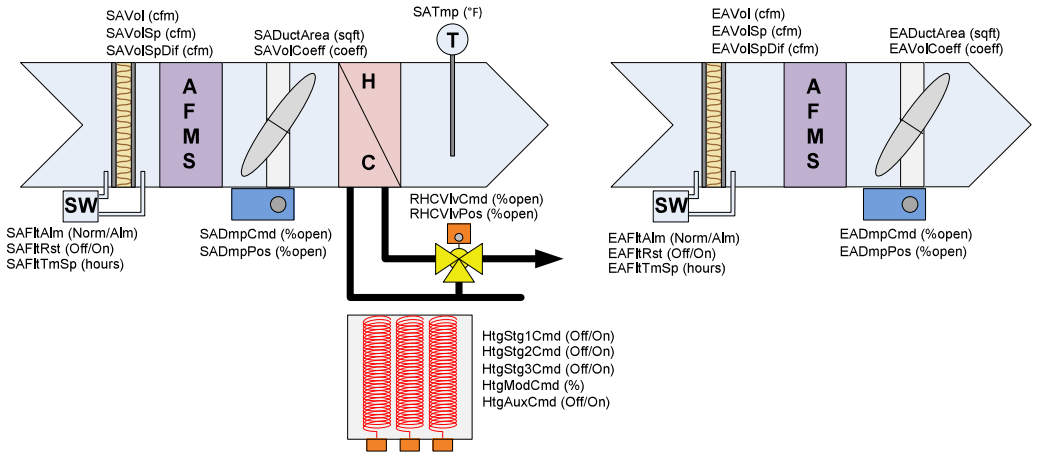
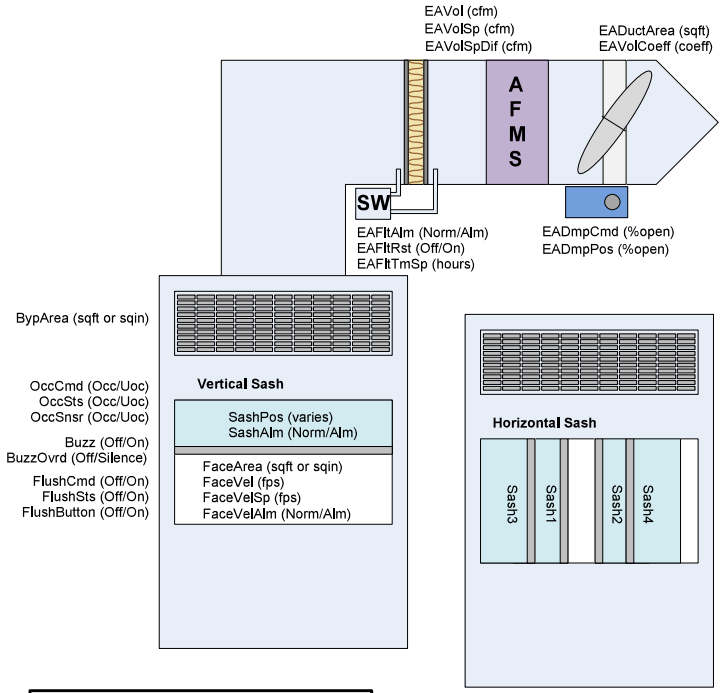
SHEET TITLE & NUMBER:

STM

Lab Room Terminal Unit Points



Fume Hood Points



Lab Room Control System Points

OccSnsr (Occ/Uoc)
OccCmd (Occ/Uoc)
OccSts (Occ/Uoc)
OccOvrd (Uoc/Ovrd)
FlushCmd (Off/On)
FlushSts (Off/On)
FlushBtn (Off/On)
DifVolAlm (Norm/Alm)
SAVolAlm (Norm/Alm)
EAVolAlm (Norm/Alm)
Buzz (Off/On)
BuzzOvrd (Off/Silence)
DoorSw (Closed/Open)
DoorAlm (Norm/Alm)

IsoModeCmd (neut/pro/inf)
IsoModeSts (neut/pro/inf)
PrsModeCmd (neut/pos/neg)
PrsModeSts (neut/pos/neg)
PrsAlm (Norm/Alm)
PrsWarn (Off/On)

RmTmp (°F)
EffRmTmpSp (°F)
OccRmTmpSp (°F)
UocRmTmpSp (°F)
OccClgSp (°F)
OccHtgSp (°F)
UocClgSp (°F)
UocHtgSp (°F)

SAVolTot (cfm)
SAVolTotSp (cfm)
EAVolTot (cfm)
EAVolTotSp (cfm)
EAVolTot (cfm)
DifVolTot (cfm)
DifVolTotSp (cfm)
SAVolSpMax (cfm)
SAVolSpMin (cfm)
EAVolSpMax (cfm)
EAVolSpMin (cfm)
TmpCtrlVol (cfm)
TrkModeCmd (none/ETS/STE)
TrkModeSts (none/ETS/STE)
AirChgRat (cph)
AirChgRatSp (cph)
RmVol (cf)

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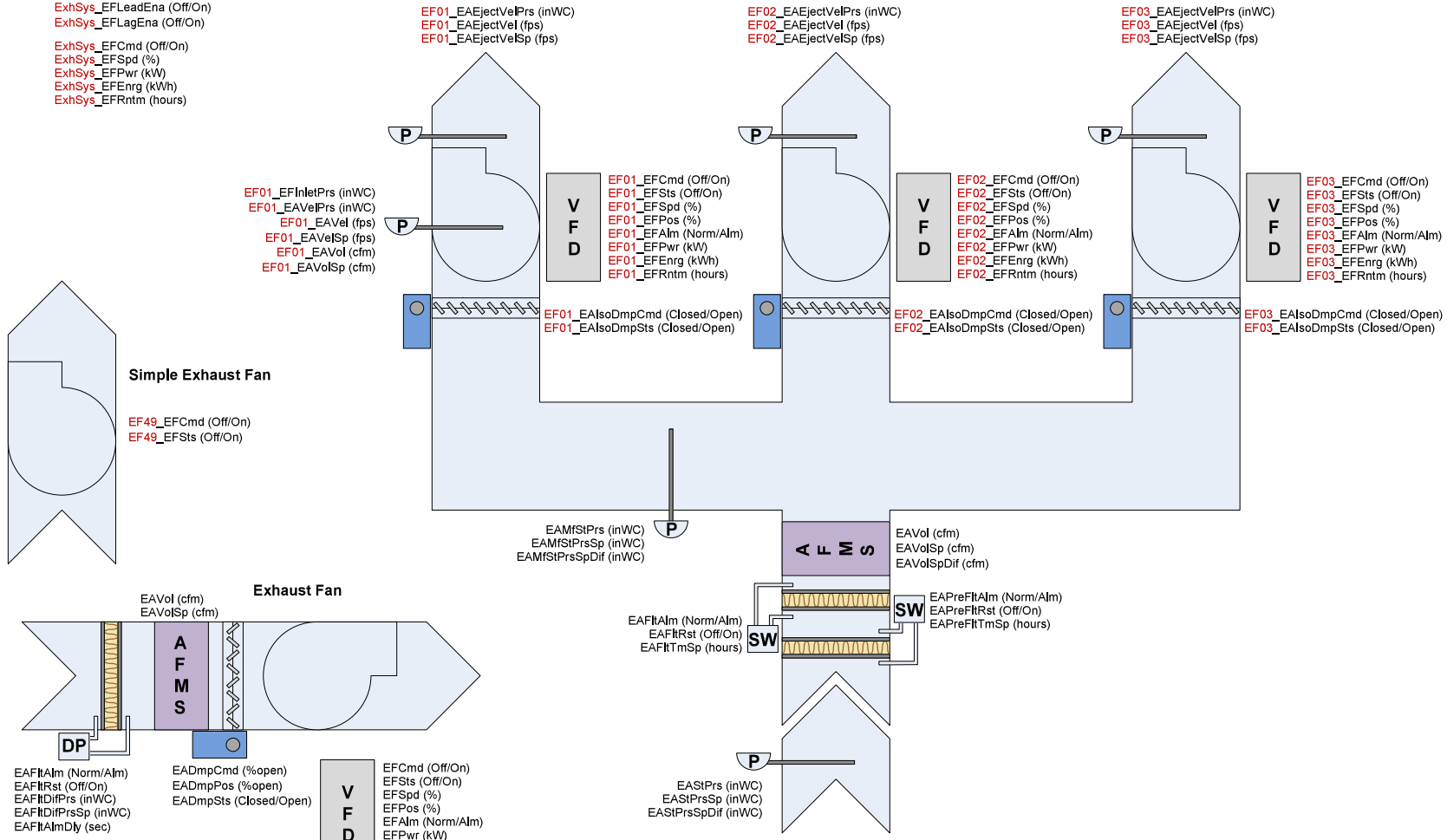
LAB

Exhaust System Control Points

ExhSys_ExhEna (Off/On)
ExhSys_EFRotCmd (Off/On)
ExhSys_EFSeq (Seq)
ExhSys_EFLeadEna (Off/On)
ExhSys_EFLagEna (Off/On)

ExhSys_EFCmd (Off/On)
ExhSys_EFSpd (%)
ExhSys_EFPwr (kW)
ExhSys_EFEnrg (kWh)
ExhSys_EFRntm (hours)

Exhaust Manifold System



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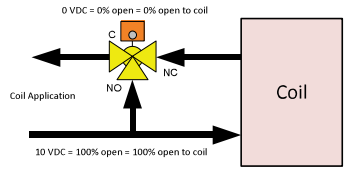
SHEET TITLE & NUMBER:

EXH

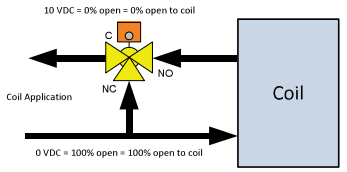
Normally Closed HW Valve

HCVlvCmd (%open)
HCVlvPos (%open)



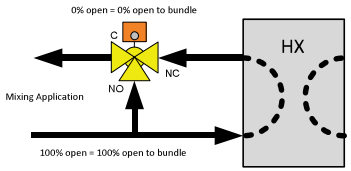
Normally Open CHW Valve

CCVlvCmd (%open)
CCVlvPos (%open)



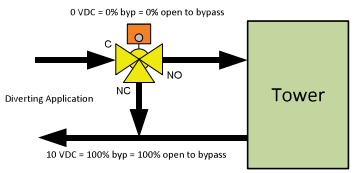
Normally Closed Mixing Valve

CHWVlvCmd (%open)
CHWVlvPos (%open)



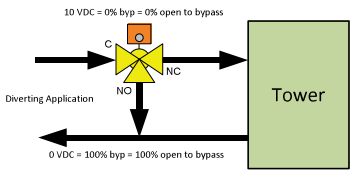
Normally Open Diverting Valve

CTDivVlvCmd (%byp)
CTDivVlvPos (%byp)



Normally Bypassing Diverting Valve

CTDivVlvCmd (%byp)
CTDivVlvPos (%byp)



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VLV

VFD

Common VFD Objects

"0046" is an example building number.
"CDWP01" is an example equipment designation.

0046_CDWP01_CDWPmpCmd (Off/On)
0046_CDWP01_CDWPmpSts (Off/On)
0046_CDWP01_CDWPmpSpd (%)
0046_CDWP01_CDWPmpPos (%) or CDWPmpFdbk (%)
0046_CDWP01_CDWPmpAlm (Norm/Alm)
0046_CDWP01_CDWPmpPwr (kW)
0046_CDWP01_CDWPmpEnrg (kWh)
0046_CDWP01_CDWPmpRntm (hours)
0046_CDWP01_CDWPmpFreq (Hz)
0046_CDWP01_CDWPmpAutoMode (Hand/Auto)
0046_CDWP01_CDWPmpCur (Amps)
0046_CDWP01_CDWPmpVltAC (VAC)
0046_CDWP01_CDWPmpVltDC (VDC)

Regenerative VFD Objects

0046_CDWP01_CDWPmpBrakeSts (Off/On)
0046_CDWP01_CDWPmpRegenSts (Off/On)
0046_CDWP01_CDWPmpRegenPos (%) or CDWPmpRegenFdbk (%)
0046_CDWP01_CDWPmpRegenFlt (Norm/Fault)
0046_CDWP01_CDWPmpRegenPwr (kW)
0046_CDWP01_CDWPmpRegenEnrg (kWh)
0046_CDWP01_CDWPmpRegenRntm (hours)
0046_CDWP01_CDWPmpRegenFreq (Hz)
0046_CDWP01_CDWPmpRegenCur (Amps)
0046_CDWP01_CDWPmpRegenVltAC (VAC)
0046_CDWP01_CDWPmpRegenVltDC (VDC)

VFD Viewed as an Electrical Submeter

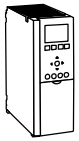
"0046" is an example building number.
"WHM" indicates that the objects are being used for metering.
"CDWP01" is an example equipment designation.

0046_WHMCDWP01_Pwr (kW)
0046_WHMCDWP01_Enrg (kWh)
0046_WHMCDWP01_Cur (Amps)
0046_WHMCDWP01_VltAC (VAC)
0046_WHMCDWP01_VltDC (VDC)

0046_WHMCDWP01_VltAB (VAC)
0046_WHMCDWP01_VltBC (VAC)
0046_WHMCDWP01_VltCA (VAC)
0046_WHMCDWP01_VltLLAvg (VAC)
0046_WHMCDWP01_VltLLMin (VAC)
0046_WHMCDWP01_VltLLMax (VAC)
0046_WHMCDWP01_VltLLMean (VAC)

0046_WHMCDWP01_VltAN (VAC)
0046_WHMCDWP01_VltBN (VAC)
0046_WHMCDWP01_VltCN (VAC)
0046_WHMCDWP01_VltLNAvg (VAC)
0046_WHMCDWP01_VltLNMin (VAC)
0046_WHMCDWP01_VltLNMax (VAC)
0046_WHMCDWP01_VltLNMean (VAC)

0046_WHMCDWP01_CurA (Amps)
0046_WHMCDWP01_CurB (Amps)
0046_WHMCDWP01_CurC (Amps)



Danfoss VLT VFD BACnet Object Map

"VFD" is used in place of the object name prefix.

Basic Commands

BV01 = VFDCmd (Off/On)
AV01 = VFDRef1Spd (%) or VFDSpd (%)
AV02 = VFDRef2Spd (%)
BV25 = VFDDirCmd (CW/CCW)

Basic Feedback

BV33 = VFDSts (Stop/Run)
AV03 = VFDPos (%)
AV25 = VFDFreq (Hz)
AV26 = VFDTorq (%)
AV27 = VFDVltDC (VDC)
AV24 = VFDOutputVlt (VDC)
AV05 = VFDCur (Amps)
AV06 = VFDPwr (kW)
AV23 = VFDEnrg (kWh)
BV28 = VFDEnrgRst (Off/On)
AV22 = VFDRnTm (hours)
BV29 = VFDRnTmRst (Off/On)
AV28 = VFDDriveTmp (°C)
BV30 = VFDDirSts (Fwd/Rev)
BV06 = VFDAutoMode (Auto/Hand)

Fault Feedback

BV05 = VFDFltSts (OK/Fault)
BV03 = VFDFltRst (Off/On)
AV51 = VFDFltLast (fault code)
BV21 = VFDWarnSts (OK/Fault)
BV22 = VFDTripSts (OK/Fault)

Other Parameters

BV02 = VFDRefSelCmd (REF1/REF2)
AV01 = VFDRef1Pos (%)
AV02 = VFDRef2Pos (%)
BV27 = VFDRst (Off/On)
BV31 = VFDAtSp (No/Yes)

Drive I/O

BO00= VFDDO27Cmd (Off/On)
BO01 = VFDDO29Cmd (Off/On)
BO02 = VFDGPIOX306Cmd (Off/On)
BO03 = VFDGPIOX307Cmd (Off/On)
BO04 = VFDRO1Cmd (Off/On)
BO05 = VFDRO2Cmd (Off/On)

AI00 = VFDAI53 (%)
AI01 = VFDAI54 (%)

Diagrams depict generic equipment containing control points and objects, some of which may or may not be present or required for a particular piece of equipment or in a particular application.

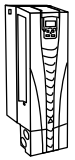


ABB ACH550 BACnet Object Map

"VFD" is used in place of the object name prefix.

Basic Commands

BV12 = VFDEna (Off/On)
BV10 = VFDCmd (Off/On)
AV16 = VFDRef1Spd (%) or VFDSpd (%)
AV17 = VFDRef2Spd (%)
BV11 = VFDDirCmd (Fwd/Rev)

Basic Feedback

BV00 = VFDSts (Stop/Run)
AV00 = VFDPos (%)
AV01 = VFDFreq (Hz)
AV05 = VFDTorq (lb-ft)
AV02 = VFDVltDC (VDC)
AV03 = VFDOutputVlt (VDC)
AV04 = VFDCur (Amps)
AV06 = VFDPwr (kW)
AV08 = VFDEnrg (kWh)
AV09 = VFDEnrgTot (MWh)
AV14 = VFDRnTm (hours)
AV15 = VFDMotorTmp (°C)
AV07 = VFDDriveTmp (°C)
BV01 = VFDDirSts (Fwd/Rev)
BV04 = VFDAutoMode (Auto/Hand)

Fault Feedback

BV02 = VFDFltSts (OK/Fault)
BV14 = VFDFltRst (Off/On)
AV18 = VFDFltLast (fault code)
AV19 = VFDFltPrev1 (fault code)
AV20 = VFDFltPrev2 (fault code)

Other Parameters

BV13 = VFDRefSelCmd (EXT1/EXT2)
BV03 = VFDRefSelSts (EXT1/EXT2)
BV05 = VFDAlmSts (OK/Alm)
BV06 = VFDMaintSts (OK/Maint)
BV07 = VFDReady (Not Ready/Ready)
BV08 = VFDAtSp (No/Yes)
BV09 = VFDEna (Off/On)
BV17 = VFDKeypadLck (Unlock/Lock)
BV18 = VFDBACnetCtrlCmd (Off/On)
BV19 = VFDBACnetCtrlSts (Off/On)
AV23 = VFDRampUpTm (sec)
AV24 = VFDRampDnTm (sec)
AV25 = VFD??? (???) *custom-programmable*
AV26 = VFD??? (???) *custom-programmable*
BV15 = VFD??? (???) *custom-programmable*
BV16 = VFD??? (???) *custom-programmable*

Drive I/O

BO00= VFDRO1Cmd (Off/On)
BO01 = VFDRO2Cmd (Off/On)
BO02 = VFDRO3Cmd (Off/On)
BO03 = VFDRO4Cmd (Off/On)
BO04 = VFDRO5Cmd (Off/On)
BO05 = VFDRO6Cmd (Off/On)
BI00 = VFDRO1Sts (Off/On)
BI01 = VFDRO2Sts (Off/On)
BI02 = VFDRO3Sts (Off/On)
BI03 = VFDRO4Sts (Off/On)
BI04 = VFDRO5Sts (Off/On)
BI05 = VFDRO6Sts (Off/On)

BI06 = VFDDI1Sts (Off/On)
BI07 = VFDDI2Sts (Off/On)
BI08 = VFDDI3Sts (Off/On)
BI09 = VFDDI4Sts (Off/On)
BI10 = VFDDI5Sts (Off/On)
BI11 = VFDDI6Sts (Off/On)

AO21 = VFDAO1Pos (mA)
AO22 = VFDAO2Pos (mA)

AI00 = VFDAI1 (varies)
AI01 = VFDAI2 (varies)

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DRAWN BY: Mike Grush
JOB NUMBER: 200762-001
REV. DATE: **04/17**

SHEET TITLE & NUMBER:
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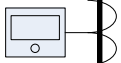
VFD

Lighting Panel EPLA

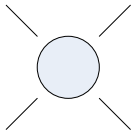
1	Rm0101_LgtCmd (Off/On)	EPLA01_LgtBrkSts (Off/On/Trip)			EPLA02_LgtBrkSts (Off/On/Trip)	Zn12_LgtCmd (Off/On)	2
3	Rm0102_LgtCmd (Off/On)	EPLA03_LgtBrkSts (Off/On/Trip)			EPLA04_LgtBrkSts (Off/On/Trip)	WHall_LgtCmd (Off/On)	4
5	Rm0103_LgtCmd (Off/On)	EPLA05_LgtBrkSts (Off/On/Trip)			EPLA06_LgtBrkSts (Off/On/Trip)	Cnf_LgtCmd (Off/On)	6
7	Rm0254_LgtCmd (Off/On)	EPLA07_LgtBrkSts (Off/On/Trip)			EPLA08_LgtBrkSts (Off/On/Trip)	Off400_LgtCmd (Off/On)	8
9	Rm0258_LgtCmd (Off/On)	EPLA09_LgtBrkSts (Off/On/Trip)			EPLA10_LgtBrkSts (Off/On/Trip)	Cpy_LgtCmd (Off/On)	10
11	Rm0844_LgtCmd (Off/On)	EPLA11_LgtBrkSts (Off/On/Trip)			EPLA12_LgtBrkSts (Off/On/Trip)	GymN_LgtCmd (Off/On)	12
13	Rm0845_LgtCmd (Off/On)	EPLA13_LgtBrkSts (Off/On/Trip)			EPLA14_LgtBrkSts (Off/On/Trip)	GymS_LgtCmd (Off/On)	14
15	Rm1012_LgtCmd (Off/On)	EPLA15_LgtBrkSts (Off/On/Trip)			EPLA16_LgtBrkSts (Off/On/Trip)	BbFld_LgtCmd (Off/On)	16
17	LbyCan_LgtCmd (Off/On)	EPLA17_LgtBrkSts (Off/On/Trip)			EPLA18_LgtBrkSts (Off/On/Trip)	LkrRm_LgtCmd (Off/On)	18
19	LbyAcc_LgtCmd (Off/On)	EPLA19_LgtBrkSts (Off/On/Trip)			EPLA20_LgtBrkSts (Off/On/Trip)	WdwCan_LgtCmd (Off/On)	20
21	LbyDpy_LgtCmd (Off/On)	EPLA21_LgtBrkSts (Off/On/Trip)			EPLA22_LgtBrkSts (Off/On/Trip)	WdwSpt_LgtCmd (Off/On)	22
23	Sgn_LgtCmd (Off/On)	EPLA23_LgtBrkSts (Off/On/Trip)			EPLA24_LgtBrkSts (Off/On/Trip)	Stage_LgtCmd (Off/On)	24
25	PkgN_LgtCmd (Off/On)	EPLA25_LgtBrkSts (Off/On/Trip)			EPLA26_LgtBrkSts (Off/On/Trip)	Seat_LgtCmd (Off/On)	26
27	PkgW_LgtCmd (Off/On)	EPLA27_LgtBrkSts (Off/On/Trip)			EPLA28_LgtBrkSts (Off/On/Trip)	Clr101_LgtCmd (Off/On)	28
29	ExtFnt_LgtCmd (Off/On)	EPLA29_LgtBrkSts (Off/On/Trip)			EPLA30_LgtBrkSts (Off/On/Trip)	Roof_LgtCmd (Off/On)	30
31	ExtBck_LgtCmd (Off/On)	EPLA31_LgtBrkSts (Off/On/Trip)			EPLA32_LgtBrkSts (Off/On/Trip)	LdgFld_LgtCmd (Off/On)	32

EPLA_LgtPnlSts (varies)
EPLA_LgtPnlFlt (Off/On)
EPLA_LgtPnlAlm (Norm/Alm)

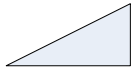


WHMEPLA_LgtEnrgTot (kWh)
WHMEPLA_LgtPwr (kW)

Rm301_LgtOccSnsrEna (Off/On)
Rm301_LgtOccSnsr (Off/On)
Rm301_DayLgtLvl (W/sqft, fc, lumens)
Rm301_LgtOvrd (Off/Ovrd)
Rm301_LgtOvrdTm (min)
Rm301_LgtIntLvl (W/sqft, fc, lumens)
Rm301_LgtWrkLvl (W/sqft, fc, lumens)
Rm301_LgtLck (Off/On)
Rm301_LgtShdCmd (Off/On, %)
Rm301_LgtShdSts (Off/On)
Rm301_LgtShdPos (%)



Rm301_LgtEna (Off/On)
Rm301_LgtSts (Off/On)
Rm301_LgtCmd (Off/On)
Rm301_LgtRlySts (Off/On)
Rm301_LgtRlyCmd (Off/On)
Rm301_LgtGrpSts (Off/On)
Rm301_LgtGrpCmd (Off/On)



Rm301_LgtOutCmd (%)
Rm301_LgtOutPos (%)

Diagrams depict generic equipment containing control points and objects, some of which may or may not be present or required for a particular piece of equipment or in a particular application.

Lighting Abbreviations

Acc = Accent lights
BbFld = Baseball Field
Brk = Breaker
Can = Can lights
Clr = Classroom
Cmd = Command
Cnf = Conference Room
Cpy = Copy Room
Dpy = Display
E = East
Ena = Enable
Ext = Exterior
FbFld = Football Field
Fld = Field/Flood lights
Grp = Group
Gym = Gymnasium
Int = Interior
Lby = Lobby
Lck = Lockout
Ldg = Loading
Lgt = Light/Lighting
Lkr = Locker Room
Lvl = Level
N = North
Occ = Occupancy
Off = Office
Out = Output
Ovrd = Override
Pos = Position
Pkg = Parking
Rly = Relay
Rm = Room
S = South
Sgn = Signage
Shd = Shade
Snsr = Sensor
Spt = Spot lights
Seat = Seating
Sts = Status
W = West
Wdw = Window
Wrk = Work
Zn = Zone

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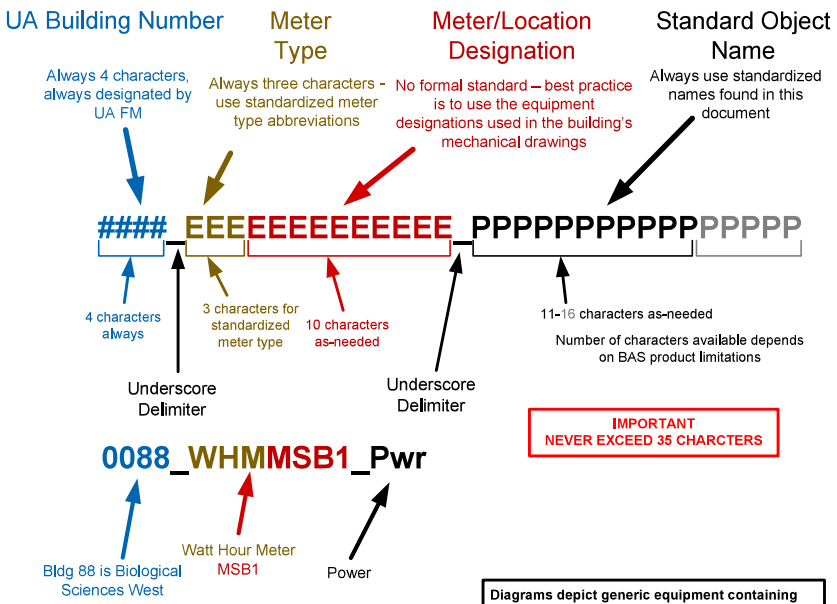
LGT

Meter Object Name Anatomy

Building_TYPEMeter_Object



IMPORTANT
NEVER EXCEED 35 CHARCTERS

Diagrams depict generic equipment containing control points and objects, some of which may or may not be present or required for a particular piece of equipment or in a particular application.

Standard Meter Type Abbreviations

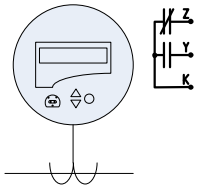
CWM = Chilled Water Meter
DWM = Domestic Water Meter
HWM = Hot Water Meter
WHM = Watt Hour Meter

BWM = Blowdown Water Meter
CDM = Condenser Water Meter
DFM = Diesel Fuel Meter
DHM = Domestic Hot Water Meter
FOM = Fuel Oil Meter
IWM = Irrigation Water Meter
MWM = Make-up Water Meter
NGM = Natural Gas Meter
RWM = Reclaimed Water Meter
PGM = Propane Gas Meter
PVM = Photovoltaic Electricity Meter
SEM = Solar (Heat) Thermal Energy Meter
SCM = Steam Condensate Meter
STM = Steam Meter
TEM = Thermal Energy Meter
TWM = Tempered Water Meter
WEM = Wind Electricity Meter
WWM = Waste Water Meter

Example Meter Designations

Main = Main meter for facility
Sub = Submeter
BTU = Thermal Energy Meter
Rec = Received
Del = Delivered
Rcv = Recovered
HiPr = High-Pressure
MdPr = Medium-Pressure
LwPr = Low-Pressure
MSB = Main Switch Board
MSAAB1 = Electric Circuit
HPLLL1A = Electric Circuit
ELHPLLB = Electric Circuit

Electric Meters



See ELEC page for additional electrical metering points.

WHMMSB_VltAC (VAC)
WHMMSB_Cur (Amps)
WHMMSB_Pwr (kW)
WHMMSB_Enrg (kWh)

WHMMSB_VltAB (VAC)
WHMMSB_VltBC (VAC)
WHMMSB_VltCA (VAC)
WHMMSB_VltLLAvg (VAC)
WHMMSB_VltLLMin (VAC)
WHMMSB_VltLLMax (VAC)
WHMMSB_VltLLMean (VAC)

WHMMSB_VltAN (VAC)
WHMMSB_VltBN (VAC)
WHMMSB_VltCN (VAC)
WHMMSB_VltLNAvg (VAC)
WHMMSB_VltLNMin (VAC)
WHMMSB_VltLNMax (VAC)
WHMMSB_VltLNMean (VAC)

WHMMSB_CurA (Amps)
WHMMSB_CurB (Amps)
WHMMSB_CurC (Amps)
WHMMSB_CurAvg (Amps)
WHMMSB_CurMin (Amps)
WHMMSB_CurMax (Amps)
WHMMSB_CurMean (Amps)

WHMMSB_Freq (Hz)

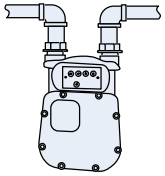
WHMMSB_EnrgRec (kWh) (imported from grid)
WHMMSB_EnrgDel (kWh) (exported to grid)

WHMMSB_PlsTot (pulses)
WHMMSB_PlsTotRst (Off/On)
WHMMSB_PlsGain (coeff)

Water Meters

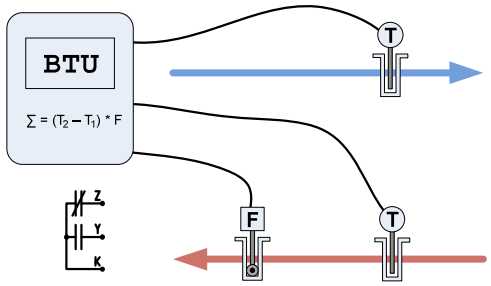
DWMain_PlsTot (pulses)
DWMain_PlsTotRst (Off/On)
DWMain_PlsGain (coeff)
DWMain_VolTot (gal)
DWMain_FlwRat (gpm)
DWMain_FlwRatMax (gpm)
DWMain_VolTotNet (gal)

Gas Meters



NGMain_PlsTot (pulses)
NGMain_PlsTotRst (Off/On)
NGMain_PlsGain (coeff)
NGMain_VolTot (cf, ccf)
NGMain_FlwRat (cfm)
NGMain_FlwRatMax (cfm)
NGMain_VolTotNet (cf, ccf)
NGMain_EnrgTot (btu, kbtu, mbtu, therms, kW, MW)
NGMain_EnrgContent (btu/cf)

Thermal Energy (BTU) Meters



THCHW_FlwRat (gpm)
THCHW_FlwRatMax (gpm)
THCHW_CHWSTmp (°F)
THCHW_CHWRTmp (°F)
THCHW_DifTmp (°F)
THCHW_DifTmpMax (°F)
THCHW_EnrgFlwRat (btu/hr, kbtu/hr)
THCHW_EnrgTot (btu, kbtu, mbtu, kW)
THCHW_EnrgRatMax (btu/hr, kbtu/hr)
THCHW_EnrgTotRst (Off/On)

THCHW_PlsTot (pulses)
THCHW_PlsTotRst (Off/On)
THCHW_PlsGain (coeff)

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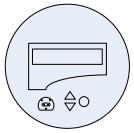
MTR

Common Electric Smart Meter Points



Basic Meter

WHM[circuit]_VltAC (VAC)
WHM[circuit]_Cur (Amps)
WHM[circuit]_Pwr (kW)
WHM[circuit]_Enrg (kWh)

DC Systems

WHM[circuit]_VltDC (VDC)
WHM[circuit]_Cur (Amps)
WHM[circuit]_Pwr (kW)
WHM[circuit]_Enrg (kWh)

WHM[circuit]_VltAB (VAC)
WHM[circuit]_VltBC (VAC)
WHM[circuit]_VltCA (VAC)
WHM[circuit]_VltLLAvg (VAC)
WHM[circuit]_VltLLMin (VAC)
WHM[circuit]_VltLLMax (VAC)
WHM[circuit]_VltLLMean (VAC)

WHM[circuit]_VltAN (VAC)
WHM[circuit]_VltBN (VAC)
WHM[circuit]_VltCN (VAC)
WHM[circuit]_VltLNAvg (VAC)
WHM[circuit]_VltLNMin (VAC)
WHM[circuit]_VltLNMax (VAC)
WHM[circuit]_VltLNMean (VAC)

WHM[circuit]_CurA (Amps)
WHM[circuit]_CurB (Amps)
WHM[circuit]_CurC (Amps)
WHM[circuit]_CurAvg (Amps)
WHM[circuit]_CurMin (Amps)
WHM[circuit]_CurMax (Amps)
WHM[circuit]_CurMean (Amps)

WHM[circuit]_Freq (Hz)

WHM[circuit]_RelPwrA (kW)
WHM[circuit]_RelPwrB (kW)
WHM[circuit]_RelPwrC (kW)
WHM[circuit]_RelPwrTotal (kW)
WHM[circuit]_RelPwrMax (kW)

WHM[circuit]_EnrgRec (kWh)
(imported from grid)
WHM[circuit]_EnrgDel (kWh)
(exported to grid)

WHM[circuit]_EnrgRecNet (kWh)
WHM[circuit]_EnrgDelNet (kWh)

WHM[circuit]_AppPwrA (kVA)
WHM[circuit]_AppPwrB (kVA)
WHM[circuit]_AppPwrC (kVA)
WHM[circuit]_AppPwrTotal (kVA)
WHM[circuit]_AppPwrMax (kVA)
WHM[circuit]_AppEnrgRec (kVAh)
WHM[circuit]_AppEnrgDel (kVAh)

WHM[circuit]_RctPwrA (kVAR)
WHM[circuit]_RctPwrB (kVAR)
WHM[circuit]_RctPwrC (kVAR)
WHM[circuit]_RctPwrTotal (kVAR)
WHM[circuit]_RctPwrMax (kVAR)
WHM[circuit]_RctEnrgRec (kVARh)
WHM[circuit]_RctEnrgDel (kVARh)

WHM[circuit]_PwrFctrA (%)
WHM[circuit]_PwrFctrB (%)
WHM[circuit]_PwrFctrC (%)
WHM[circuit]_PwrFctrAvg (%)

WHM[circuit]_VltUnbal
WHM[circuit]_CurUnbal
WHM[circuit]_PhsRev (False/True)
WHM[circuit]_VltPhsSeq

WHM[circuit]_PlsOut1 (Off/On)
WHM[circuit]_PlsOut2 (Off/On)
WHM[circuit]_PlsOut3 (Off/On)
WHM[circuit]_PlsOut4 (Off/On)

WHM[circuit]_PlsIn1 (Off/On)
WHM[circuit]_PlsIn2 (Off/On)
WHM[circuit]_PlsIn3 (Off/On)
WHM[circuit]_PlsIn4 (Off/On)

WHM[circuit]_PlsTot1 (pulses)
WHM[circuit]_PlsTot2 (pulses)
WHM[circuit]_PlsTot3 (pulses)
WHM[circuit]_PlsTot4 (pulses)

WHM[circuit]_THDVltA (THD)
WHM[circuit]_THDVltB (THD)
WHM[circuit]_THDVltC (THD)

WHM[circuit]_THDCurA (THD)
WHM[circuit]_THDCurB (THD)
WHM[circuit]_THDCurC (THD)

WHM[circuit]_KfctrCurA (coeff)
WHM[circuit]_KfctrCurB (coeff)
WHM[circuit]_KfctrCurC (coeff)

WHM[circuit]_CfctrCurA (coeff)
WHM[circuit]_CfctrCurB (coeff)
WHM[circuit]_CfctrCurC (coeff)

WHM[circuit]_CtRatio (Ratio)
WHM[circuit]_PtRatio (Ratio)
WHM[circuit]_Serial (SN)

WHM[circuit]_RO1 (Off/On)
WHM[circuit]_RO2 (Off/On)
WHM[circuit]_RO3 (Off/On)
WHM[circuit]_RO4 (Off/On)

Standard Metering Point Name Format:

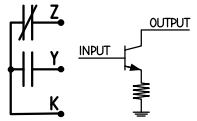
####_TTTEEEEEEEE_PPPPPPPPPPPPPPPPPPPPPPPPP

Where:

= 4-character UA Building Number
TTT = 3-character Standard Meter Type Abbreviations
EEEEEEEEEE = 10-character Meter Designation (variable)
PPPPPPPPPPPPPPPPP = 11 to 16-character Standard Point Name

Standard Meter Type Abbreviations

WHM = Watt Hour Meter
PVM = Photovoltaic Electricity Meter
WEM = Wind Electricity Meter



KYZ & Open Collector Pulses

WHM[circuit]_PlsTot (pulses)
WHM[circuit]_PlsTotRst (Off/On)
WHM[circuit]_PlsGain (coeff)

Common Photovoltaic System Points

PV System Points

Inverter

WHMInverter01_ModuleTmp (°F)
WHMInverter01_IrradPOA (W/m^2)
WHMInverter01_IrradGlbHor (W/m^2)
WHMInverter01_GndFlt (Off/On)
WHMInverter01_Perf (%)
WHMInverter01_ModuleTmpCoeff (coeff)
WHMInverter01_InvPwrMax (kW)
WHMInverter01_InvPwrMax (kW)
WHMInverter01_Comb###Cur (Amps)
WHMInverter01_Comb###Vlt (VDC)
WHMInverter01_Comb###Enrg (kWh)
WHMInverter01_InvSts (varies)
WHMInverter01_InvMode (varies)
WHMInverter01_DCLnkVlt (VDC)
WHMInverter01_DCBusVlt (VDC)

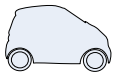
WHMArray1_ArrayPwrMax (kW)
WHMArray1_IrradPOA (W/m^2)
WHMArray1_IrradGlbHor (W/m^2)
WHMArray1_Perf (%)
WHMArray1_ModuleTmpCoeff (coeff)

Common Generator Points

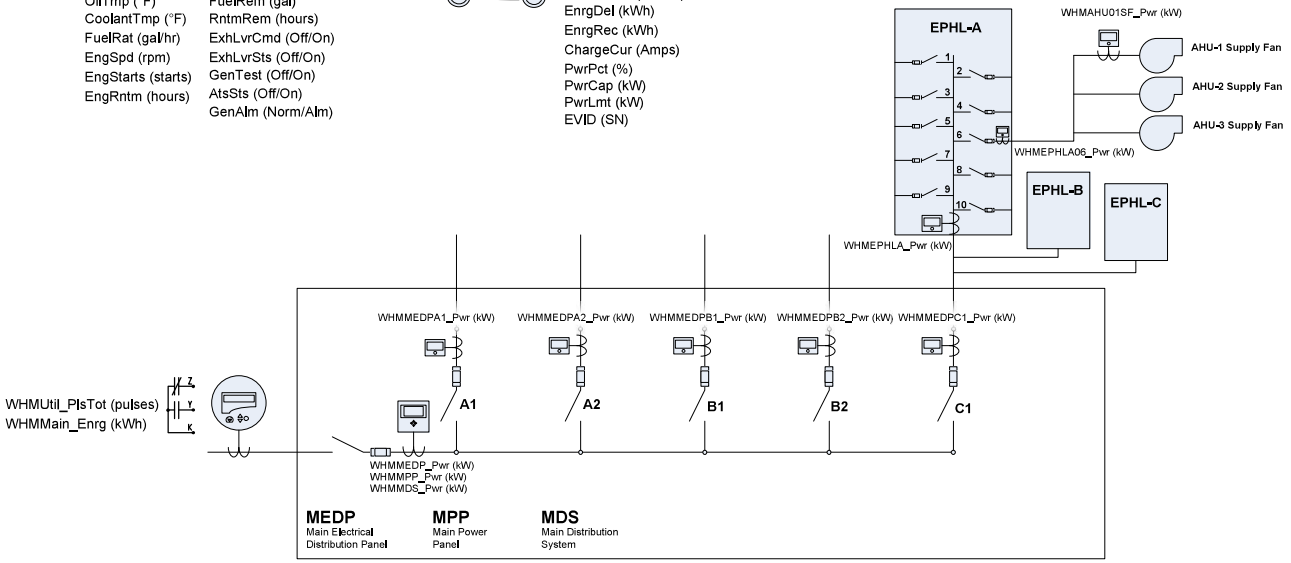
PwrCap (kW)
PwrPct (%)
BattVlt (VDC)
OilPrs (psi)
OilTmp (°F)
CoolantTmp (°F)
FuelRat (gal/hr)
EngSpd (rpm)
EngStarts (starts)
EngRntm (hours)

EngStartCmd (Off/On)
RstCmd (Off/On)
FltCode (varies)
WarnCode (varies)
FuelRem (gal)
RntmRem (hours)
ExhLvrCmd (Off/On)
ExhLvrSts (Off/On)
GenTest (Off/On)
AtsSts (Off/On)
GenAlm (Norm/Alm)

Common EV Charging Station Points



CurLmt (Amps)
StationMode (varies)
StationSts (varies)
StationEna (Off/On)
EnrgDel (kWh)
EnrgRec (kWh)
ChargeCur (Amps)
PwrPct (%)
PwrCap (kW)
PwrLmt (kW)
EVID (SN)



Diagrams depict generic equipment containing control points and objects, some of which may or may not be present or required for a particular piece of equipment or in a particular application.

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THE UNIVERSITY OF ARIZONA

Smart Building Technology Device & Object Naming Standard for Building Automation Systems

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STATUS: Version 3
DRAWN BY: Mike Grush
JOB NUMBER: 200762-001
REV. DATE: **04/17**

SHEET TITLE & NUMBER:

ELEC

Devices

Device Names

0046_ChwSys_SC4
0046_ChwSys_UC60012
0046_CHL01_UC800
0046_GP04_VFD
0174_ChwSys_SC5
0174_ChwSys_UC60021
0174_CHL06A_UC800
0174_CT1C1F_VFD
0205_ChwSys_SC1
0205_ChwSys_UC6001
0205_CHL01_UC800
0205_CWP04_VFD
0240_AHU01_CDCtlr
0240_AHU01_HDCtlr
0240_AHU01_SF1AVFD
0240_AHU01_SF1BVFD
0119_AHU04_GCM05
0119_AHU04_VFD
0119_AHU04_AFMS
0119_RmS110_JACE7AX
0119_LGT_Zn01

Generic Device Points

Device

DevSts (OK/Fault)
DevAlm (Norm/Alm)
DevMfg (Manufacturer)
DevModel (Model)
DevHWVer (Version)
DevSWVer (Version)
DevFWVer (Version)
DevSerial (sn)

DevBootCount (boots)
ErrorCode (varies)
Uptime (sec, min, hours)
PcbTmp (°F)
DevFlt (Off/On)
PrevFltCode (varies)
ActiveFltCode (varies)
FltCount (faults)
RstCmd (Off/On)
RebootCmd (Off/On)
UTC (UTC)

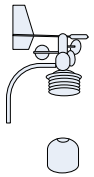
Device Communications Points

DevComSts (OK/Fault)
DevLink (varies)
DevMACAdd (MAC Address)
DevID (Device ID)
DevIPAdd (IP Address)
DevNetID (Network ID)
DevAdd (Device Address)

Wireless Device Points

Signal (%)
NodesTot (nodes)
NodesOnline (nodes)
RadioGrp (group)
RadioAdd (address)
RadioSts (Off/On)
NodeSts (Off/On)
BattSts (Off/On)
BattAlm (Norm/Alm)
BattRem (%)

Weather Points



Wthr_OATmp (°F)
Wthr_OATmpMax (°F)
Wthr_OATmpMin (°F)
Wthr_OATmpAvg (°F)

Wthr_OARelHum (%)
Wthr_OADew (°F)
Wthr_OAPrs (inHg)
Wthr_OAEnth (btu-lb)

Wthr_WindChill (°F)
Wthr_HtIndex (°F)

Wthr_PrecipGauge (in)
Wthr_PrecipSts (Off/On)

Wthr_WindSpd (mph, fps)
Wthr_WindDir (deg)
Wthr_WindSpdMax (mph, fps)

Wthr_IrradGlbHor (W/m^2)
Wthr_IrradDirNorm (W/m^2)

Diagrams depict generic equipment containing control points and objects, some of which may or may not be present or required for a particular piece of equipment or in a particular application.

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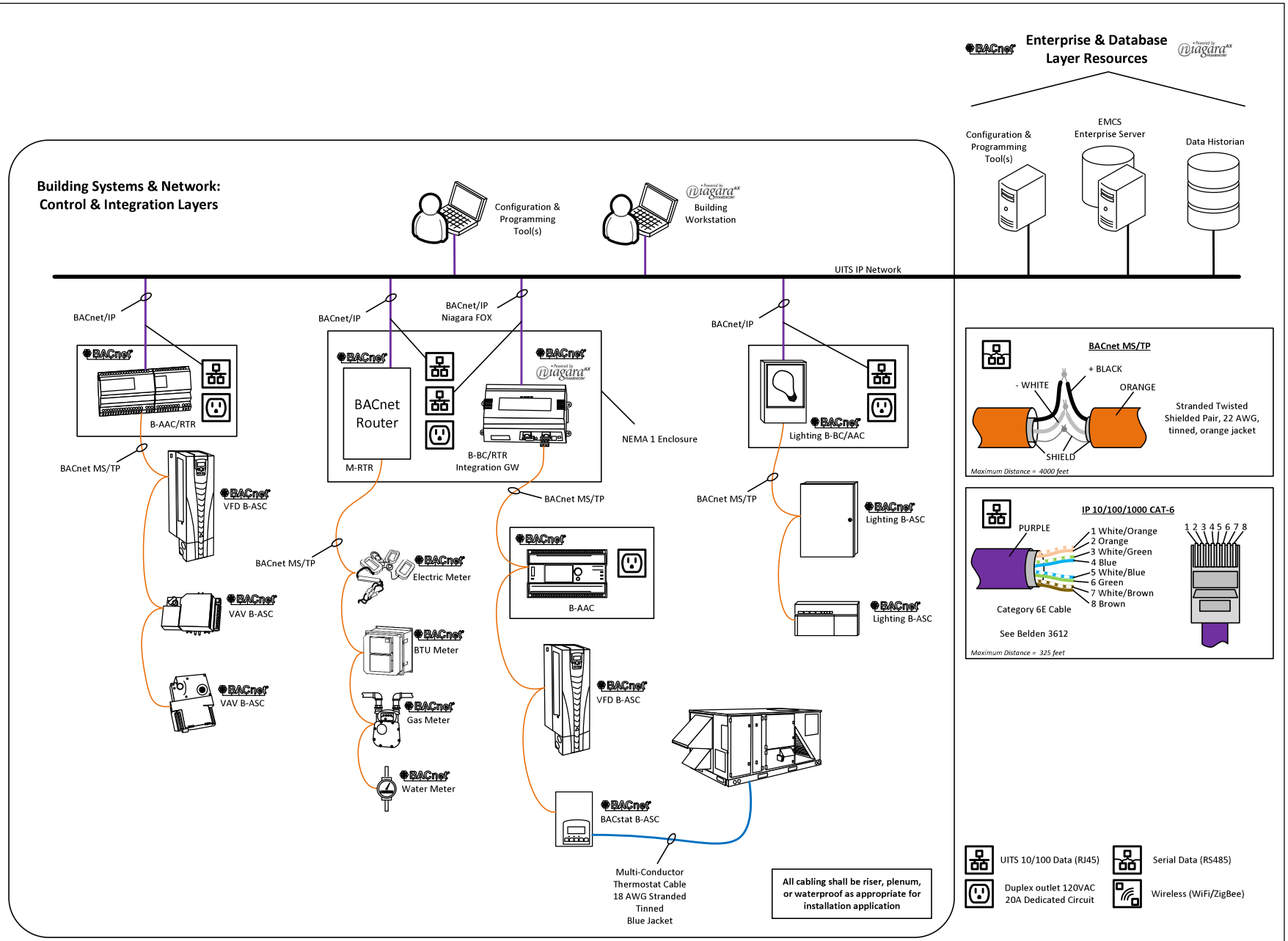
MISC

BACnet Device Schedule

EMCS Contractor/Vendor											University of Arizona UITS/Facilities Management							
Name	Manufacturer	Model	Device Type	Net type	SW Version	FW Version	Location	Controlled Equipment	MS/TP Network(s) Supported	Host Controller	IP Address	Subnet Mask	Default Gateway	UDP Port	Device ID	Network #	BBMD	MS/TP (MAC) Add

Modbus Device Schedule

EMCS Contractor/Vendor									University of Arizona UITS/Facilities Management				
Name	Manufacturer	Model	Device Type	SW Version	FW Version	Location	Controlled Equipment	RTU Network Supported	IP Address	Subnet Mask	Default Gateway	TCP Port	MAC Add



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EMCS Interface Schematic

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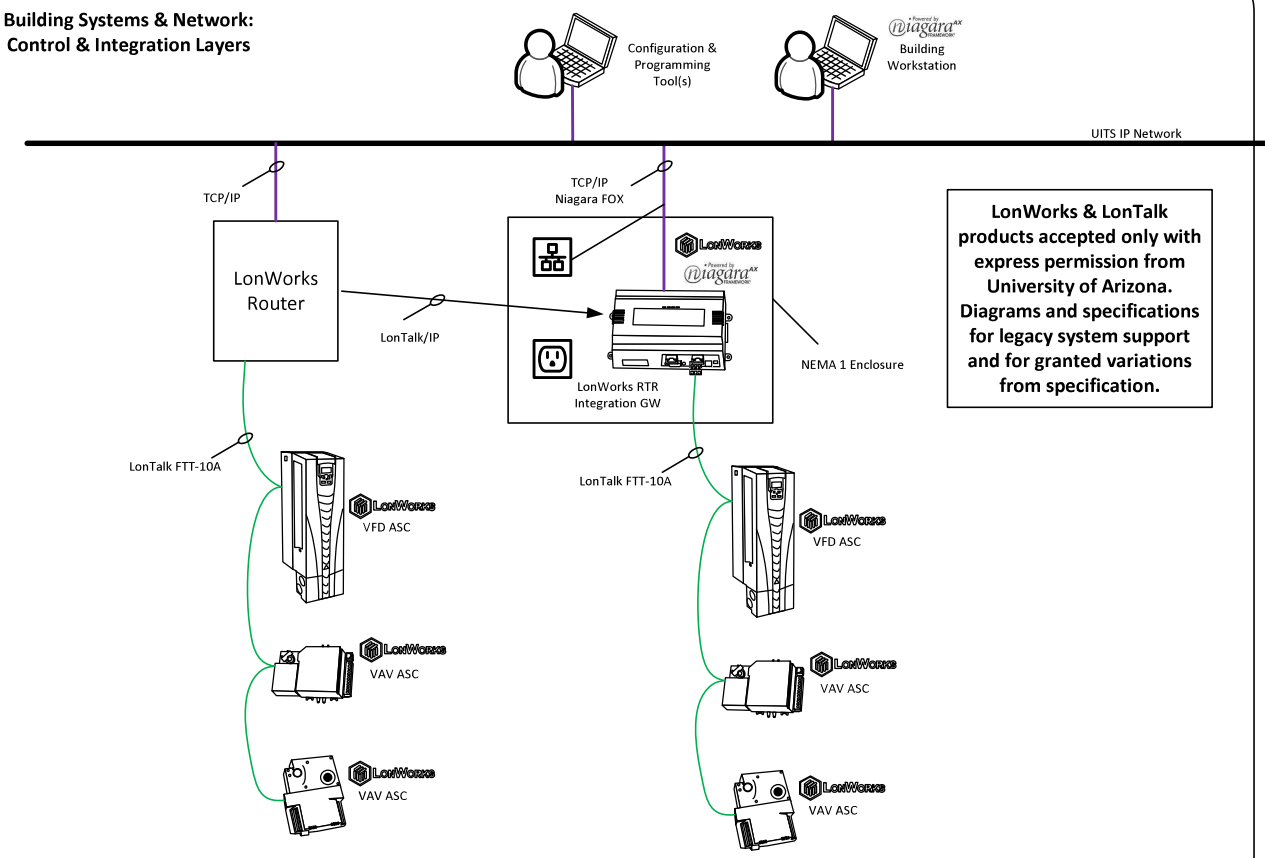
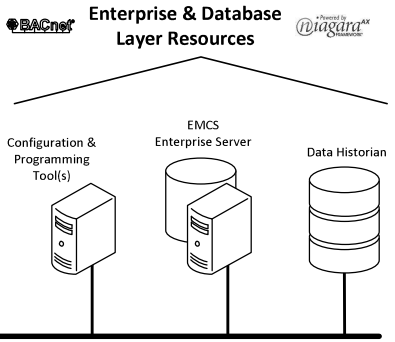
Building Systems & Network: Control & Integration Layers



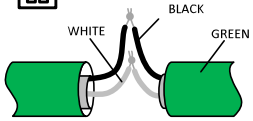
LonWorks & LonTalk products accepted only with express permission from University of Arizona. Diagrams and specifications for legacy system support and for granted variations from specification.

All cabling shall be riser, plenum, or waterproof as appropriate for installation application

Enterprise & Database Layer Resources



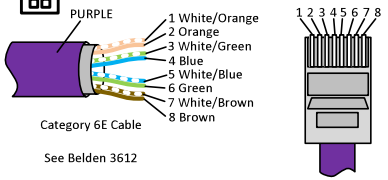
LonWorks LonTalk FTT-10A



Stranded Twisted Pair, 16 AWG, tinned copper, green jacket

Maximum Distance = 2700 feet

IP 10/100 Cat-6



Category 6E Cable

See Belden 3612

Maximum Distance = 325 feet

UITS 10/100 Data (RJ45)

Serial Data (RS485)

Duplex outlet 120VAC 20A Dedicated Circuit

Wireless (WiFi/ZigBee)

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Legacy LonWorks Interface Schematic

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-	-	-

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REV. DATE: 04/17

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