

**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

## 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. Major equipment (AHUs, heat exchangers, hydronic systems, etc.) controllers shall be IP-based, and will connect to the University of Arizona network environment. All major equipment controllers, sensors, and actuators shall be electronic.
    - e. Minor equipment (terminal units, fan coils, heat pumps, etc.) controllers may use serial-based network technology (RS-485/EIA-485), and must be connected via routers to the University of Arizona network. All minor equipment controllers, sensors, and actuators shall be electronic.
    - f. Provide electronic speed control for variable volume systems. Electronic speed control devices shall communicate using BACnet. See Section III.B for details.
    - g. Wireless technology is not preferred. Wireless systems that are installed shall operate error-free for the entire warranty term, or shall be replaced with a hardwired system at no cost or disruption to the University of Arizona.
    - h. 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.
  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 shall be provided and used by the controls contractor, and shall be removed by the controls contractor when all 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 work with University of Arizona to coordinate the logistics and provisioning as appropriate for the project.
- C. EMCS trend data shall flow from the BACnet field devices to the data historian through overlapping cascading reservoirs as follows:
  - 1. Trend data shall be recorded by the trending-capable BACnet device topologically nearest to the device where the object resides. This is this initial data reservoir, and shall hold a minimum of three (3) days or 700 data records for each control object, whichever is larger.
    - a. Trend data shall be recorded using BACnet Trend Objects in the local BACnet HVAC controller.
    - b. 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

- c. 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.
  - 2. The data contained in the BACnet Trend Objects shall be uploaded to the local integration device or directly to the enterprise server with scheduled synchronizations. If a scheduled synchronization is missed due to network or other issues, the next successful synchronization shall include the data missed by the previous synchronization(s). The enterprise server is the second data reservoir and shall hold a minimum of one year (365) days of data for each control object.
  - 3. The enterprise server shall make the data available to the data historian through scheduled synchronizations. The data historian is the final repository for the data. A minimum of two (2) years of data shall be maintained.
  - 4. 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. Alarm events shall be created in the local BACnet devices, each assigned to the appropriate alarm class.
    - b. Alarms events shall be created in local B-BC or B-AAC devices for alarm points that are located in packaged B-ASC-type devices to allow those alarms to be routed properly.
    - c. Alarm description text shall be completed to describe alarm condition.
    - d. Appropriate alarm conditions, deadbands, and delays shall be used to avoid nuisance alarms.
  - 2. Alarm Classes:
    - a. Control Layer:
      - 1. “XXXX\_StandardAlm” (where “XXXX” is the building number)
      - 2. “XXXX\_CriticalAlm” (where “XXXX” is the building number)
      - 3. “LocalAlm”
    - b. Integration layer:
      - 1. “XXXX\_StandardAlm” (where “XXXX” is the building number)
      - 2. “XXXX\_CriticalAlm” (where “XXXX” is the building number)
      - 3. “LocalAlm”
      - 4. “DeviceAlm”
    - c. Enterprise Layer
      - 1. “XXXX\_StandardAlm” (where “XXXX” is the building number)
        - a. A separate “StandardAlm” alarm class shall be created for each building
      - 2. “XXXX\_CriticalAlm” (where “XXXX” is the building number)
        - a. A separate “CriticalAlm” alarm class shall be created for each building
      - 3. “DeviceAlm”
      - 4. “StationAlm”
  - 3. 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. Basic alarm guidelines are shown in the table below:

Object	Alarm State	Deadband	Alarm Condition(s)	Delay	Alarm Class	Notes
RmTmp	> or < RmTmpSp	+/-5°F	occupied times	30m	StandardAlm	
RmRelHum	> or < RmRelHumSp	+/-15%	occupied times	30m	StandardAlm	
Cmd/Sts	Cmd on, Sts off	NA	any	90s	LocalAlm	
SATmp	> or < SATmpSp	+/-10°F	when SFSts is on	15m	StandardAlm	if there is no Sts point, use SFCmd
SASTprs	> or < SASTprsSp	+/-0.5" WC	when SFSts is on	15m	StandardAlm	if there is no Sts point, use SFCmd
Alm (any)	on	NA	any	none	LocalAlm*	*default - depends on application
CHWSTmpAlmH	on	NA	any	15m	CriticalAlm	
HWSTmpAlm	> or < HWSTmpSp	+/-20°F	any	15m	CriticalAlm	
HWSTmpAlmH	>190	NA	any	none	CriticalAlm	
Device	down	NA	any	30m	DeviceAlm	
Niagara Station	down	NA	any	30m	StationAlm	

4. Local Alarms (LocalAlm):
  - a. These alarms are configured and assigned to the "LocalAlm" alarm class, and are not routed beyond the local controller or integration device.
5. Standard Alarms (XXXX\_StandardAlm):
  - a. These alarms are configured and assigned to the "StandardAlm" alarm class, and are routed to the Enterprise Level.
6. Critical Alarms (XXXX\_CriticalAlm):
  - a. These alarms are configured and assigned to the "CriticalAlm" alarm class, and are routed to the Enterprise Level.
  - b. Contractor shall request from the University information regarding which alarms should be considered "critical", and shall assign those alarms to the "XXXX\_CriticalAlm" alarm class.
7. 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, trigger too quickly without allowing conditions to stabilize, trigger repeatedly for the same event, or are routed incorrectly.
8. Alarm Notifications:
  - a. Alarm management consoles:
    1. For each building, "XXXX\_StandardAlm\_Console" and a "XXXX\_CriticalAlm\_Console" shall be created on the Enterprise server. Alarms shall be routed to each accordingly.
    2. Device and Station "down" alarms shall be routed to "DeviceAlm\_Console" and "StationAlm\_Console" respectively on the Enterprise server.
    3. "LocalAlm" alarm class events are routed to the local alarm console in the building, if there is one.
  - 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. Schneider Electric I/A (BACnet)
  3. Delta Controls (BACnet)
  4. Others only with written approval
- c. All software and firmware for all products shall be the latest stable version available on the date of substantial completion.
- 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 (heating/cooling pumps and heat exchangers, air-handling units) shall be powered using battery backup (UPS) sufficient to power critical devices for at least fifteen (15) minutes. Battery backup and loads fed from battery shall be wired using standard 120 VAC receptacle plugs to facilitate simple bypass in case of battery failure. UPS device shall incorporate 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. Chilled water flow (gpm), totalized energy (btu)
  2. Chilled water header differential pressure (psig)
  3. Heating Hot water flow in GPM, totalized energy in btu's
  4. Domestic Hot water flow in GPM totalized in btu's
  5. Domestic water totalized in gallons
  6. Electric use totalized in kW hrs
  7. real time demand in kW
  8. Individual equipment power and energy use where required by University of Arizona

9. Chilled water supply and return pressure and temperatures
  10. Steam pressures
  11. Domestic water pressures
  12. Hot water supply and return pressure and temperatures
  13. Status of equipment pumps and drives
  14. Change of set point capability for all variable frequency drives
  15. Provide HVAC equipment greater than 1 HP with time scheduling capability via EMCS
  16. Reset of hot water supply temperatures
  17. Chiller operational status, run times, pressures and temperatures
  18. Cooling tower operational status and temperatures
  19. Report of any EMCS component failures on critical equipment as required by University of Arizona
  20. Emergency generator-run time, load, kW, kVA
  21. Alarms as specified in other sections
  22. 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, and mixed air temperatures
  3. Return air relative humidity (expressed as dew point temperature)
  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<sub>2</sub> 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. Adjustable dead-band
  5. Discharge air temperature
  6. Valve position
  7. % cooling load
  8. % heating load
  9. Current air volume set point
  10. Current air volume
- p. Provide a single building outdoor air station that measures temperature and relative humidity. (This station will be used for all building reset and AHU mode decisions, i.e.: economizer, dehumidification.) This station must be installed on the North side of the facility out of direct sunlight 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.
1. Dew point temperature is to be used for humidity control actions not relative humidity.
- 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 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, D, Bias, and Deadband as-needed to provide control within the required parameters.
    - 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.
      - ii. Excess Error:
        - a. Temperature Control: Error must be  $< 2^{\circ}\text{F}$ .
        - b. Humidity Control: Error must be  $< 10\%$ .
        - c. Static Pressure Control: Error must be  $< 0.10''$  WC.
        - d. Hydronic Pressure Control: Error must be  $< 5$  PSI.
        - e. Air Volume Control: Error must be  $< 10\%$ .
        - f. Hydronic Volume Control: Error must be  $< 10\%$ .
      - iii. Gross overshoot:
        - a. Upon Sp change or load upset, Pv shall not be allowed to overshoot Sp by  $\pm 10\%$  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<sup>AX</sup>-based products (only Open-AX products).
    - 2. Niagar<sup>a</sup> 4-based products (only Open Niagara 4 products) – per written University of Arizona approval only.
    - 3. Schneider Electric Automation Server (AS) upon written approval of University of Arizona.
      - a. If approved for use, AS shall convert all legacy objects to BACnet.
  - c. All software and firmware for all products shall be the latest version available at the date of substantial completion.
- 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.  $72^{\circ}\text{F}\{\text{ok}\} = 72/1 = 72$
            - b.  $72^{\circ}\text{F}\{\text{fail}\} = 72/0 = \text{nan}$  (not-a-number)
            - c.  $72^{\circ}\text{F}\{\text{fail}\} = 72/0 = \text{null}$
          - 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<sup>AX</sup>, Niagara<sup>4</sup>, 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.
      - 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 deletable, 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-BC
      - iii. B-AAC
      - iv. B-AWS
      - v. B-OWS
      - vi. B-GW
    - b. BACnet MS/TP is permitted for the following controllers:
      - i. B-ASC
      - ii. B-SS
      - iii. B-SA
      - iv. B-OD
    - 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 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.
- g. 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.
- h. 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
- i. 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.
- j. 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<sup>AX</sup>:
  - a. Only "Open" Niagara<sup>AX</sup> products will be accepted, where "Open" refers to interoperability with other "Open" Niagara<sup>AX</sup> products/drivers/tools/software/etc., regardless of supplier. Proprietary versions of Tridium-based Niagara<sup>AX</sup> products will not be accepted.
5. All Niagara<sup>AX</sup> 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<sup>4</sup> and Niagara<sup>AX</sup> products/drivers/tools/software/etc., regardless of supplier. Proprietary versions of Tridium-based Niagara 4 products 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-Net<sup>AX</sup> Workbench
      - a. EC-Configure EC-Net<sup>AX</sup> Wizards
      - b. EC-gfxProgram Graphical Programming Interface
    2. Honeywell Controls
      - a. WEBS-AX Workbench
    3. Vykon Controls
      - a. Niagara<sup>AX</sup> 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 preferred by University of Arizona, tools shall be installed on servers provided by University of Arizona.
- 5. Workstation-based tool software:
  - a. Where applicable and preferred 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:

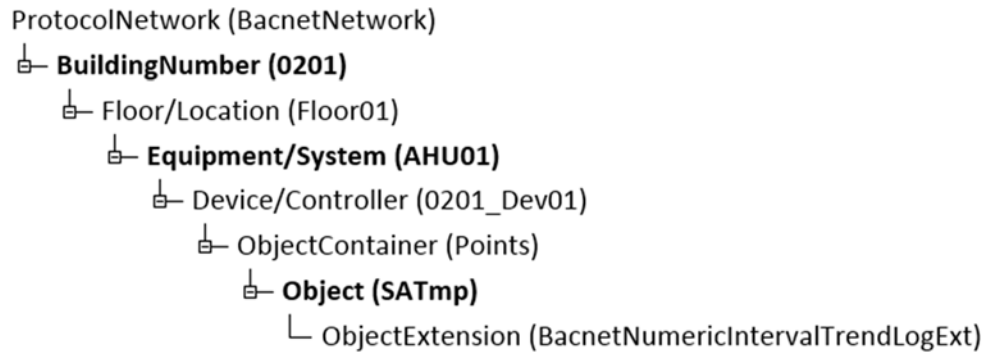
1. Submittals provided must meet requirements outlined in any/all contract or specification documents pertaining to the project, and for the evaluation of the technology systems proposed shall also include at minimum:
  - a. Device schedule in electronic spreadsheet format (use template available from 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<sup>AX</sup> hardware products are the current standard for integration of obsolete, legacy, proprietary, LonWorks, and Modbus devices. Niagara<sup>4</sup> hardware products may be accepted where they are compatible with existing enterprise systems.
    - b. Niagara<sup>AX</sup> software products are the current standard for enterprise software. Niagara<sup>4</sup> 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.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

**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*

### REVISION LOG

#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

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

SHEET TITLE & NUMBER:

1 of 34

Device & Object  
Naming Standard

<b>3</b>	<b>INTRO - Introduction</b>	
<b>4</b>	<b>ANATOMY – Naming Anatomy</b>	
<b>5</b>	<b>ABRV - Abbreviations</b>	
<b>6</b>	<b>LEGEND – Symbol Legend</b>	
<b>7</b>	<b>AHUVAV – VAV/CV AHU</b>	<b>23</b>
<b>8</b>	<b>AHUMISC – AHU Control</b>	<b>24</b>
<b>9</b>	<b>AHUMZ – Multi-Zone AHU</b>	<b>25</b>
<b>10</b>	<b>AHUDD – Dual-Duct AHU</b>	<b>26</b>
<b>11</b>	<b>AHUOA – 100% OA AHU/MUA</b>	<b>27</b>
<b>12</b>	<b>AHUHXR – Air Heat Recovery</b>	<b>28</b>
<b>13</b>	<b>AHUDX – DX AHU/RTU</b>	<b>29</b>
<b>14</b>	<b>ZONE – Zone Control</b>	<b>30</b>
<b>15</b>	<b>VAV CV VVT – Terminal Units</b>	<b>31</b>
<b>16</b>	<b>FTU – Fan Terminal Units</b>	<b>32</b>
<b>17</b>	<b>FCU – Fan Coil Units</b>	<b>33</b>
<b>18</b>	<b>CRAC – Computer Room AC</b>	<b>34</b>
<b>19</b>	<b>VRV – Variable Refrigerant Vol</b>	<b>MISC - Miscellaneous</b>
<b>20</b>	<b>CHW TER – Tertiary CHW Sys</b>	
<b>21</b>	<b>PMP – Pumps</b>	
<b>22</b>	<b>WSHP – Water-Source HP</b>	

**REVISION LOG**

#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

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

SHEET TITLE & NUMBER:

**2** of **34**

**CONTENTS**

## 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 3<sup>rd</sup>-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.

### REVISION LOG

#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

STATUS: Version 3

DRAWN BY: Mike Grush

JOB NUMBER: 200762-001

REV. DATE: **04/17**

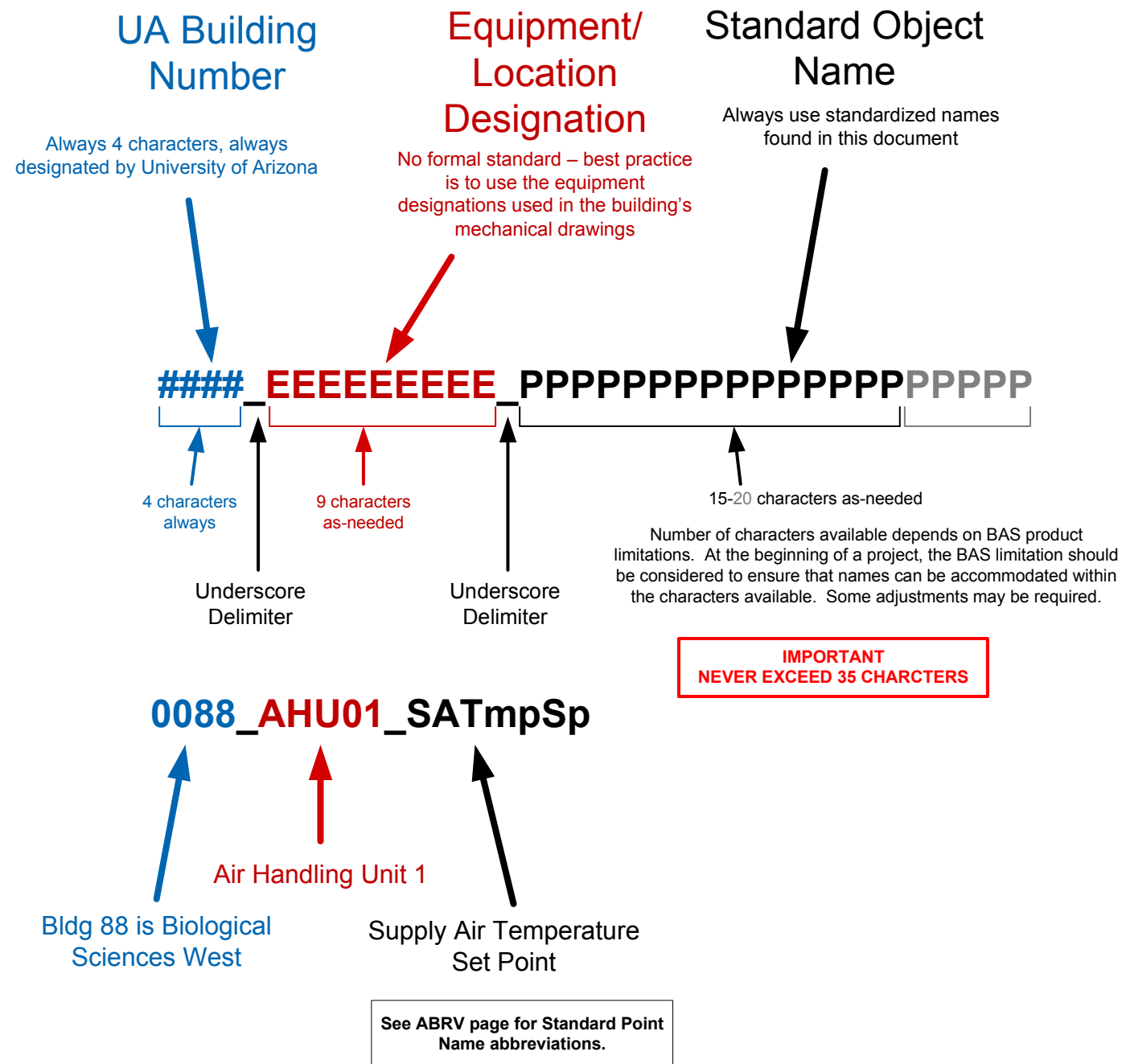
SHEET TITLE & NUMBER:

**3** of **34**

INTRO

# Object Name Anatomy

## Building\_Equipment\_Object



### 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

### REVISION LOG

#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

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

SHEET TITLE & NUMBER:

4 of 34



**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  
Viv = Valve  
VOC = Volatile Organic Compounds  
Vol = Volume  
**W**  
Warn = Warning  
Wh = Wheel  
Wtr = Water  
**Z**  
Zn = Zone

**Standard Engineering Units & Unit Abbreviations**

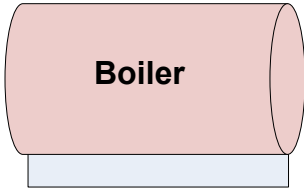
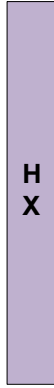
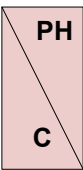
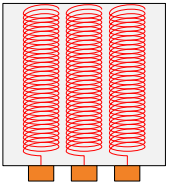
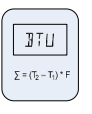

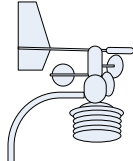
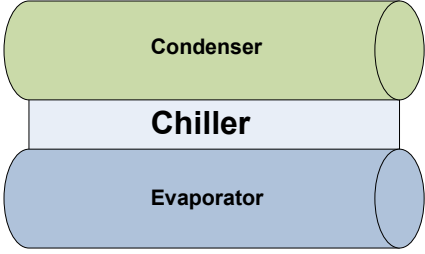

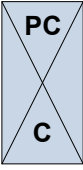
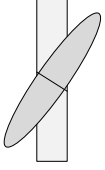



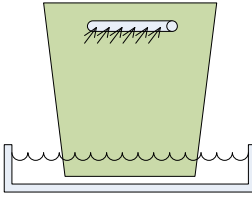
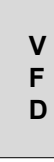
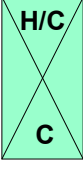
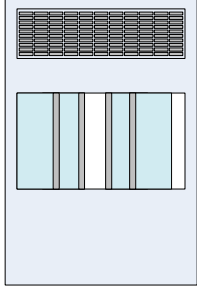



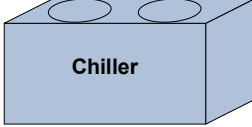
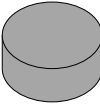
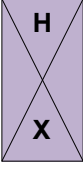
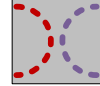



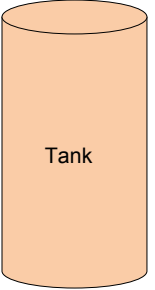

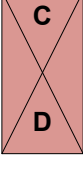
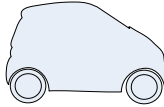


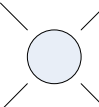
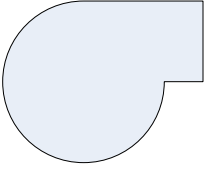


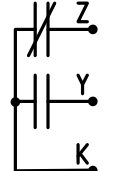

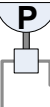

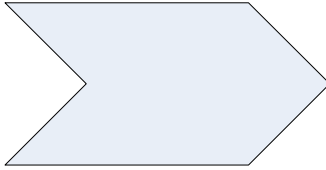


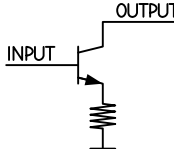


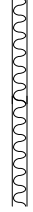

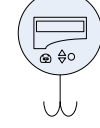







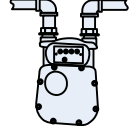


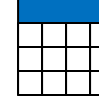




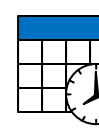
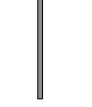



Temperature: Degrees Fahrenheit (°F)  
Water Pressure: Pounds per Square Inch (psiG)  
Water Pressure Differential: Pounds per Square Inch Differential (psiD)  
Air Pressure: Inches of Water Column (inWC, "WC)  
Air Pressure Differential: Inches of Water Column Differential (inWCD, "WCD)  
Relative Humidity: 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)

**REVISION LOG**

#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

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

SHEET TITLE & NUMBER:

	Boiler		Air-to-Air Heat Exchanger		Pre-Heating Coil		Electric Duct Heater		Thermal Energy Meter		Averaging Duct Temperature Sensor		Weather Station				
	Water-Cooled Chiller			Coil		Pre-Cooling Coil		Terminal Unit Damper			Wireless			Averaging Duct Temperature Switch		Space Temperature Sensor	
	Cooling Tower			Variable Frequency Drive		2-Pipe Heating/Cooling Coil		Lab Fume Hood		Electric Meter		Duct Smoke Detector			Space Relative Humidity Sensor		
	Air-Cooled Chiller			DX Compressor		Heat Exchanger Coil			Water-to-Water Heat Exchanger			Fuse		Well Temperature Sensor		Space Occupancy Sensor	
	Storage Tank			Cooling Coil		Condenser Coil			Electric Vehicle		Reversing Valve			Hydronic Pressure Sensor		Lighting Load	
	Fan or Pump			Heating Coil		Air Flow Measuring Station			Pulse Output		3-Way Valve			Hydronic Pressure Differential Sensor		Lighting Level	
	Ductwork			DX Coil		Filter			Open Collector Output		2-Way Valve			Hydronic Flow Sensor		Wall	
				Control Damper				Electric Meter		Strainer			Air Temperature Duct Sensor			Air Pressure Differential Switch	
	Reheat Coil		Reheat Coil		Face/Bypass Damper			Gas Meter		Solenoid Valve		Air Pressure Duct Sensor		Calendar			
								Water Meter		Direct-Expansion Valve			Relative Humidity Duct Sensor		Air Pressure Differential Switch		Schedule
								Air Quality Duct Sensor		Air Quality Duct Sensor			Pyranometer		Refrigerant		

**REVISION LOG**

#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

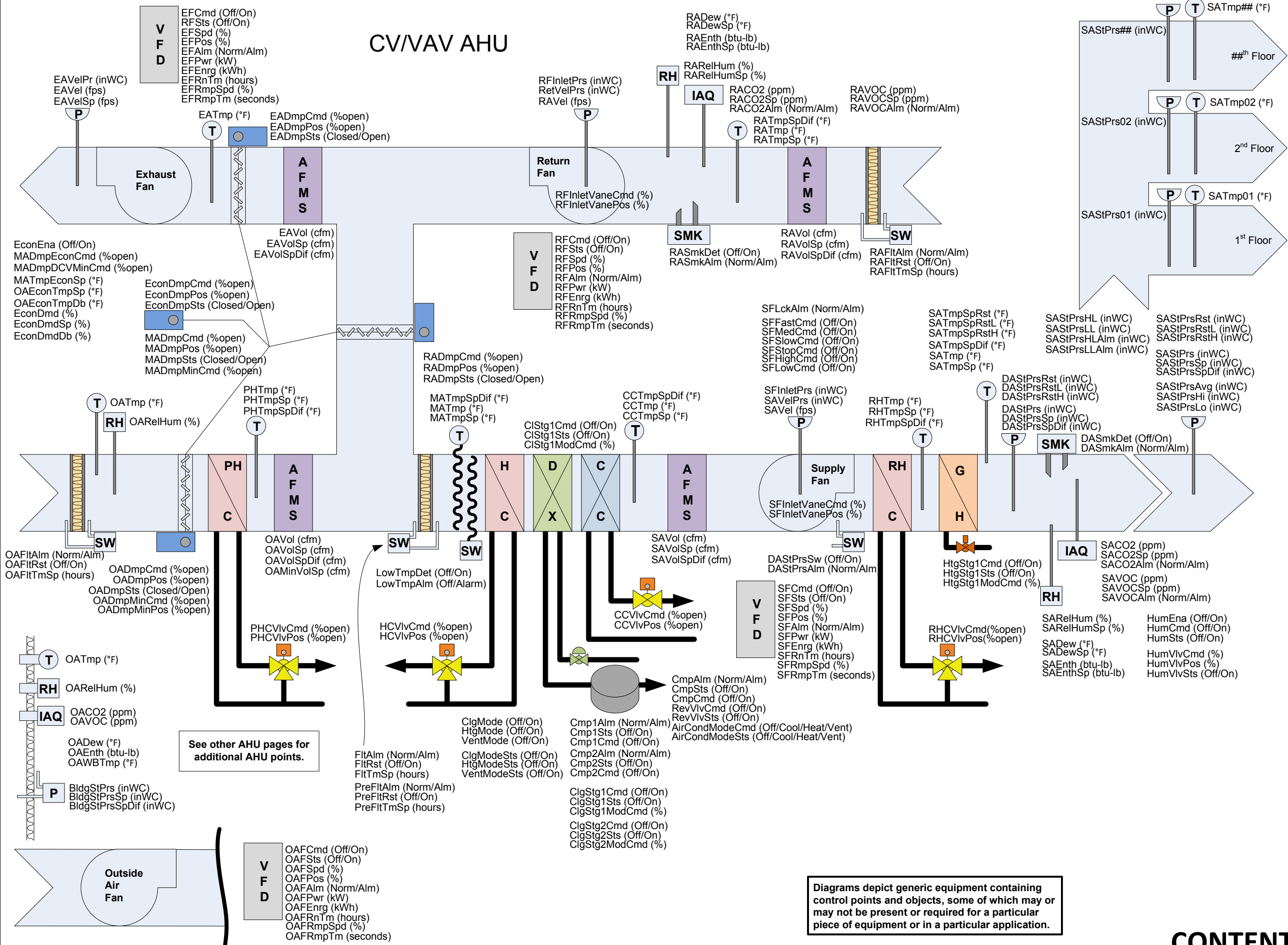
STATUS: Version 3  
DRAWN BY: Mike Grush  
JOB NUMBER: 200762-001  
REV. DATE: **04/17**

SHEET TITLE & NUMBER:

**LEGEND**

**CONTENTS**

# CV/AV AHU



See other AHU pages for additional AHU points.

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.

REVISION LOG		
#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

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

SHEET TITLE & NUMBER:  
 7 of 34

AHUVAV

**CONTENTS**

# 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)

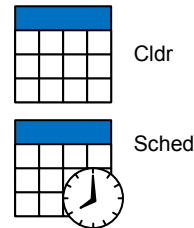
## Equipment Runtime

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

CigEna (Off/On)  
CigEnaSp (°F)  
CigDmd (Off/On)

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

VentEna (Off/On)

### Lockout Points

CigLckCmd (Off/On)  
CigLckSts (Off/On)  
CigLckTmSp (°F)  
CigLckTmDb (°F)

HtgLckCmd (Off/On)  
HtgLckSts (Off/On)  
HtgLckTmSp (°F)  
HtgLckTmDb (°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)  
CoolDnRmTmSp (°F)

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

LowTmAlm (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]LpLGain (lgain)  
[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)  
SATmpLpLGain (lgain)  
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 Valve 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)  
TmpLpLGain (lgain)  
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)

OptStZn (null)  
OptStMode (null)  
OptStNextStrtTm (min)  
OptStNextStopTm (min)  
OptStErlyStrtTm (min)  
OptStLateStrtTm (min)  
OptStNextOccTm (min)  
OptStErlyStopTm (min)  
OptStLateStopTm (min)  
OptStNextUocTm (min)  
OptStAdjStrtTm (min)  
OptStAdjStopTm (min)  
OptStSeason (Summer/Winter)  
OptStZnTmP (°F)  
OptStOATmp (°F)  
OptStClgSp (°F)  
OptStClgCoeff1 (hours)  
OptStClgCoeff2 (hours)  
OptStClgCoeff3 (hours)  
OptStClgCoeff4 (hours)  
OptStHtgSp (°F)  
OptStHtgCoeff1 (hours)  
OptStHtgCoeff2 (hours)  
OptStHtgCoeff3 (hours)  
OptStHtgCoeff4 (hours)

### OSS Objects (Zone Optimization)

OptStClgSp (°F)  
OptStHtgSp (°F)  
OptStDesOper (null)  
OptStEffClgSp (°F)  
OptStEffHtgSp (°F)  
OptStMode (null)  
OptStLastMode (null)  
OptStNextMode (null)  
OptStNextOccTmr (min)  
OptStNextOccTm (min)  
OptStNextStrtTmr (min)  
OptStNextStopTmr (min)  
OptStNextStopTm (min)  
OptStNextStrtTm (min)  
OptStNextUocTmr (min)  
OptStNextUocTm (min)  
OptStOATmp (°F)  
OptStClgSp (°F)  
OptStOATmp (°F)  
OptStOATmpStop (°F)  
OptStOATmpStrt (°F)  
OptStOccClgSp (°F)  
OptStOccHtgSp (°F)  
OptStLastOccTm (min)  
OptStPhase (null)  
OptStStopDrtn (min)  
OptStStopMode (null)  
OptStStopTm (min)  
OptStStrtDrtn (min)  
OptStStrtMode (null)  
OptStStrtTm (min)  
OptStStopTmDif (°F)  
OptStStrtTmDif (°F)  
OptStStopTGTemp (°F)  
OptStStrtTGTemp (°F)  
OptStAdjStrtTm (min)  
OptStAdjStopTm (min)  
OptStUocClgSp (°F)  
OptStUocHtgSp (°F)  
OptStUocTm (min)  
OptStZnTmP (°F)  
OptStZnTmPStop (°F)  
OptStZnTmPStrt (°F)

## REVISION LOG

#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

STATUS: Version 3

DRAWN BY: Mike Grush

JOB NUMBER: 200762-001

REV. DATE: 04/17

SHEET TITLE & NUMBER:

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.

### Zone Control

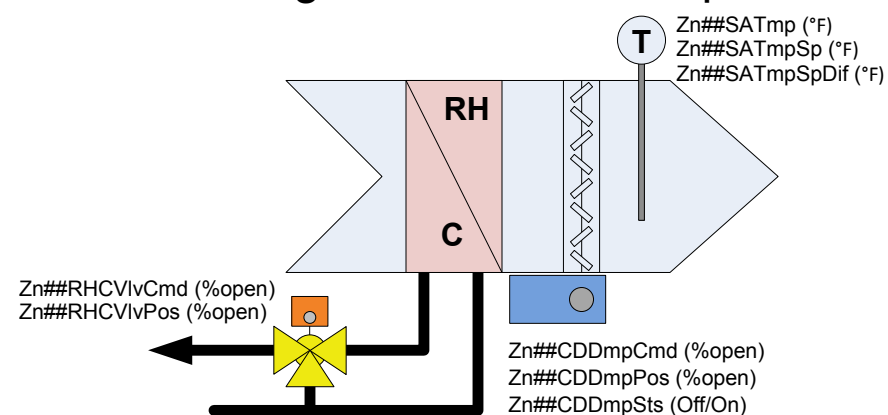
- Zn##OccCmd (Off/On)
  - Zn##EffTmp (°F)
  - Zn##EffSp (°F)
  - Zn##OccClgSp (°F)
  - Zn##OccHtgSp (°F)
  - Zn##UocClgSp (°F)
  - Zn##UocHtgSp (°F)
  - Zn##StbyClgSp (°F)
  - Zn##StbyHtgSp (°F)
- T** Zn##Tmp (°F)  
Zn##TmpSp (°F)
  - RH** Zn##RelHum (%)  
Zn##RelHumSp (%)  
Zn##Enth (btu-lb)  
Zn##EnthSp (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##VOCAIm (Norm/Alm)

See other AHU pages for additional AHU points.

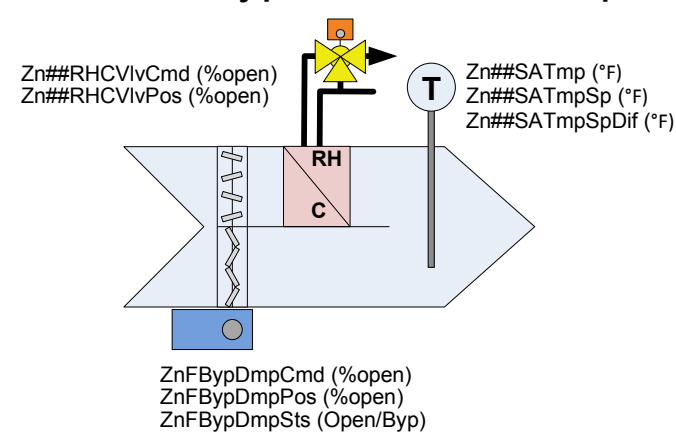
### General Zone Management

- ZnDmpMax (%open)
- ZnDmpMin (%open)
- ZnDmpAvg (%open)
- ZnHDDmpMax (%open)
- ZnHDDmpMin (%open)
- ZnHDDmpAvg (%open)
- ZnCDDmpMax (%open)
- ZnCDDmpMin (%open)
- ZnCDDmpAvg (%open)
- ZnRHCvIvMax (%open)
- ZnRHCvIvMin (%open)
- ZnRHCvIvAvg (%open)

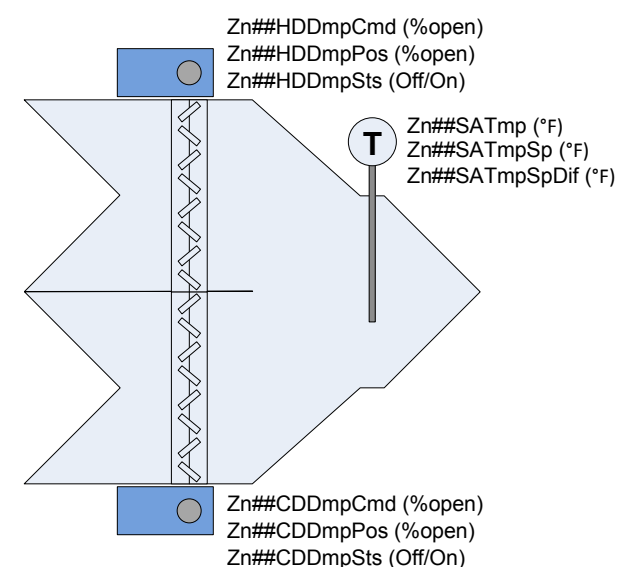
### Single-duct Zone Damper



### Face/Bypass Zone Damper



### Dual-duct Zone Dampers



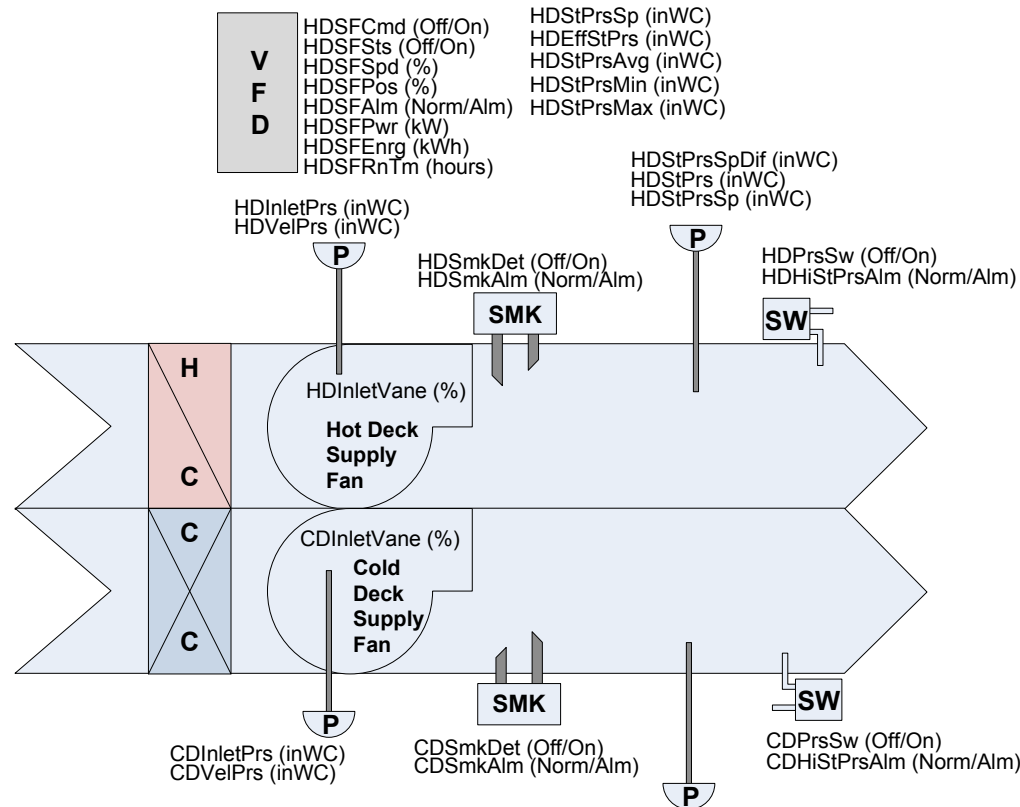
Diagrams depict generic equipment containing control points and objects, some of which may or may not be present or required for a particular piece of equipment or in a particular application.

REVISION LOG		
#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

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

SHEET TITLE & NUMBER:

# Dual Supply Fan Dual Duct AHU



- VFD**
- HDSFCmd (Off/On)
  - HDSFSts (Off/On)
  - HDSFSpd (%)
  - HDSFPos (%)
  - HDSFAlm (Norm/Alm)
  - HDSFPwr (kW)
  - HDSFEnrg (kWh)
  - HDSFRnTm (hours)

- HDStPrsSp (inWC)
- HDEffStPrs (inWC)
- HDStPrsAvg (inWC)
- HDStPrsMin (inWC)
- HDStPrsMax (inWC)

- HDInletPrs (inWC)
- HDVelPrs (inWC)
- HDSmkDet (Off/On)
- HDSmkAlm (Norm/Alm)
- HDPrsSw (Off/On)
- HDHiStPrsAlm (Norm/Alm)

- VFD**
- CDSFCmd (Off/On)
  - CDSFSts (Off/On)
  - CDSFSpd (%)
  - CDSFPos (%)
  - CDSFAlm (Norm/Alm)
  - CDSFPwr (kW)
  - CDSFEnrg (kWh)
  - CDSFRnTm (hours)

- CDStPrsSpDif (inWC)
- CDStPrs (inWC)
- CDStPrsSp (inWC)
- CDStPrsSp (inWC)
- CDEffStPrs (inWC)
- CDStPrsAvg (inWC)
- CDStPrsMin (inWC)
- CDStPrsMax (inWC)

- SFInletPrs (inWC)
- SAVelPrs (inWC)
- SASmkDet (Off/On)
- SASmkAlm (Norm/Alm)

- VFD**
- SFCmd (Off/On)
  - SFSts (Off/On)
  - SFSpd (%)
  - SFPos (%)
  - SFAlm (Norm/Alm)
  - SFPwr (kW)
  - SFEnrg (kWh)
  - SFRnTm (hours)

- DASTPrsSw (Off/On)
- HiStPrsAlm (Norm/Alm)
- DASTPrs (inWC)
- DASTPrsSp (inWC)
- DASTPrsSpDif (inWC)

## AHU Control Parameters

- Unit Control Points**
- ManOvrCmd (Off/On)
  - ScheduleCmd (Off/On)
  - ScheduleSts (Off/On)
  - OccCmd (Occ/Uoc)
  - OvrCmd (Off/Ovrd)
  - OccSts (Occ/Uoc)
  - EffOcc (Occ/Uoc)
  - OTOcc (Occ/Uoc)
  - OTOccTm (hours)
- Miscellaneous Points**
- NightLLCmd (Off/LL)
  - NightHLCmd (Off/HL)
  - CigEna (Off/On)
  - CigDmd (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**
- CigLckCmd (Off/On)
  - CigLckSts (Off/On)
  - CigLckTmpSp (°F)
  - CigLckTmpDb (°F)
  - HtgLckCmd (Off/On)
  - HtgLckSts (Off/On)
  - HtgLckTmpSp (°F)
  - HtgLckTmpDb (°F)
  - StmLck (Off/On)
  - RHLck (Off/On)
  - PHLck (Off/On)

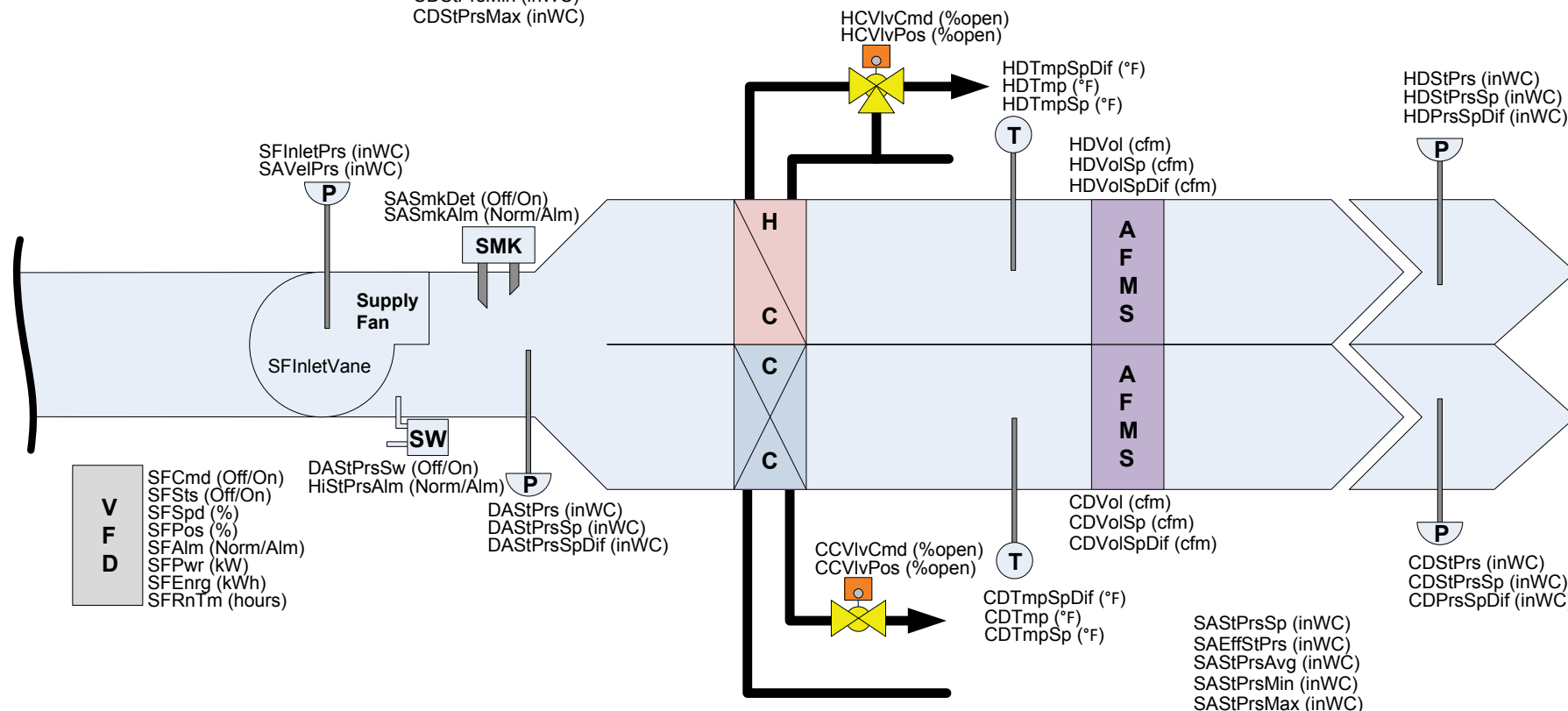
See other AHU pages for additional AHU points.

## Zone Control Setpoints

- OccCmd (Occ/Uoc)  
UocOvrCmd (Uoc/Ovrd)  
OvrTimeSp (hours)
- T** Tmp (°F)  
TmSp (°F)
- EffTmSp (°F)  
EffSp (°F)  
OccCigSp (°F)  
OccHtgSp (°F)  
UocCigSp (°F)  
UocHtgSp (°F)  
StbyCigSp (°F)  
StbyHtgSp (°F)
- UsrSpAdjEna (Off/On)  
UsrSpAdjRng (°F)  
UsrSpAdjHL (°F)  
UsrSpAdjLL (°F)  
UsrSpAdj (°F)  
EffUsrSp (°F)  
OccSnsrSts (Off/On)

- MinCigVolSp (cfm)
- MaxCigVolSp (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



- HCVlvCmd (%open)
- HCVlvPos (%open)
- HDTmpSpDif (°F)
- HDTmp (°F)
- HDVol (cfm)
- HDVolSp (cfm)
- HDVolSpDif (cfm)

- CCVlvCmd (%open)
- CCVlvPos (%open)
- CDTmSpDif (°F)
- CDTmSp (°F)
- CDVol (cfm)
- CDVolSp (cfm)
- CDVolSpDif (cfm)

- HDStPrs (inWC)
- HDStPrsSp (inWC)
- HDPrsSpDif (inWC)

- CDStPrs (inWC)
- CDStPrsSp (inWC)
- CDPrsSpDif (inWC)

- SASTPrsSp (inWC)
- SAEffStPrs (inWC)
- SASTPrsAvg (inWC)
- SASTPrsMin (inWC)
- SASTPrsMax (inWC)

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.

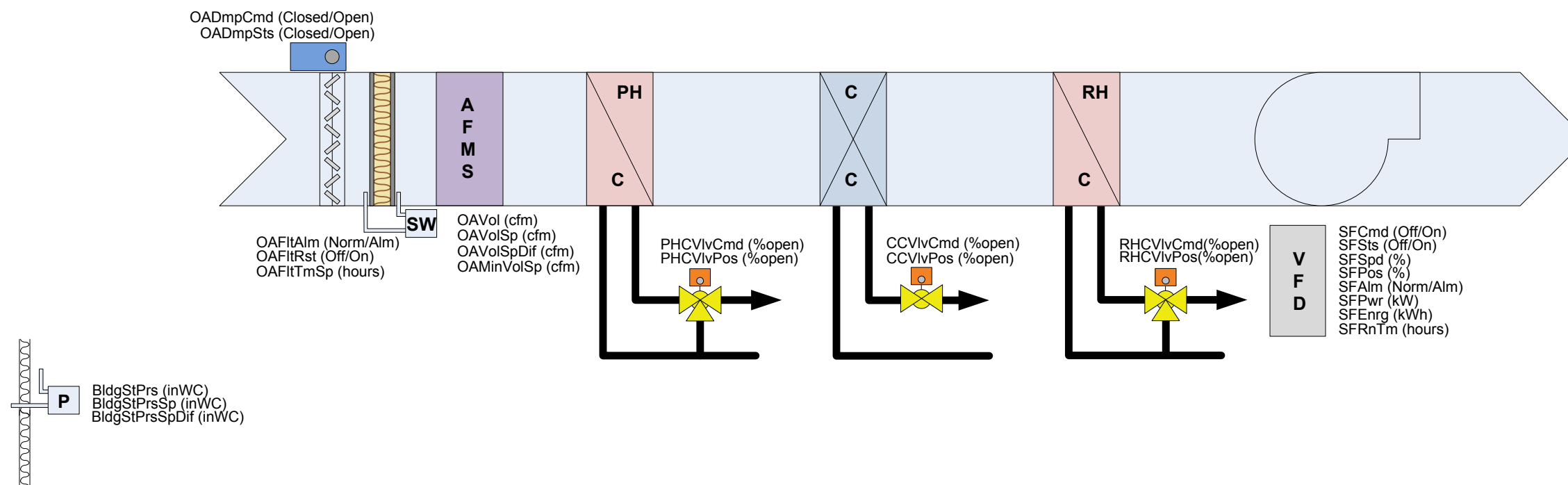
### REVISION LOG

#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

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

SHEET TITLE & NUMBER:  
10 of 34

### OSA AHU/MUA AHU



**REVISION LOG**

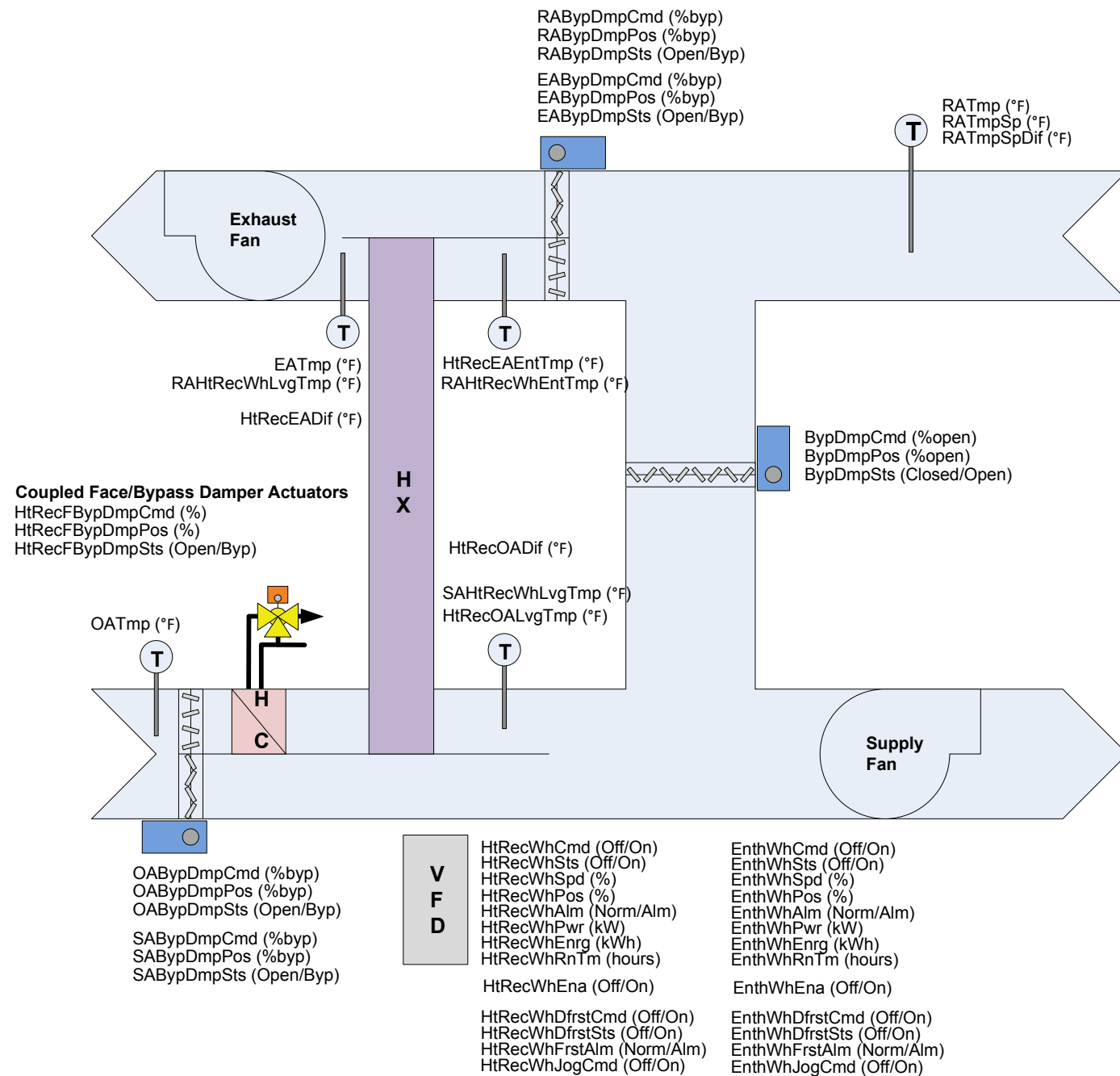
#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

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

SHEET TITLE & NUMBER:

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.

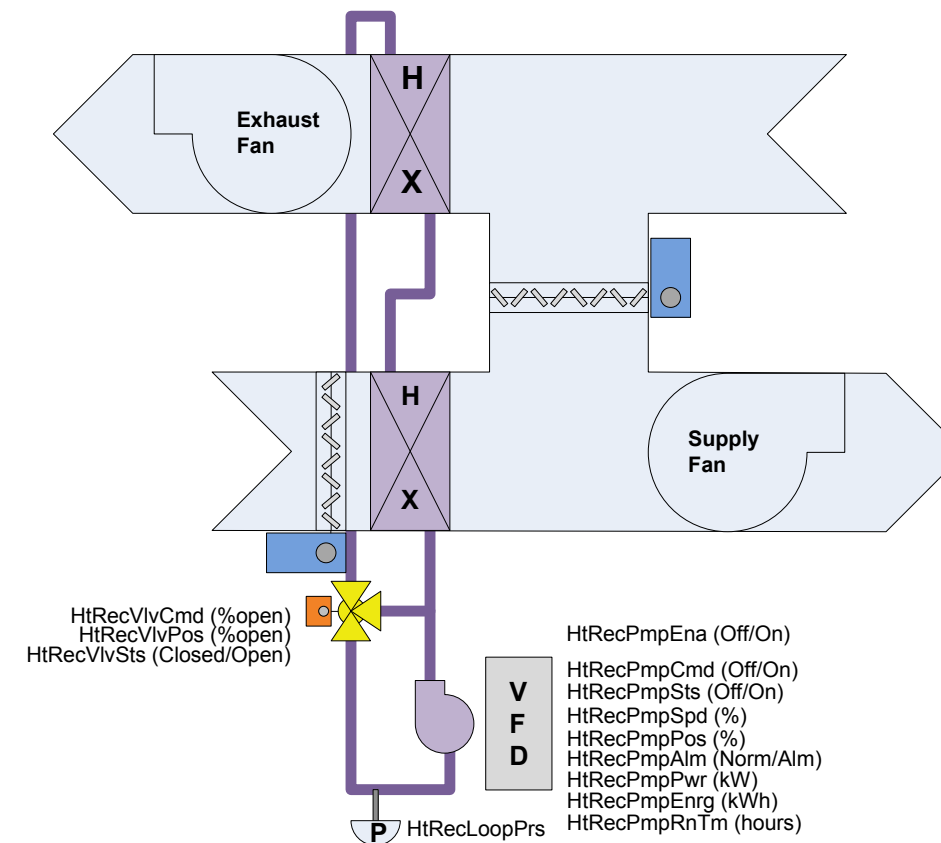
### Air-to-Air Heat Recovery



### 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.

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.

#### REVISION LOG

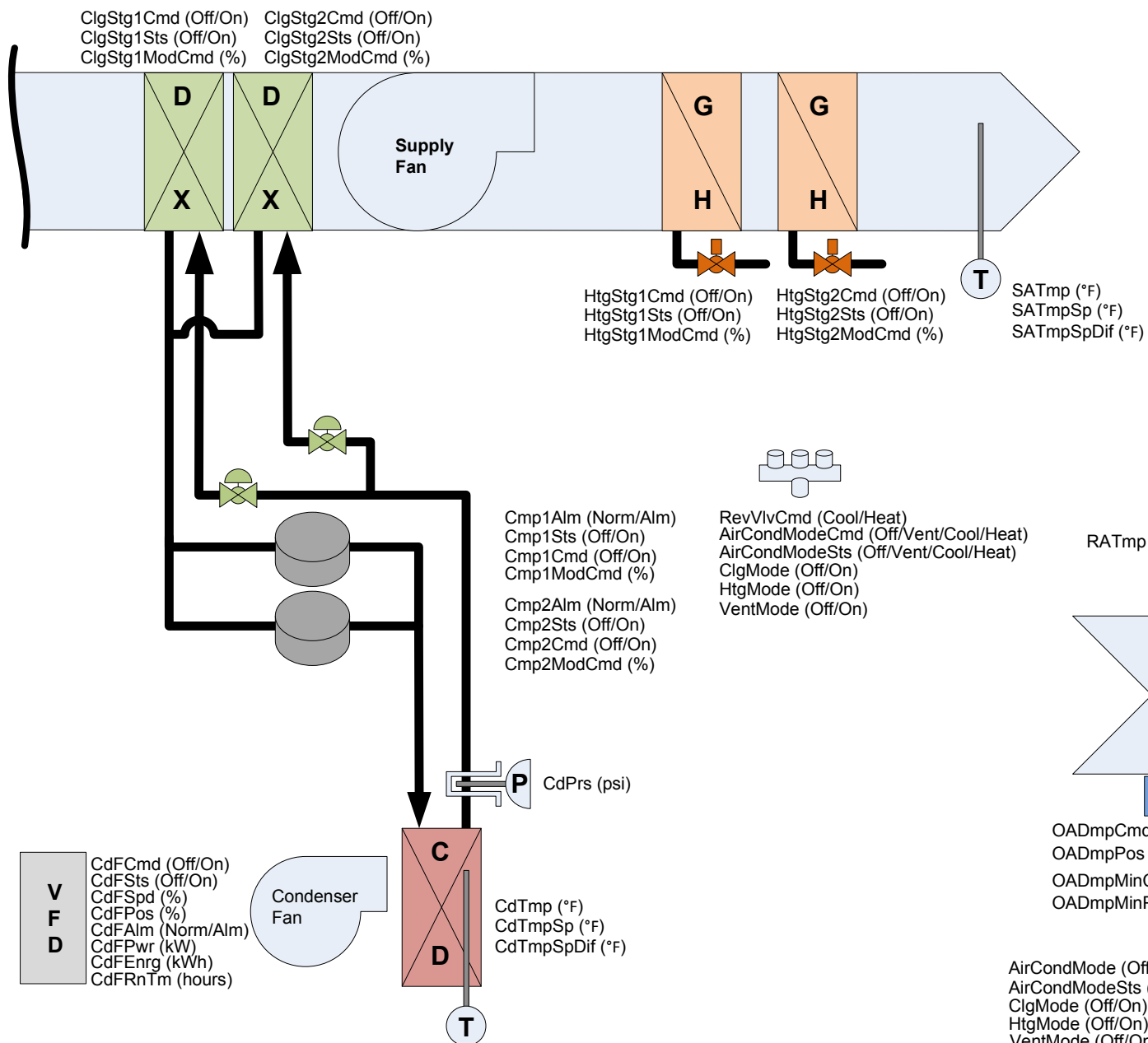
#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

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

SHEET TITLE & NUMBER:

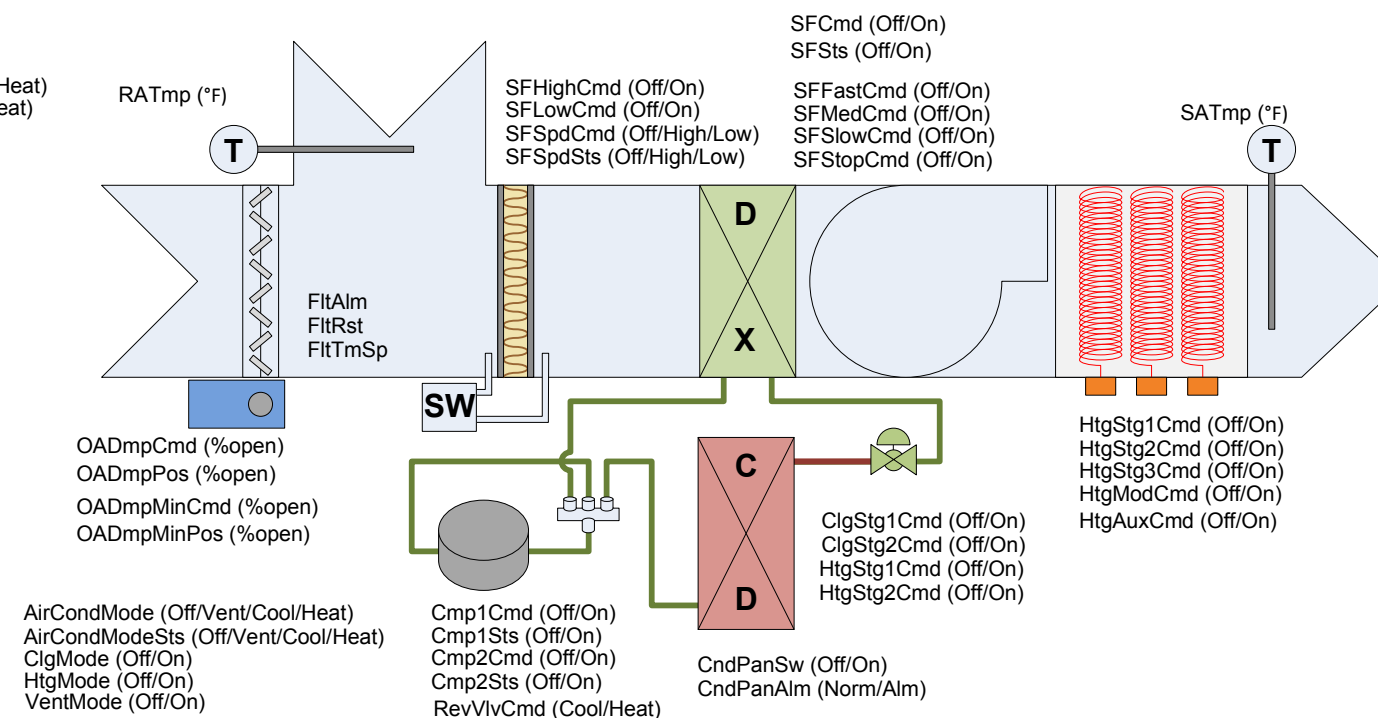


### DX AHU w/ Gas Heat



See other AHU pages for additional AHU points.

### Unit Ventilator/Heat Pump



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.

REVISION LOG		
#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

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

SHEET TITLE & NUMBER:  
13 of 34

AHUDX

## Zone/Terminal Unit Control Setpoints

OccCmd (Occ/Uoc)  
UocOvrCmd (Uoc/Ovr)  
OvrTimeSp (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)



RmTmp (°F)  
RmTmpSp (°F)



RmRelHum (%)  
RmRelHumSp (%)



RmEnth (btu-lb)  
RmEnthSp (btu-lb)  
RmDew (°F)  
RmDewSp (°F)

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

### REVISION LOG

#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

STATUS: Version 3

DRAWN BY: Mike Grush

JOB NUMBER: 200762-001

REV. DATE: **04/17**

SHEET TITLE & NUMBER:

**14** of **34**

ZONE

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.

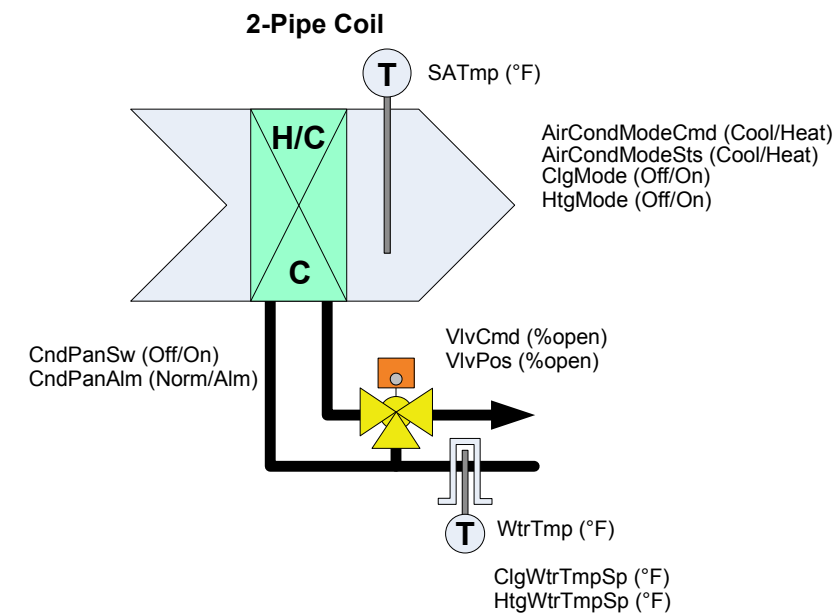
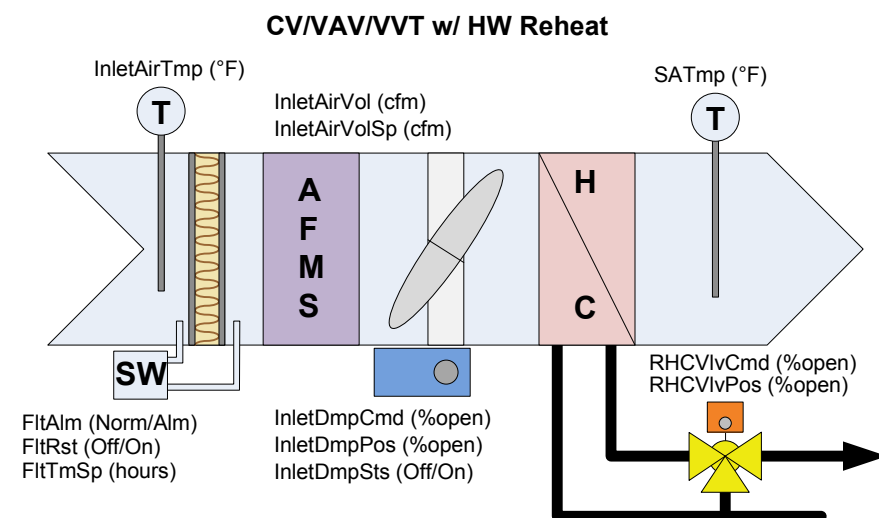
**CONTENTS**

**REVISION LOG**

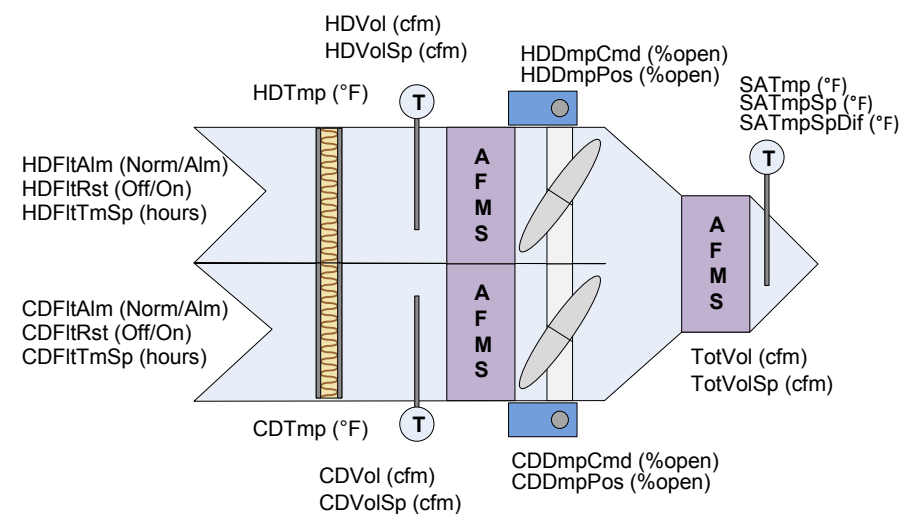
#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

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

SHEET TITLE & NUMBER:

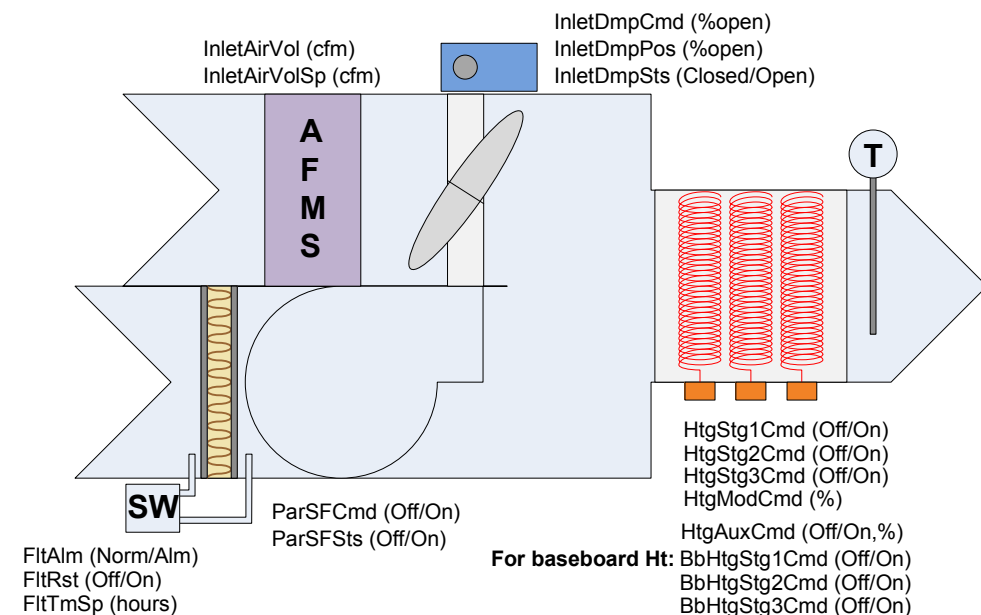


**Dual-Duct Terminal Unit**

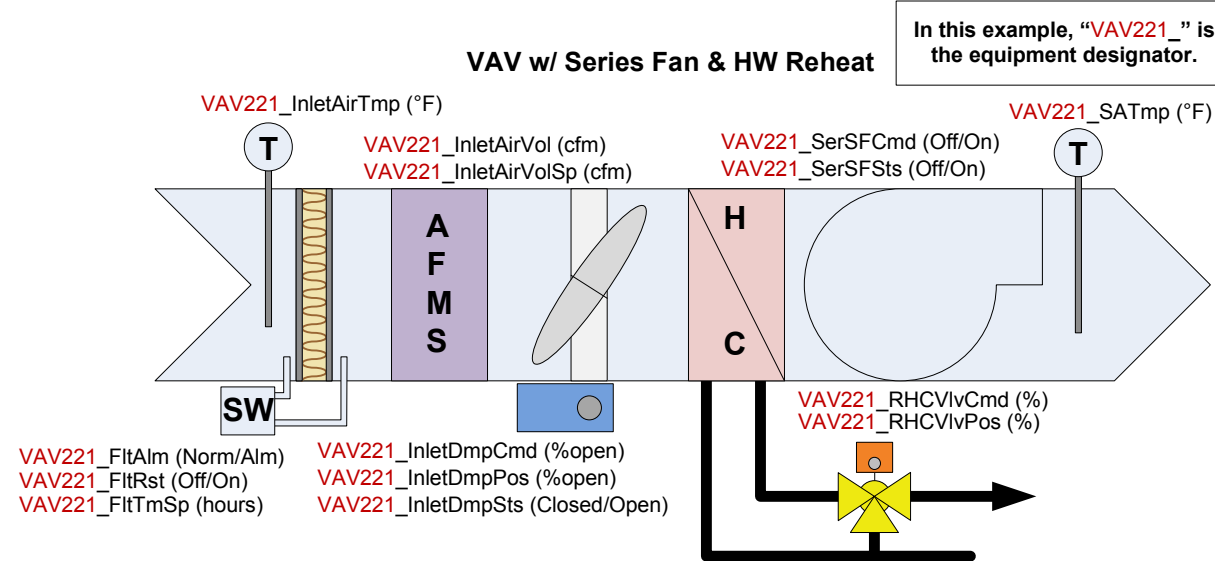


Diagrams depict generic equipment containing control points and objects, some of which may or may not be present or required for a particular piece of equipment or in a particular application.

**VAV w/ Parallel Fan & Electric Reheat**

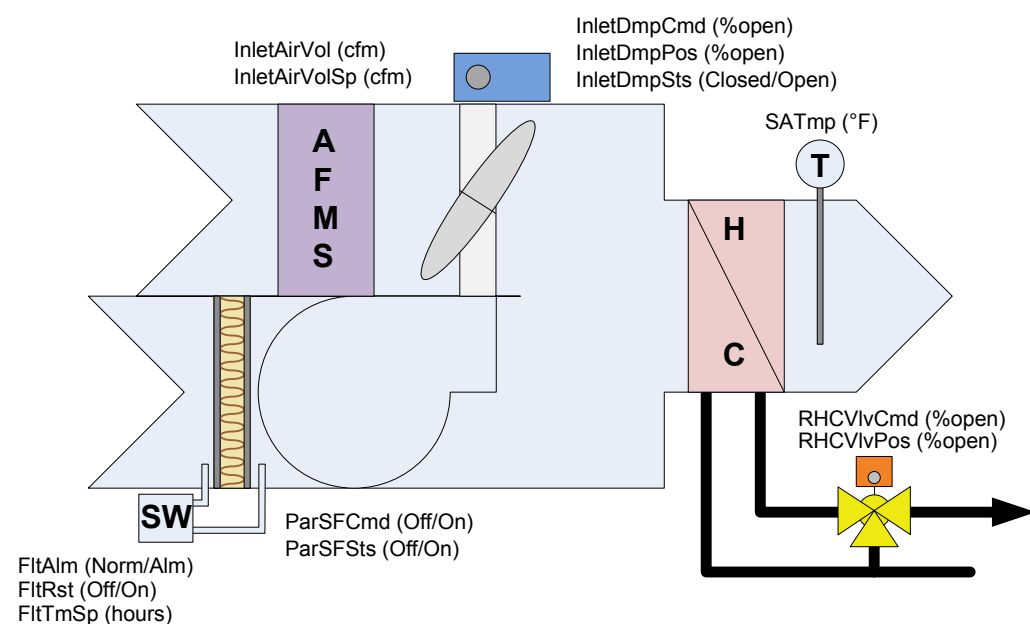


**VAV w/ Series Fan & HW Reheat**

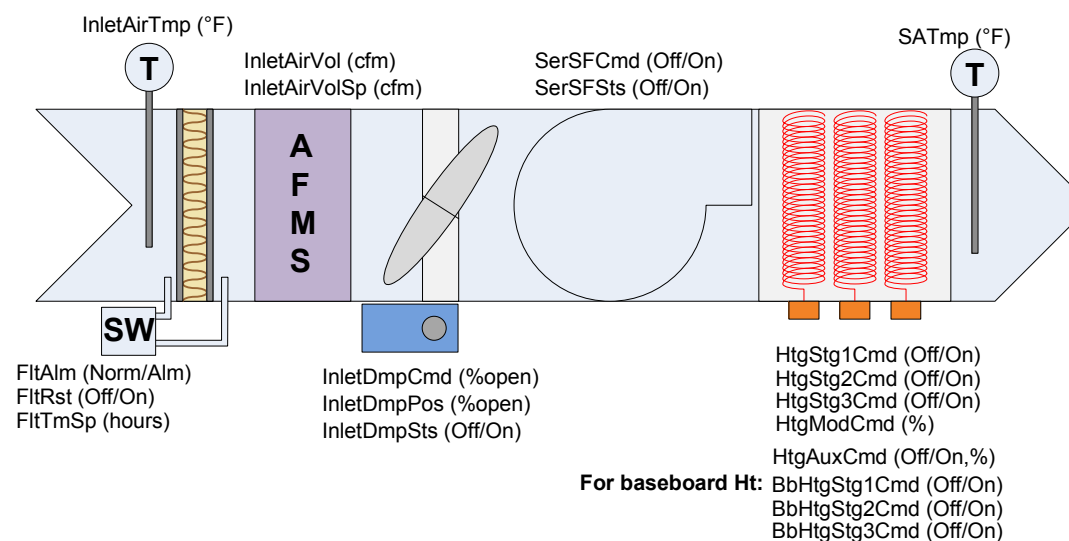


In this example, "VAV221\_" is the equipment designator.

**VAV w/ Parallel Fan & HW Reheat**



**VAV w/ Series Fan & Electric Reheat**



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.

**REVISION LOG**

#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

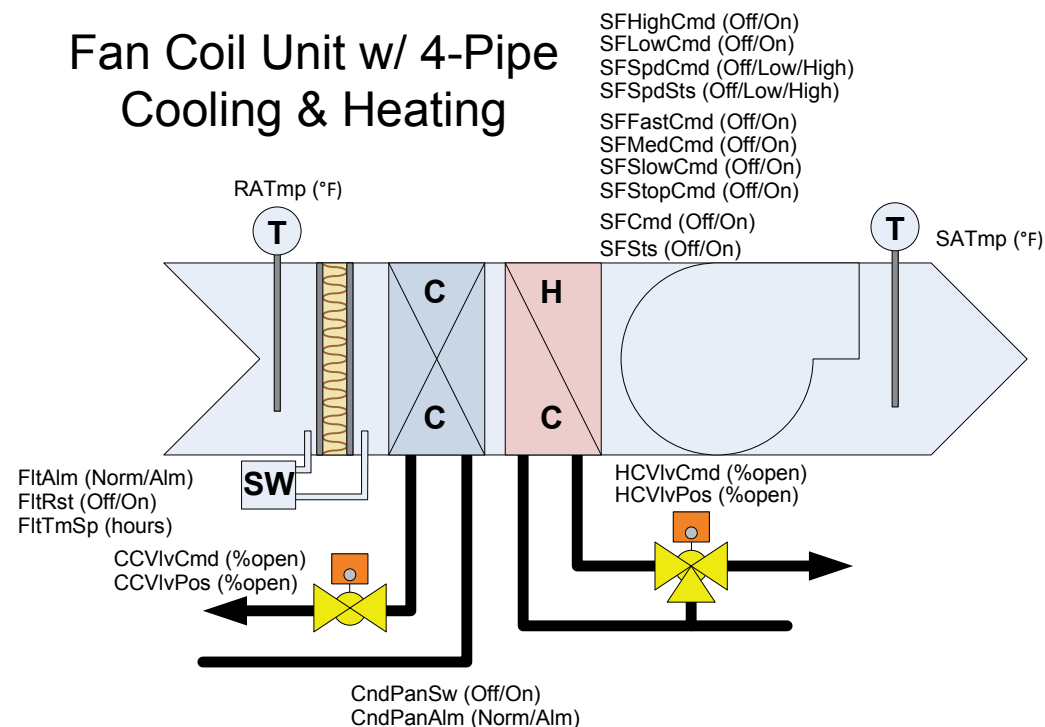
STATUS: Version 3  
 DRAWN BY: Mike Grush  
 JOB NUMBER: 200762-001  
 REV. DATE: 04/17

SHEET TITLE & NUMBER:

## Fan Coil Unit Control Setpoints

OccCmd (Occ/Uoc)	<b>T</b>	RmTmp (°F)	AirCondModeCmd (Cool/Heat)
UocOvrCmd (Uoc/Ovr)		RmTmpSp (°F)	AirCondModeSts (Cool/Heat)
OvrTimeSp (hours)			ClgModeSts (Off/On)
OccRmTmpSp (°F)	<b>RH</b>	RmRelHum (%)	HtgModeSts (Off/On)
UocRmTmpSp (°F)		RmRelHumSp (%)	StbyModeSts (Off/On)
		RmEnth (btu-lb)	
EffRmTmp (°F)		RmEnthSp (btu-lb)	
EffRmTmpSp (°F)		RmDew (°F)	
OccClgSp (°F)		RmDewSp (°F)	
UocClgSp (°F)			
UocHtgSp (°F)	<b>IAQ</b>	RmCO2 (ppm)	
StbyClgSp (°F)		RmCO2Sp (ppm)	
StbyHtgSp (°F)		RmCO2Alm (Norm/Alm)	
		RmIAQAlm (Norm/Alm)	
UsrSpAdjEna (Off/On)		RmVOC (ppm)	
UsrSpAdjRng (°F)		RmVOCSp (ppm)	
UsrSpAdjHL (°F)		RmVOCAlm (Norm/Alm)	
UsrSpAdjLL (°F)			
UsrSpAdj (°F)			
EffUsrSp (°F)			
OccSnsrSts (Off/On)			

## Fan Coil Unit w/ 4-Pipe Cooling & Heating



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.

### REVISION LOG

#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

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

SHEET TITLE & NUMBER:

**General Objects**  
UnitStartCmd (Off/On)  
SysSts (varies)  
SysOpState (varies)  
AutoMode (Manual/Auto)  
Shtdn (Off/On)  
Stby (Off/On)  
SATmp (°F)  
RATmp (°F)  
OATmp (°F)  
ZnTmp (°F)  
SARelHum (%)  
RARelHum (%)  
OARelHum (%)  
ZnRelHum (%)  
SADew (°F)  
RADew (°F)  
OADew (°F)  
ZnDew (°F)  
CHWSTmp (°F)  
CHWRTmp (°F)  
CWSTmp (°F)  
CWRTmp (°F)  
CHWFlwSw (Off/On)  
CWFlwSw (Off/On)  
CHWFlwRat (gpm)  
CWFlwRat (gpm)  
FanSts (Off/On)  
CCVlvPos (%)  
CWVlvPos (%)  
CmpSts (Off/On)  
PmpSts (Off/On)  
CMode (Off/On)  
HtMode (Off/On)  
DehumMode (Off/On)  
HumMode (Off/On)  
EconMode (Off/On)  
ActCapPct (%)  
ZnEnth (btu-lb)  
SAEnth (btu-lb)  
RAEnth (btu-lb)  
OAEth (btu-lb)

**Description**  
Unit On/Off Command  
System Status  
System Operating State  
System Operating State  
Unit Shutdown  
Unit Standby  
Supply Air Temperature  
Return Air Temperature  
Outside Air Temperature  
Zone Air Temperature  
Supply Air Relative Humidity  
Return Air Relative Humidity  
Outside Air Relative Humidity  
Zone Relative Humidity  
Supply Air Dew Point Temperature  
Return Air Dew Point Temperature  
Outside Air Dew Point Temperature  
Zone Air Dew Point Temperature  
Chilled Water Supply Temperature  
Chilled Water Return Temperature  
Condenser Water Supply Temperature  
Condenser Water Return Temperature  
Chilled Water Flow Switch  
Condenser Water Flow Switch  
Chilled Water Flow Rate  
Condenser Water Flow Rate  
Fan Status  
Chilled Water Valve Position  
Condenser Water Valve Position  
Compressor Status  
Pump Status  
Cooling Mode  
Heating Mode  
Dehumidification Mode  
Humidification Mode  
Economizer Mode  
Active Capacity Percentage  
Zone Enthalpy  
Supply Air Enthalpy  
Return Air Enthalpy  
Outside Air Enthalpy

**Faults**  
GeneralFlt (Off/On)  
CHWVFlt (Off/On)  
PwrFlt (Off/On)  
TmpFlt (Off/On)  
AirFlwFlt (Off/On)  
SATmpFlt (Off/On)  
RATmpFlt (Off/On)  
ZnTmpFlt (Off/On)  
OATmpFlt (Off/On)  
RARelHumFlt (Off/On)  
FanFlt (Off/On)  
CmpFlt (Off/On)  
FireAlm (Norm/Alm)  
ExtDmpPosFlt (Off/On)  
WtrLeakFlt (Off/On)

**Warnings**  
MaintDue (Off/On)  
ServiceReq (Off/On)  
SATmpHi (Off/On)  
SATmpLo (Off/On)  
RATmpHi (Off/On)  
RATmpLo (Off/On)  
ZnTmpHi (Off/On)  
ZnTmpLo (Off/On)  
RADewHi (Off/On)  
RADewLo (Off/On)  
RARelHumHi (Off/On)  
RARelHumLo (Off/On)  
ZnDewHi (Off/On)  
ZnDewLo (Off/On)  
ZnRelHumHi (Off/On)  
ZnRelHumLo (Off/On)  
CHWSTmpHi (Off/On)  
ExtTmpHi (Off/On)  
WtrUdrFirFlt (Off/On)  
SmokeAlm (Norm/Alm)  
FitAlm (Norm/Alm)  
HeadPrsHiAlm (Norm/Alm)

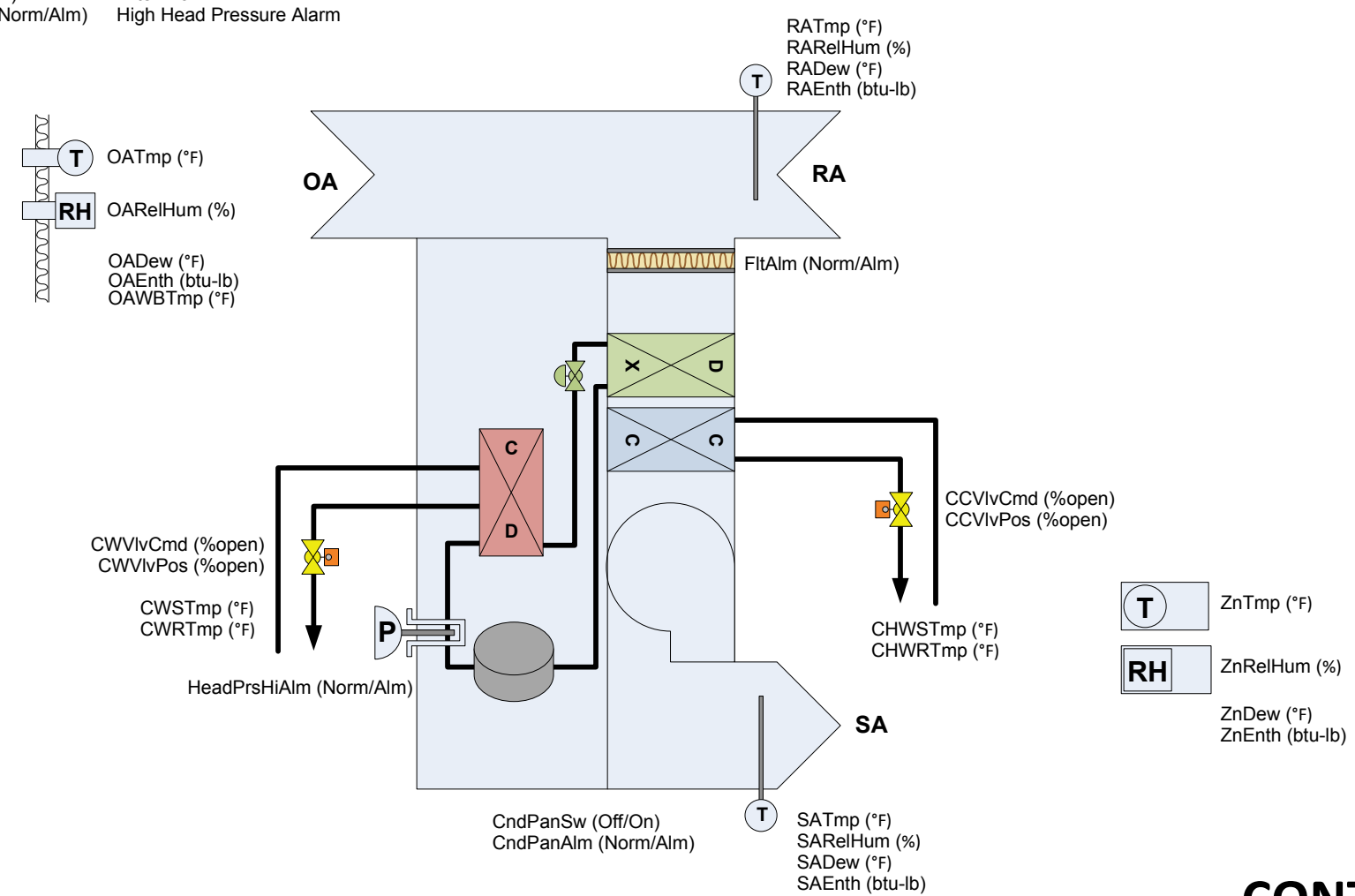
**Description**  
General Fault  
Chilled Water Control Valve Failure  
Ext Power Source Failure  
Temperature Control Sensor Issue  
Airflow Sensor Issue  
Supply Air Sensor Issue  
Return Air Sensor Issue  
Ext Air Sensor Issue  
Outside Air Sensor Issue  
Return Air Relative Humidity Sensor Issue  
Fan Failure  
Compressor Failure  
External Fire Alarm Contacts  
External Air Damper Position Issue  
Water Leakage Detector Sensor Issue

**Description**  
Maintenance Due  
Service Required  
Supply Air Over Temperature  
Supply Air Under Temperature  
Return Air Over Temperature  
Return Air Under Temperature  
Ext Air Sensor Over Temperature  
Ext Air Sensor Under Temperature  
Return Air Dew Point High  
Return Air Dew Point High  
Return Air Relative Humidity High  
Return Air Relative Humidity Low  
Zone Dew Point High  
Zone Dew Point Low  
Zone Relative Humidity High  
Zone Relative Humidity Low  
Supply Chilled Water Over Temp  
Ext Over Temperature  
Water Under Floor  
Smoke Alarm  
Filter Alarm  
High Head Pressure Alarm

**Set Points**  
ZnTmpSp (°F)  
ZnDewSp (°F)  
ZnRelHumSp (%)  
ZnEnthSp (btu-lb)

**Description**  
Zone Temperature Set Point  
Zone Dew Point Temperature Set Point  
Zone Relative Humidity Set Point  
Zone Enthalpy Set Point

**CRAC Unit**



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.

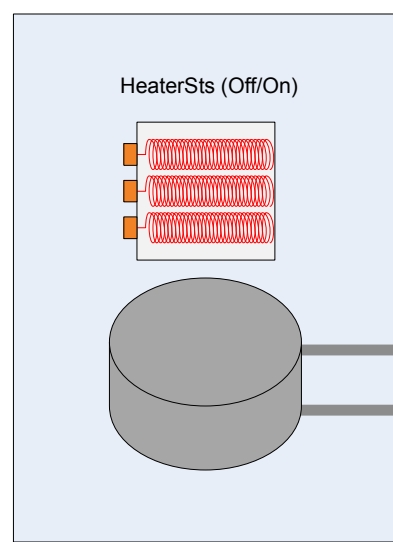
REVISION LOG		
#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

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

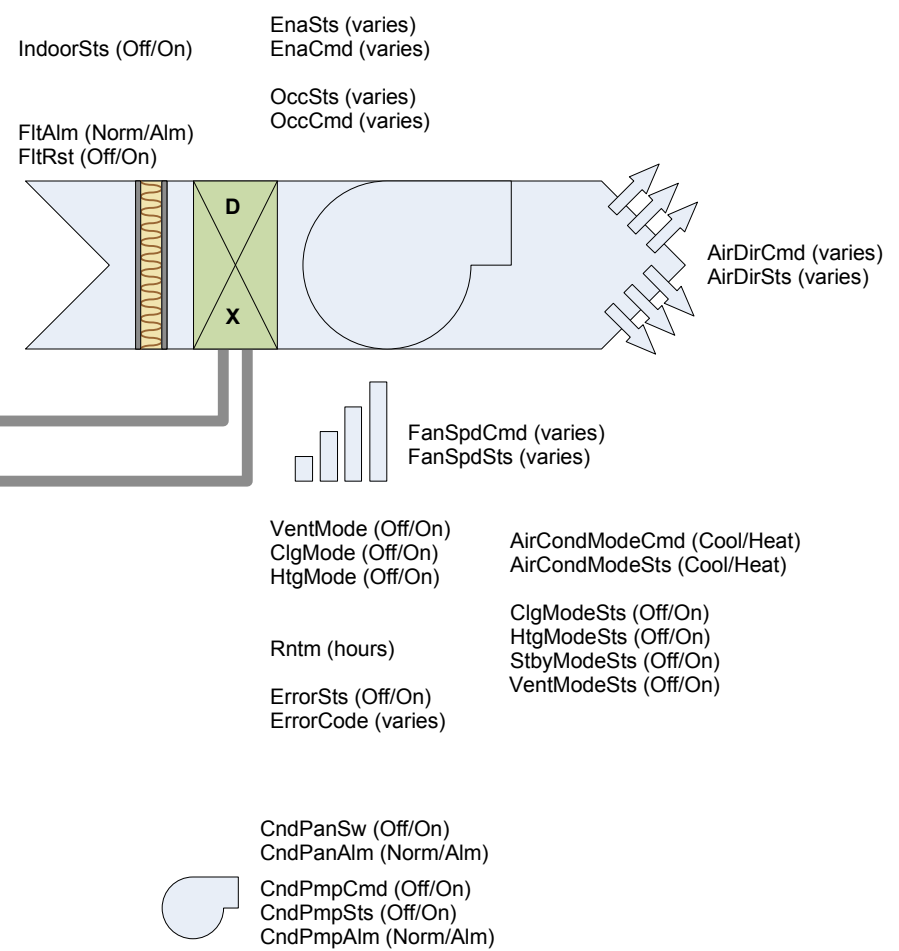
SHEET TITLE & NUMBER:  
18 of 34

CRAC

**VRV Outdoor Unit**



**VRV Indoor Unit**



- T** RmTmp (°F)
- RmTmpSp (°F)
- RmTmpDualSp (Off/On)
- OccClgSp (°F)
- OccHtgSp (°F)
- OpModeSts (varies)
- OpModeCmd (varies)

**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.**

**REVISION LOG**

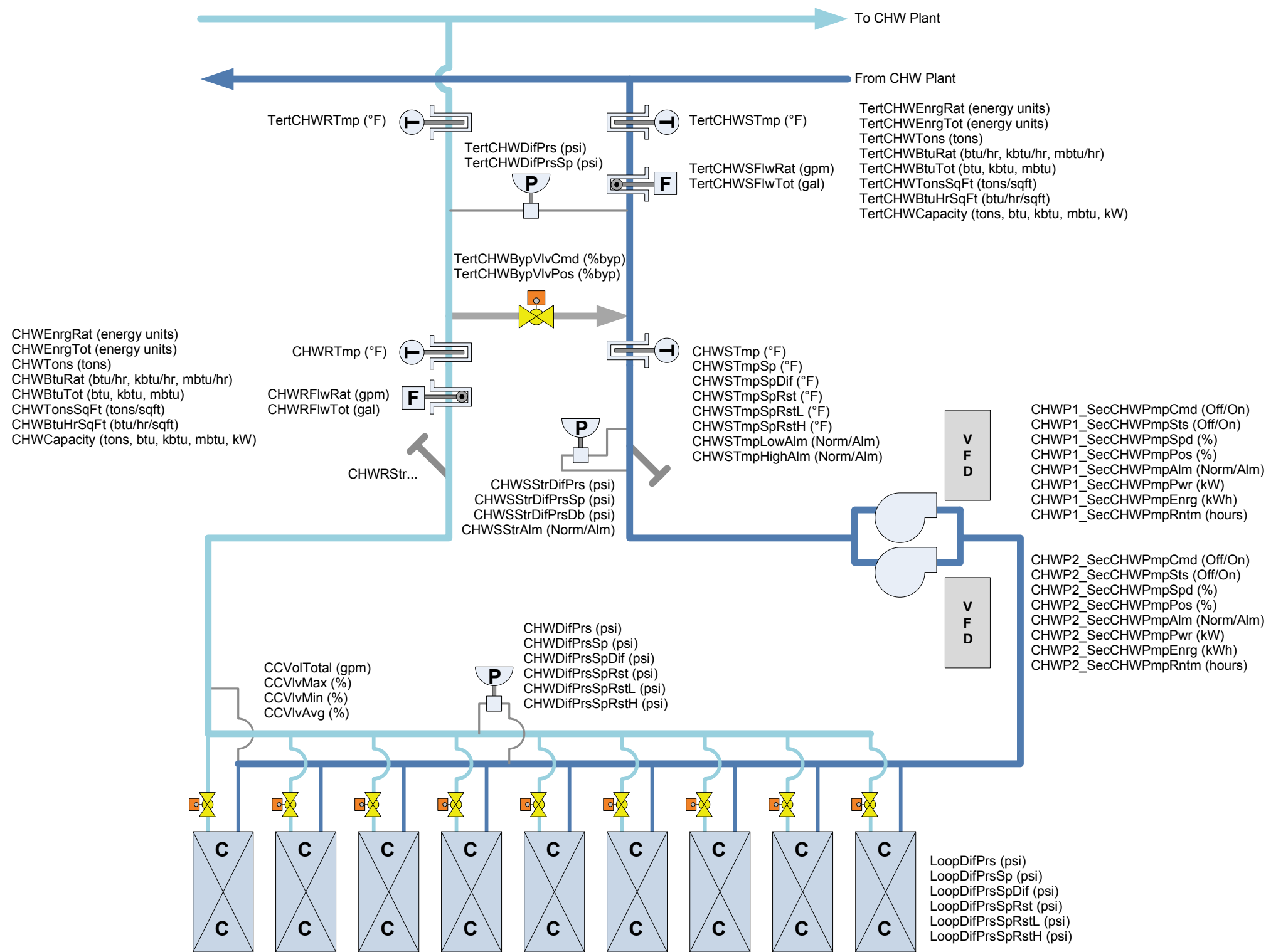
#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

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

SHEET TITLE & NUMBER:  
 19 of 34

VRV

### Tertiary CHW



See other CHW pages for additional CHW points.

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.

REVISION LOG		
#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

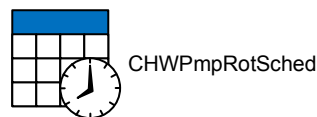
STATUS: Version 3  
 DRAWN BY: Mike Grush  
 JOB NUMBER: 200762-001  
 REV. DATE: 04/17

SHEET TITLE & NUMBER:  
 CHW TER 20 of 34



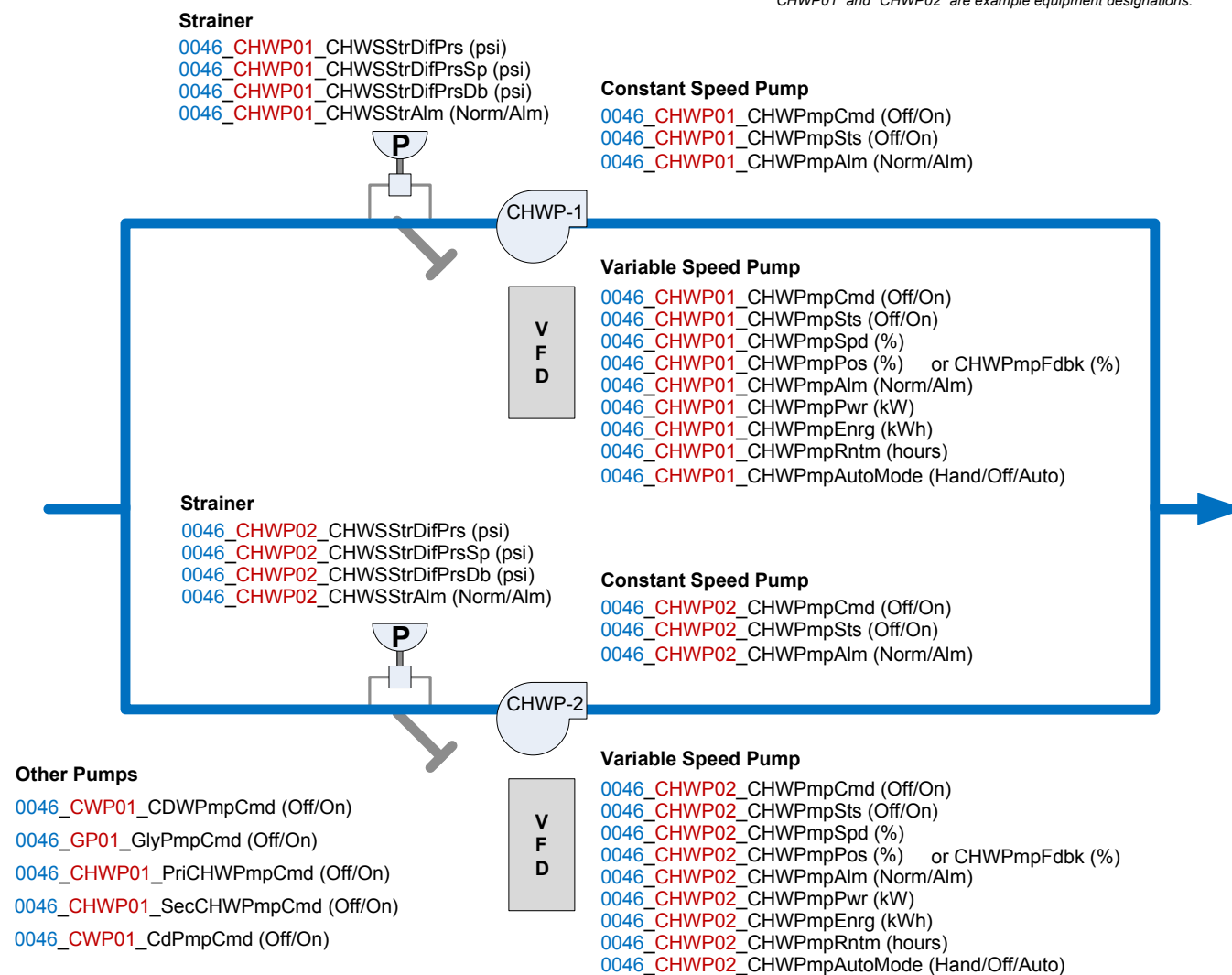
## Pump Control Objects

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



## Pump Objects Example

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



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.

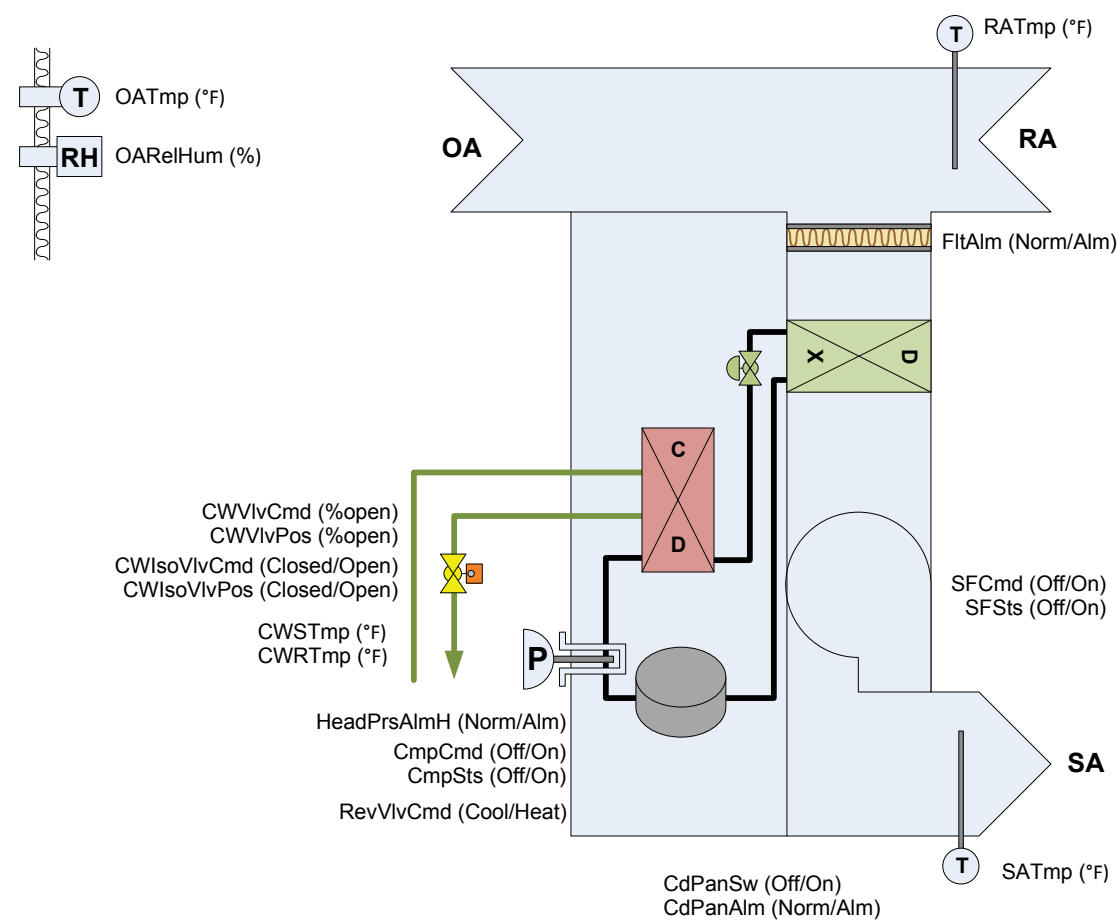
REVISION LOG		
#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

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

SHEET TITLE & NUMBER:  
 PMP 21 of 34

## Water Source Heat Pump

## Room Control Setpoints



- OccCmd (Occ/Uoc)
- UocOvrCmd (Uoc/Ovr)
- OvrTimeSp (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)

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.

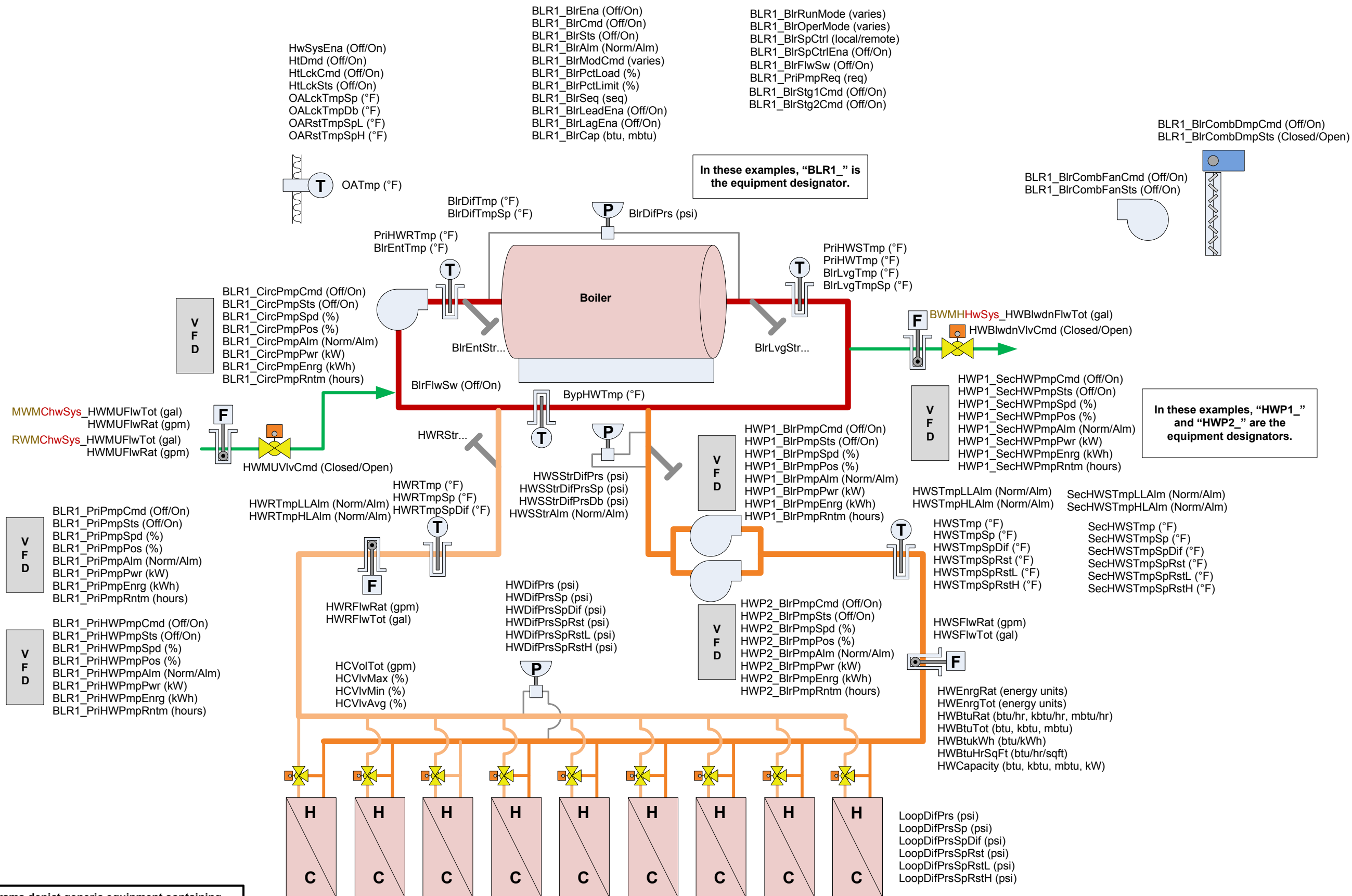
REVISION LOG		
#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

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

SHEET TITLE & NUMBER:

22 of 34

WSHP

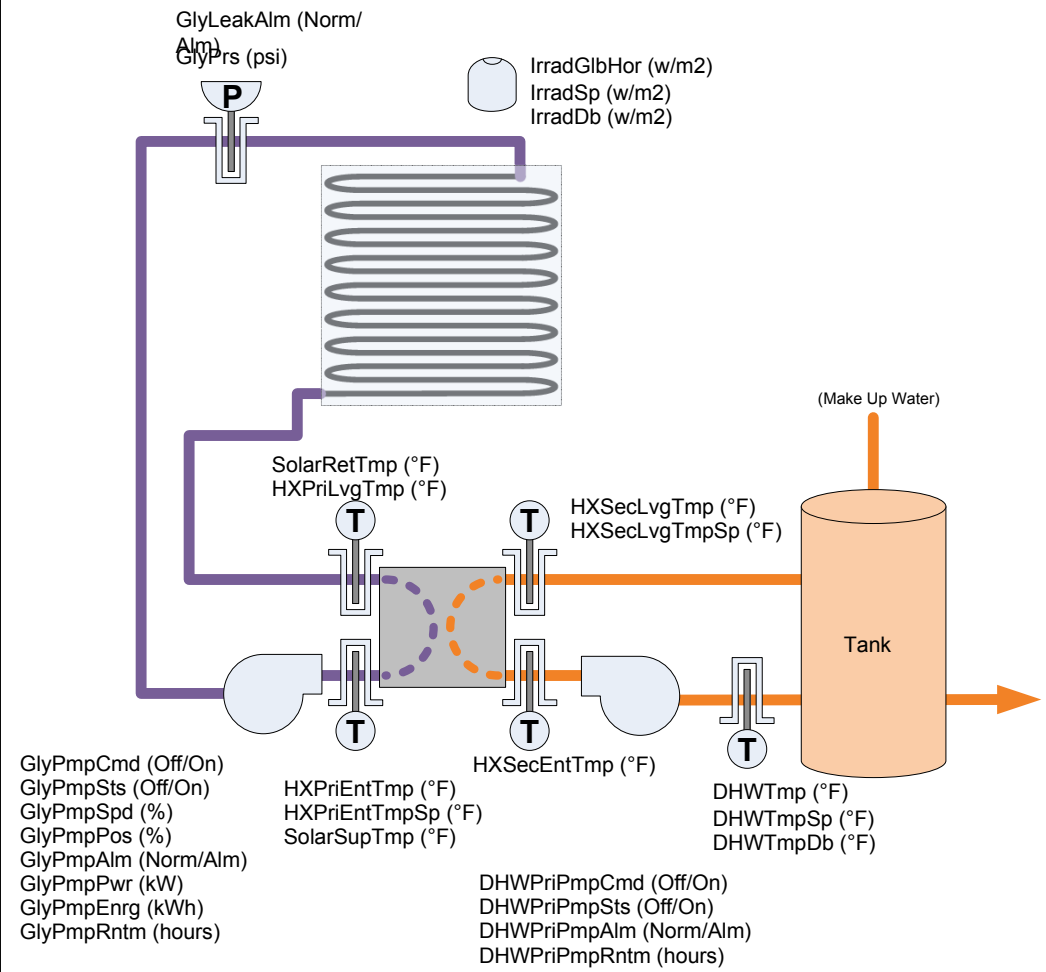


Diagrams depict generic equipment containing control points and objects, some of which may or may not be present or required for a particular piece of equipment or in a particular application.

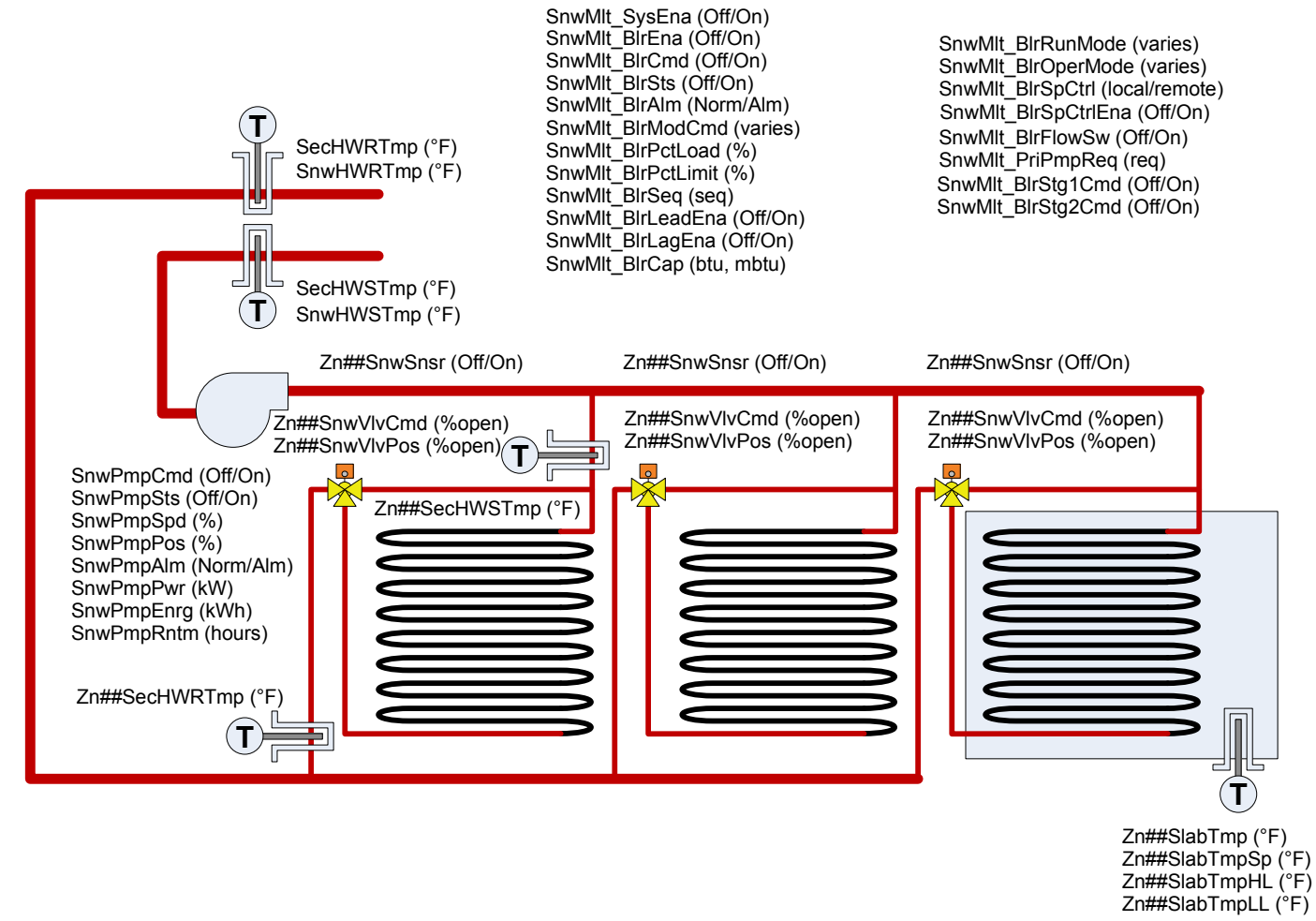
REVISION LOG		
#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

STATUS: Version 3  
 DRAWN BY: Mike Grush  
 JOB NUMBER: 200762-001  
 REV. DATE: 04/17  
 SHEET TITLE & NUMBER: 23 of 34

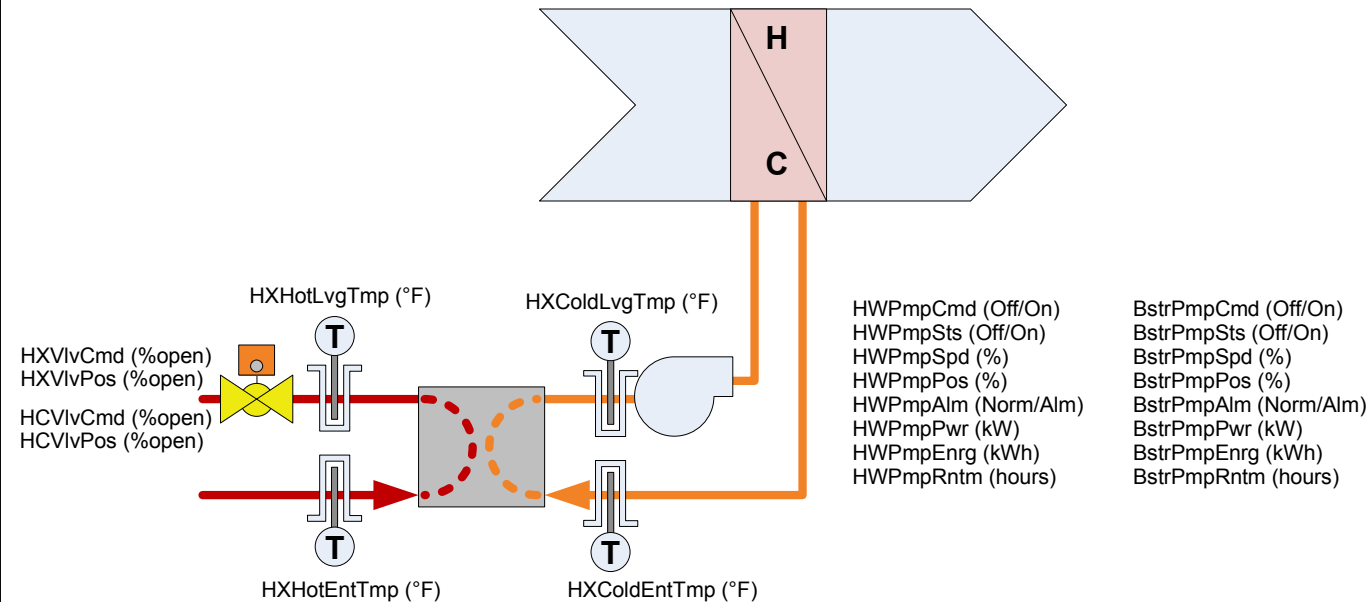
### Solar Thermal Hot Water



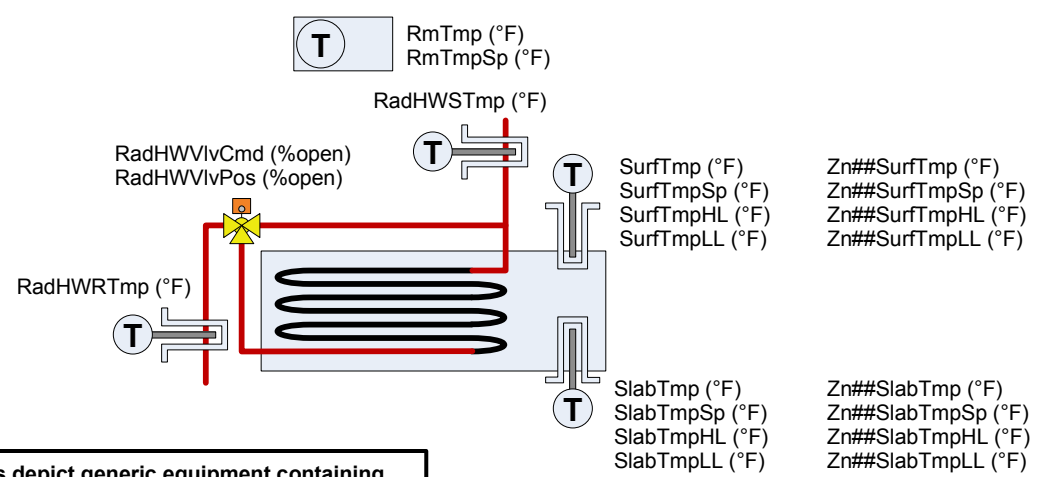
### Snow Melt System



### HW HX & Booster Pump



### Radiant Floor Heat

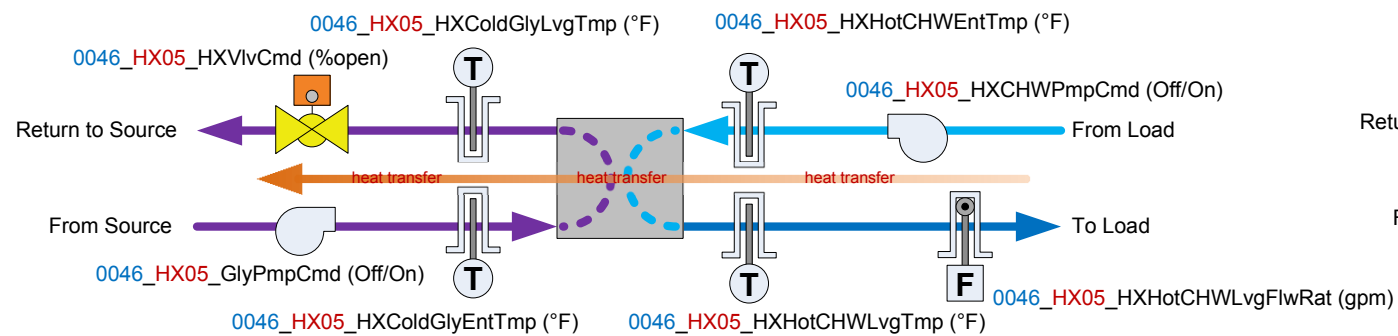


Diagrams depict generic equipment containing control points and objects, some of which may or may not be present or required for a particular piece of equipment or in a particular application.

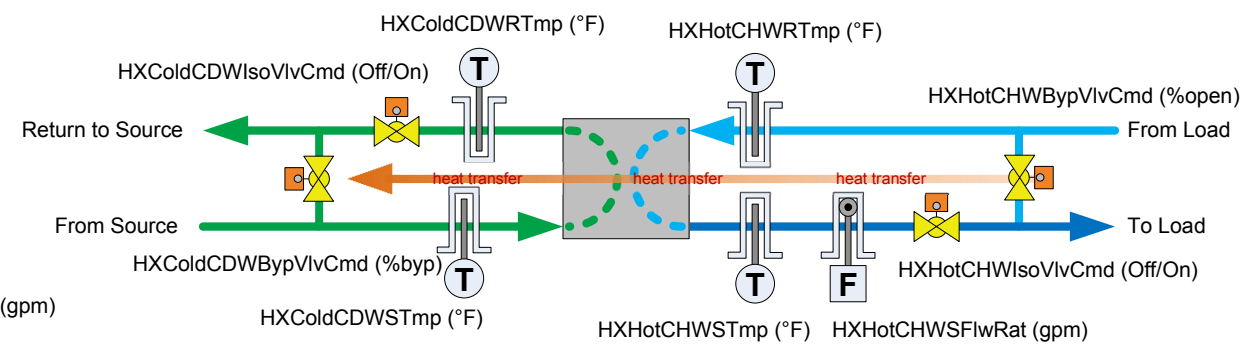
REVISION LOG		
#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

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

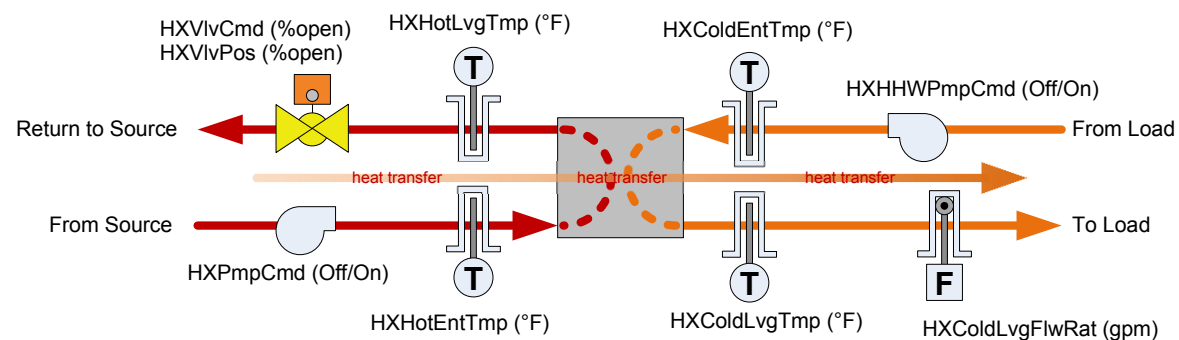
**Glycol Cooling Application**



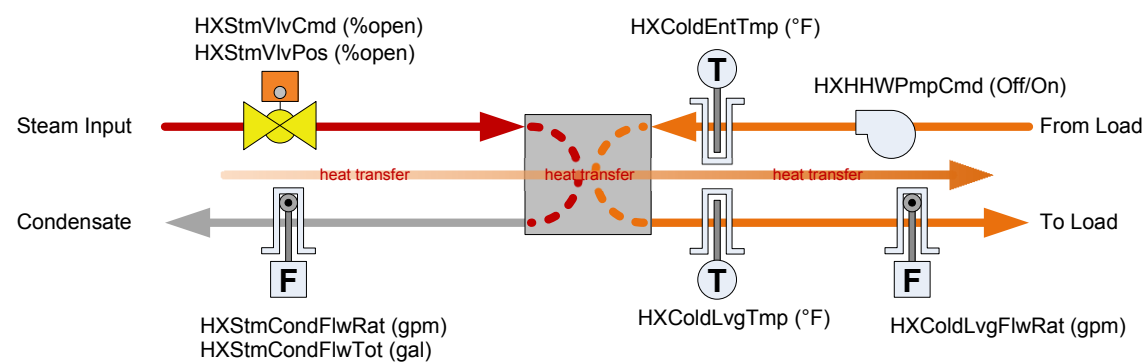
**Free-Cooling Condenser Water Application**



**Hot Water Heating Application**



**Steam/Hot Water Heating Application**



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.

**REVISION LOG**

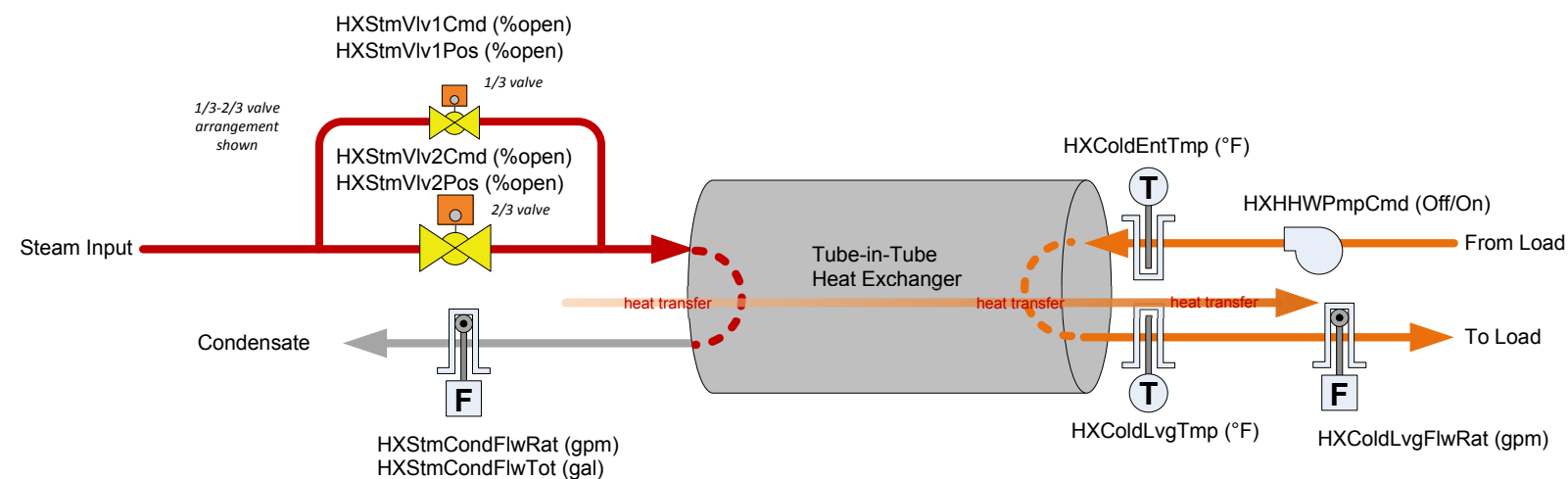
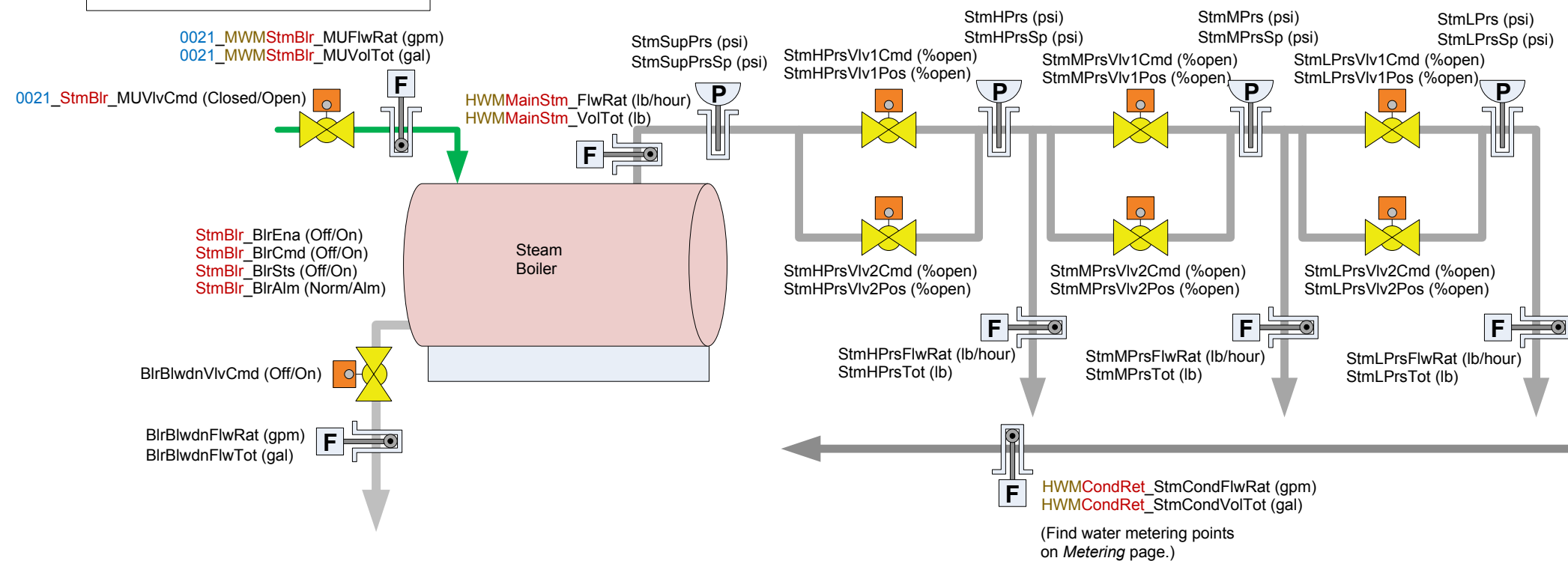
#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

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

SHEET TITLE & NUMBER:

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

**Steam Reduction Station**



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.

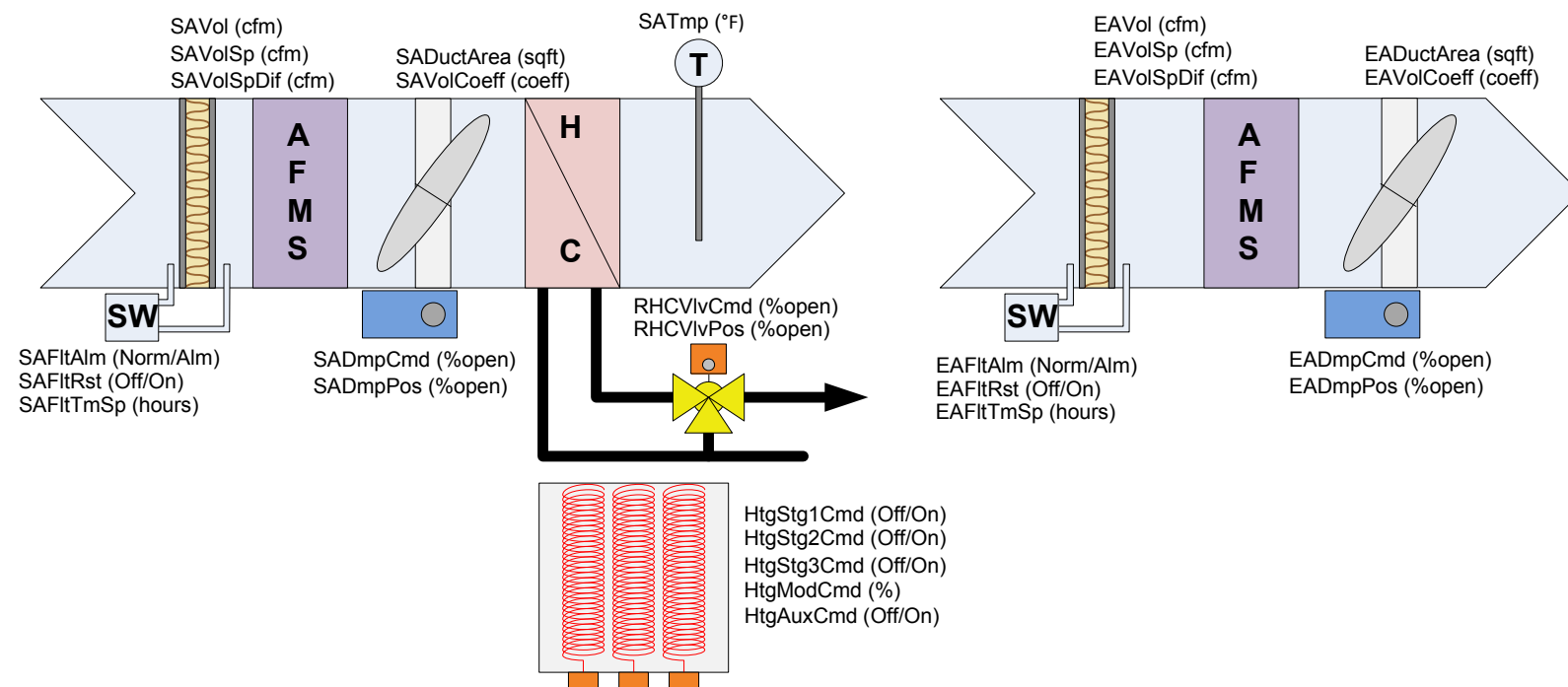
**REVISION LOG**

#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

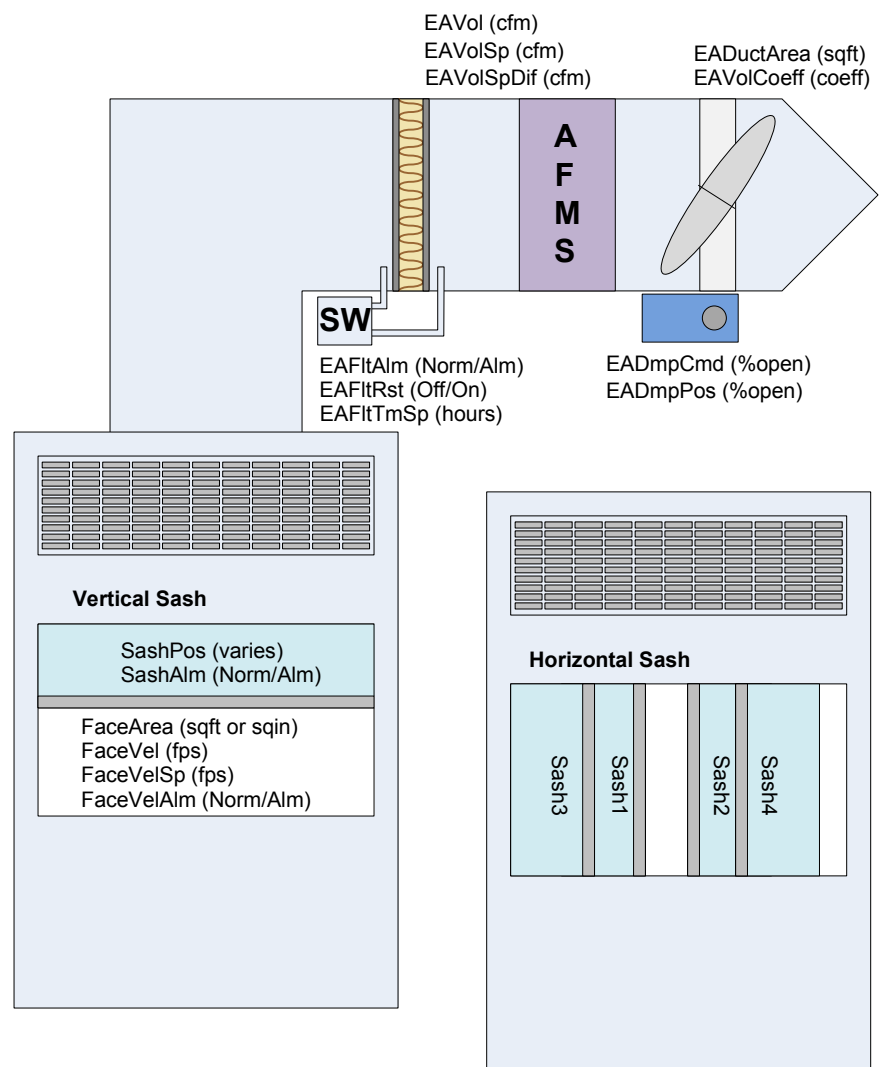
STATUS: Version 3  
DRAWN BY: Mike Grush  
JOB NUMBER: 200762-001  
REV. DATE: 04/17

SHEET TITLE & NUMBER:

### 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)
- 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)

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.

REVISION LOG		
#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

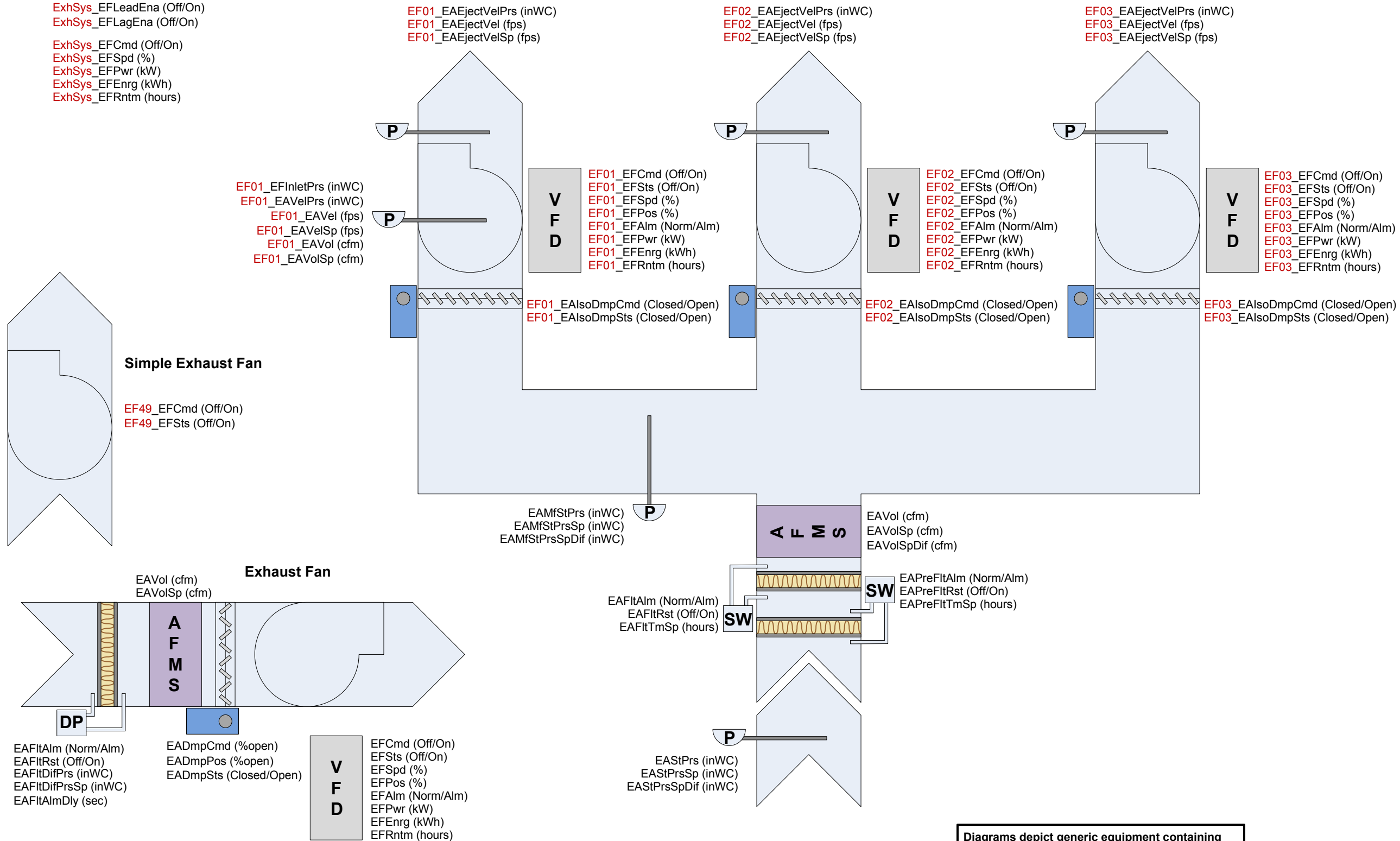
STATUS: Version 3  
 DRAWN BY: Mike Grush  
 JOB NUMBER: 200762-001  
 REV. DATE: 04/17  
 SHEET TITLE & NUMBER:  
 27 of 34

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



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.

REVISION LOG		
#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

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

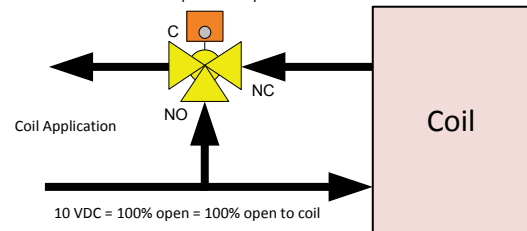
SHEET TITLE & NUMBER:  
EXH 28 of 34



**Normally Closed HW Valve**

HCVlvCmd (%open)  
HCVlvPos (%open)

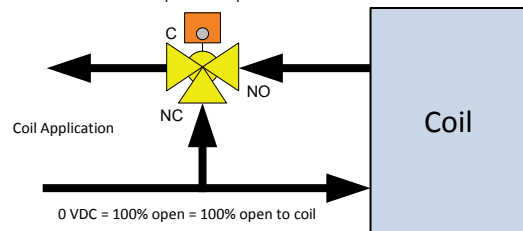
0 VDC = 0% open = 0% open to coil



**Normally Open CHW Valve**

CCVlvCmd (%open)  
CCVlvPos (%open)

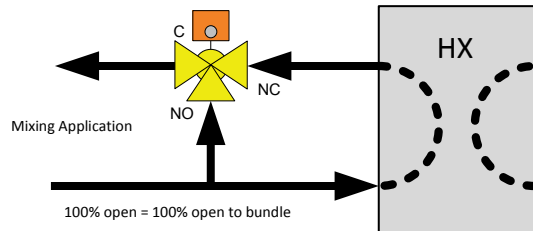
10 VDC = 0% open = 0% open to coil



**Normally Closed Mixing Valve**

CHWVlvCmd (%open)  
CHWVlvPos (%open)

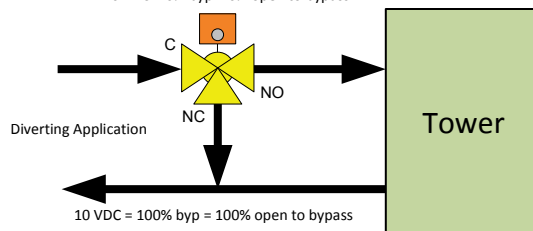
0% open = 0% open to bundle



**Normally Open Diverting Valve**

CTDivVlvCmd (%byp)  
CTDivVlvPos (%byp)

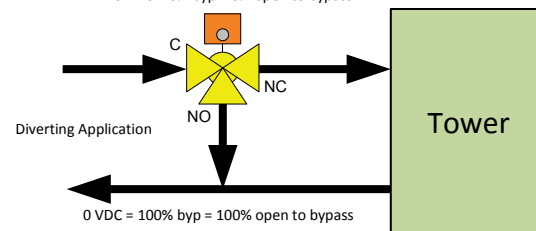
0 VDC = 0% byp = 0% open to bypass



**Normally Bypassing Diverting Valve**

CTDivVlvCmd (%byp)  
CTDivVlvPos (%byp)

10 VDC = 0% byp = 0% open to bypass



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.

**REVISION LOG**

#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

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

SHEET TITLE & NUMBER:

## 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)

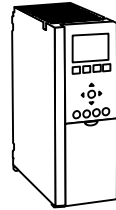
### Regenerative VFD Objects

- 0046\_CDWP01\_CDWPmpBrakeSts (Off/On)
- 0046\_CDWP01\_CDWPmpRegenSts (Off/On)
- 0046\_CDWP01\_CDWPmpRegenPos (%) or CDWPmpRegenFdbk (%)
- 0046\_CDWP01\_CDWPmpRegenFit (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 = VFDRf1Spd (%) or VFDSpd (%)
- AV02 = VFDRf2Spd (%)
- BV25 = VFDDirCmd (CW/CCW)

### Basic Feedback

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

### Fault Feedback

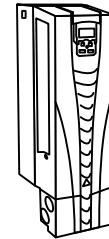
- BV05 = VFDFltSts (OK/Fault)
- BV03 = VFDFltRst (Off/On)
- AV51 = VFDFltLast (fault code)
- BV21 = VFDWarnSts (OK/Fault)
- BV22 = VFDTripSts (OK/Fault)

### Other Parameters

- BV02 = VFDRfSelCmd (REF1/REF2)
- AV01 = VFDRf1Pos (%)
- AV02 = VFDRf2Pos (%)
- BV27 = VFDRst (Off/On)
- BV31 = VFDAtp (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 (%)



## 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 = VFDRf1Spd (%) or VFDSpd (%)
- AV17 = VFDRf2Spd (%)
- BV11 = VFDDirCmd (Fwd/Rev)

### Basic Feedback

- BV00 = VFDSts (Stop/Run)
- AV00 = VFDPs (%)
- AV01 = VFDFreq (Hz)
- AV05 = VFDTorq (lb-ft)
- AV02 = VFDVltDC (VDC)
- AV03 = VFDDirCmd (CW/CCW)
- AV04 = VFDCur (Amps)
- AV06 = VFDPwr (kW)
- AV08 = VFDEnrg (kWh)
- AV09 = VFDEnrgTot (MWh)
- AV14 = VFDRnTm (hours)
- AV15 = VFDMotorTm (°C)
- AV07 = VFDDriveTm (°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 = VFDRfSelCmd (EXT1/EXT2)
- BV03 = VFDRfSelSts (EXT1/EXT2)
- BV05 = VFDAImSts (OK/Alm)
- BV06 = VFDMaintSts (OK/Maint)
- BV07 = VFDReady (Not Ready/Ready)
- BV08 = VFDAtp (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)

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.

### REVISION LOG

#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

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

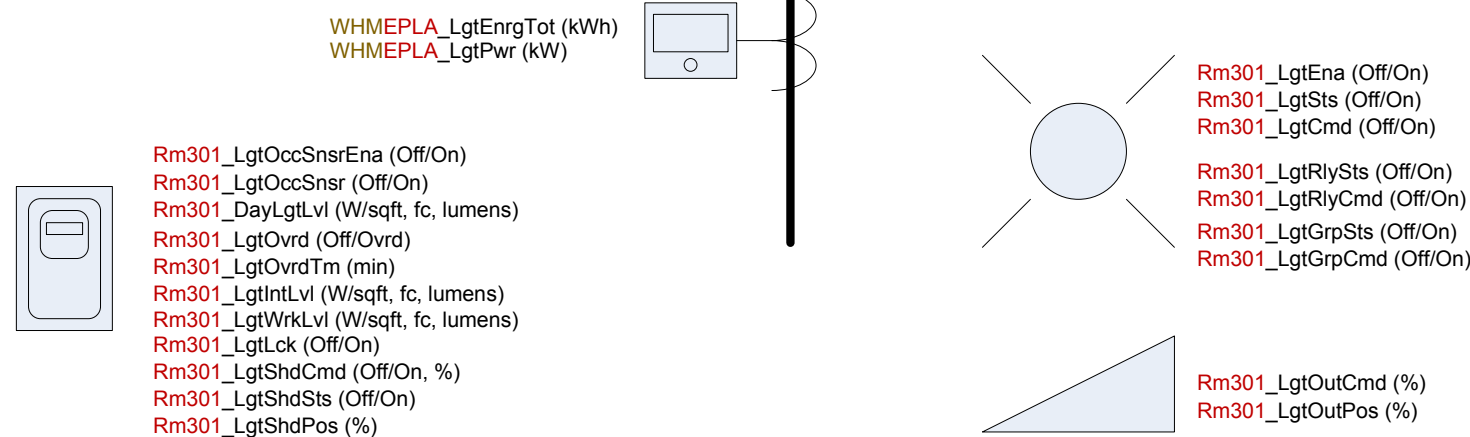
SHEET TITLE & NUMBER:

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\_LgtPnlFit (Off/On)  
 EPLA\_LgtPnlAlm (Norm/Alm)

**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



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.

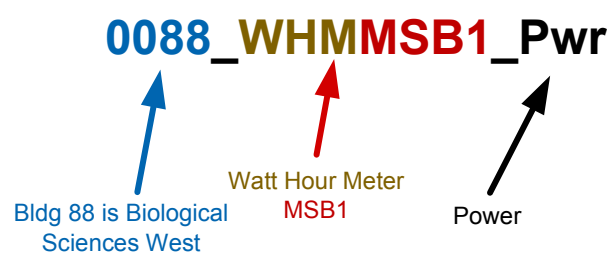
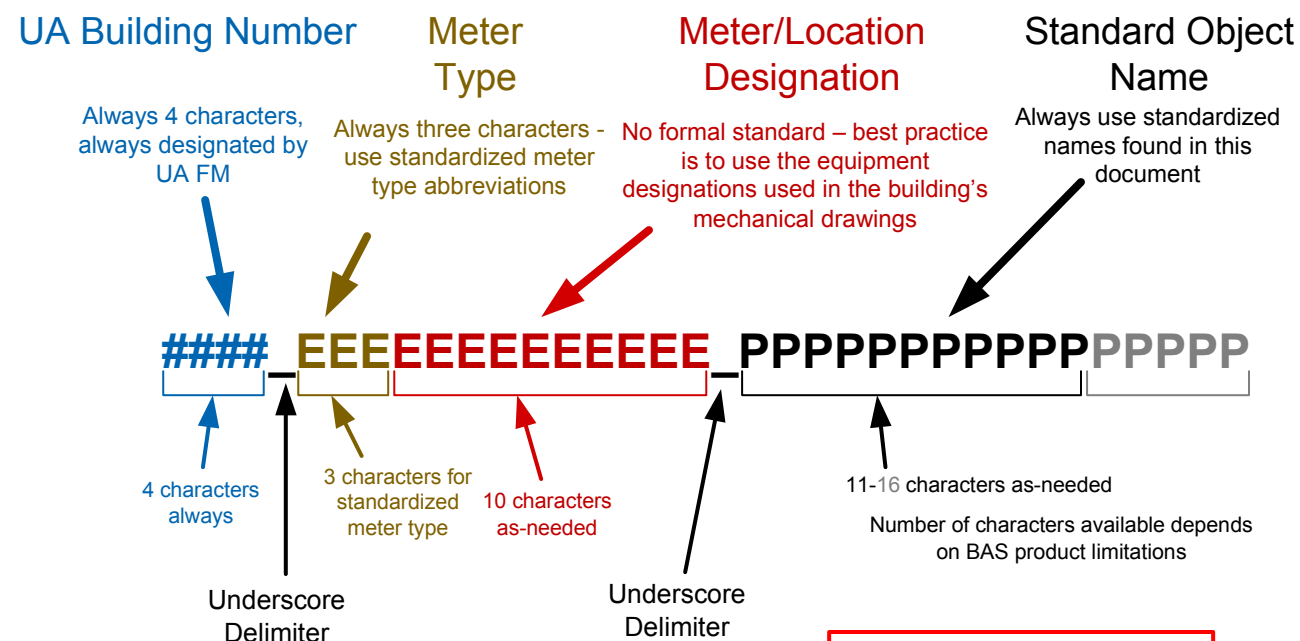
REVISION LOG		
#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

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

SHEET TITLE & NUMBER:  
 LGT 31 of 34

# Meter Object Name Anatomy

## Building\_TYPEMeter\_Object



**IMPORTANT NEVER EXCEED 35 CHARACTERS**

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.

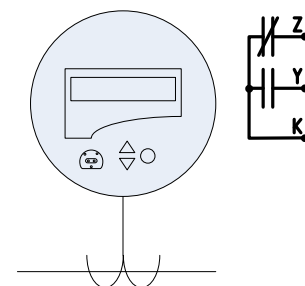
### Standard Meter Type Abbreviations

- 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

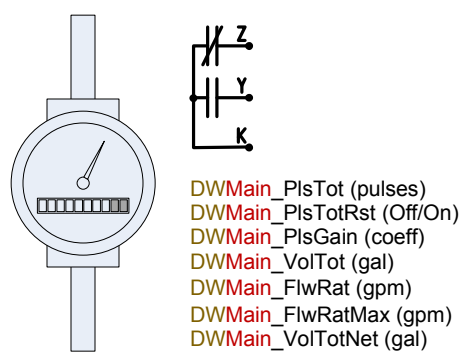
### Electric Meters



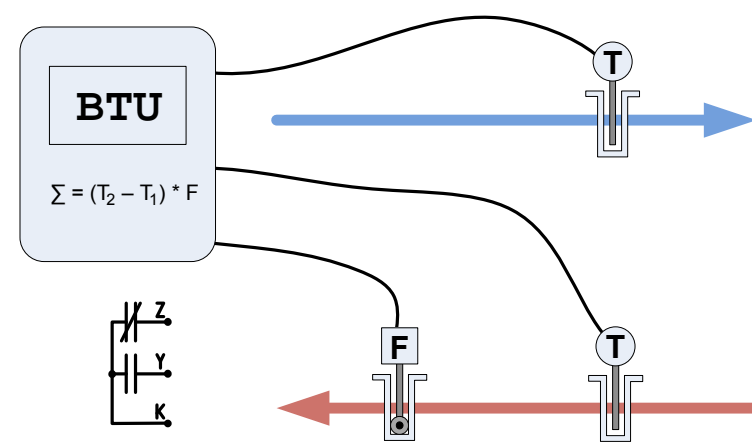
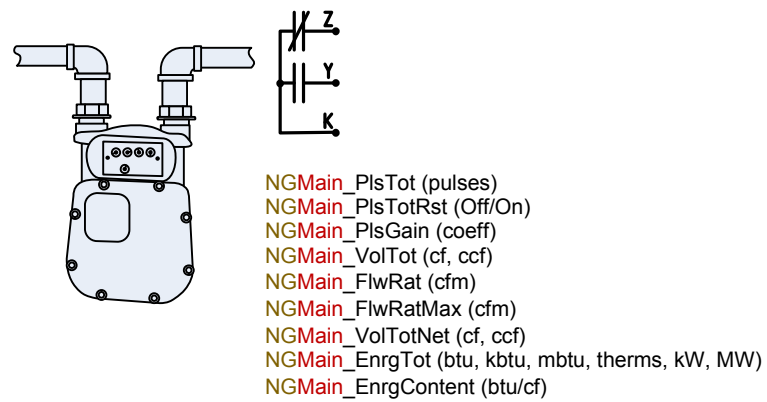
See ELEC page for additional electrical metering points.

- WHMMSB\_VitAC (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)
- WHMMSB\_VitAB (VAC)
- WHMMSB\_VitBC (VAC)
- WHMMSB\_VitCA (VAC)
- WHMMSB\_VitLLAvg (VAC)
- WHMMSB\_VitLLMin (VAC)
- WHMMSB\_VitLLMax (VAC)
- WHMMSB\_VitLLMean (VAC)
- WHMMSB\_VitAN (VAC)
- WHMMSB\_VitBN (VAC)
- WHMMSB\_VitCN (VAC)
- WHMMSB\_VitLNAvg (VAC)
- WHMMSB\_VitLNMin (VAC)
- WHMMSB\_VitLNMax (VAC)
- WHMMSB\_VitLNMean (VAC)

### Water Meters



### Gas Meters



### 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)

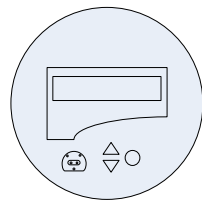
REVISION LOG		
#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

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

SHEET TITLE & NUMBER: 32 of 34

MTR

# Common Electric Smart Meter Points



**Basic Meter**

- WHM[circuit]\_VitAC (VAC)
- WHM[circuit]\_Cur (Amps)
- WHM[circuit]\_Pwr (kW)
- WHM[circuit]\_Enrg (kWh)

**DC Systems**

- WHM[circuit]\_VitDC (VDC)
- WHM[circuit]\_Cur (Amps)
- WHM[circuit]\_Pwr (kW)
- WHM[circuit]\_Enrg (kWh)

- WHM[circuit]\_VitAB (VAC)
- WHM[circuit]\_VitBC (VAC)
- WHM[circuit]\_VitCA (VAC)
- WHM[circuit]\_VitLLAvg (VAC)
- WHM[circuit]\_VitLLMin (VAC)
- WHM[circuit]\_VitLLMax (VAC)
- WHM[circuit]\_VitLLMean (VAC)
- WHM[circuit]\_VitAN (VAC)
- WHM[circuit]\_VitBN (VAC)
- WHM[circuit]\_VitCN (VAC)
- WHM[circuit]\_VitLNAvg (VAC)
- WHM[circuit]\_VitLNMin (VAC)
- WHM[circuit]\_VitLNMax (VAC)
- WHM[circuit]\_VitLNMean (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]\_VitUnbal
- WHM[circuit]\_CurUnbal
- WHM[circuit]\_PhsRev (False/True)
- WHM[circuit]\_VitPhsSeq
- 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]\_THDVItA (THD)
- WHM[circuit]\_THDVItB (THD)
- WHM[circuit]\_THDVItC (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:**

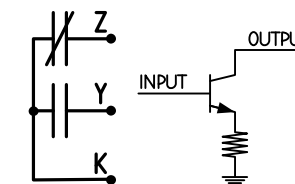
###\_TTTEEEEEE\_PPPPPPPPPPPPPPPPPPPPPPP

Where:

- ### = 4-character UA Building Number
- TTT = 3-character Standard Meter Type Abbreviations
- EEEEEEEEE = 10-character Meter Designation (variable)
- PPPPPPPPPPPPPPPPPP = 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

**Inverter**

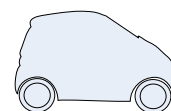
**PV System Points**

- WHMInverter01\_ModuleTmp (°F)
- WHMInverter01\_IrradPOA (W/m^2)
- WHMInverter01\_IrradGibHor (W/m^2)
- WHMInverter01\_GndFlt (Off/On)
- WHMInverter01\_Perf (%)
- WHMInverter01\_ModuleTmpCoeff (coeff)
- WHMInverter01\_InvPwrMax (kW)
- WHMInverter01\_InvPwrMax (kW)
- WHMInverter01\_Comb###Cur (Amps)
- WHMInverter01\_Comb###VIt (VDC)
- WHMInverter01\_Comb###Enrg (kWh)
- WHMInverter01\_InvSts (varies)
- WHMInverter01\_InvMode (varies)
- WHMInverter01\_DCLnkVIt (VDC)
- WHMInverter01\_DCBusVIt (VDC)
- WHMArray1\_ArrayPwrMax (kW)
- WHMArray1\_IrradPOA (W/m^2)
- WHMArray1\_IrradGibHor (W/m^2)
- WHMArray1\_Perf (%)
- WHMArray1\_ModuleTmpCoeff (coeff)

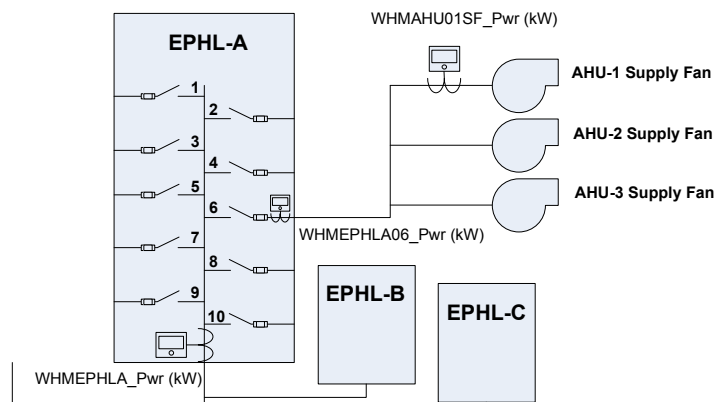
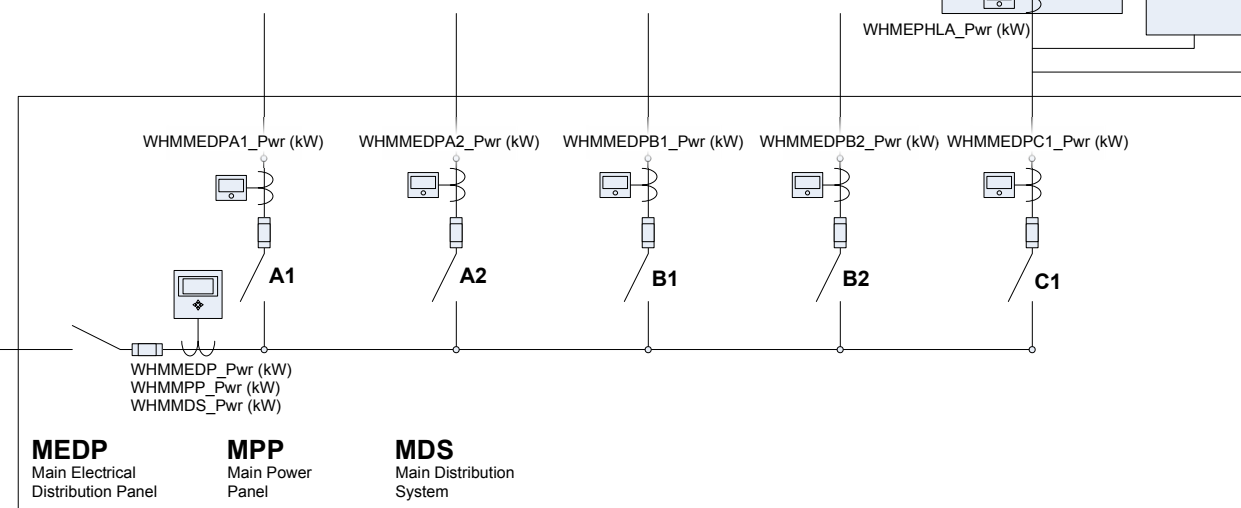
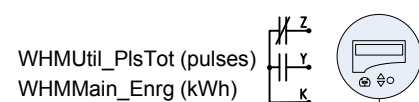
## Common Generator Points

- PwrCap (kW)
- PwrPct (%)
- BattVIt (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.

**REVISION LOG**

#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

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

SHEET TITLE & NUMBER:

## Devices

**Device Names**

0046_ChwSys_SC4	0240_AHU01_CDCltr
0046_ChwSys_UC60012	0240_AHU01_HDCtlr
0046_CHL01_UC800	0240_AHU01_SF1AVFD
0046_GP04_VFD	0240_AHU01_SF1BVFD
0174_ChwSys_SC5	0119_AHU04_GCM05
0174_ChwSys_UC60021	0119_AHU04_VFD
0174_CHL06A_UC800	0119_AHU04_AFMS
0174_CT1C1F_VFD	0119_RmS110_JACE7AX
0205_ChwSys_SC1	0119_LGT_Zn01
0205_ChwSys_UC6001	
0205_CHL01_UC800	
0205_CWP04_VFD	

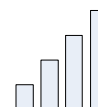
**Generic Device Points**

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

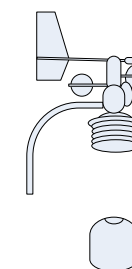
DevBootCount (boots)  
ErrorCode (varies)  
Uptime (sec, min, hours)  
PcbTmp (°F)  
DevFlt (Off/On)  
PrevFltCode (varies)  
ActiveFltCode (varies)  
FltCount (faults)  
RstCmd (Off/On)  
RebootCmd (Off/On)  
UTC (UTC)

**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)

Device

**REVISION LOG**

#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

STATUS: Version 3

DRAWN BY: Mike Grush

JOB NUMBER: 200762-001

REV. DATE: **04/17**

SHEET TITLE & NUMBER:

**34** of **34**

MISC

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.

**CONTENTS**

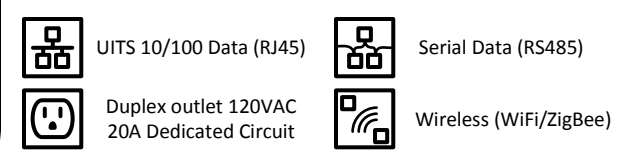
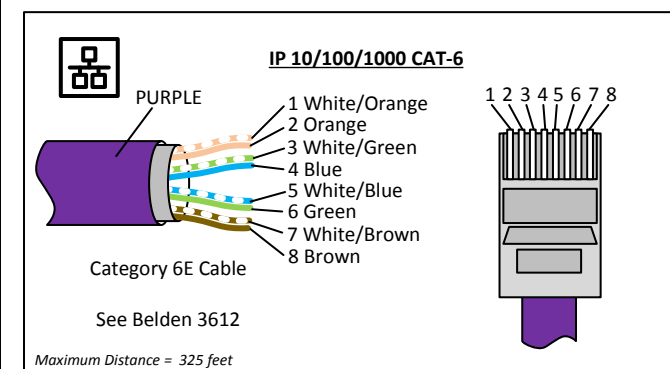
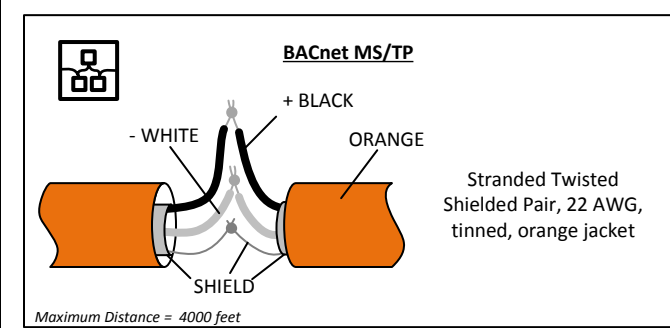
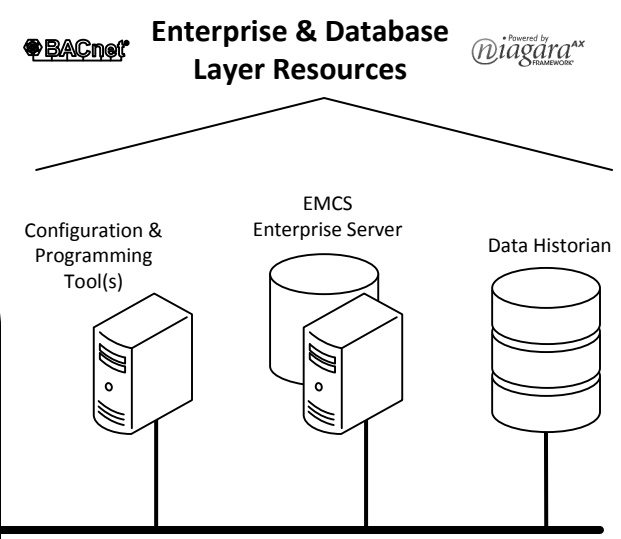
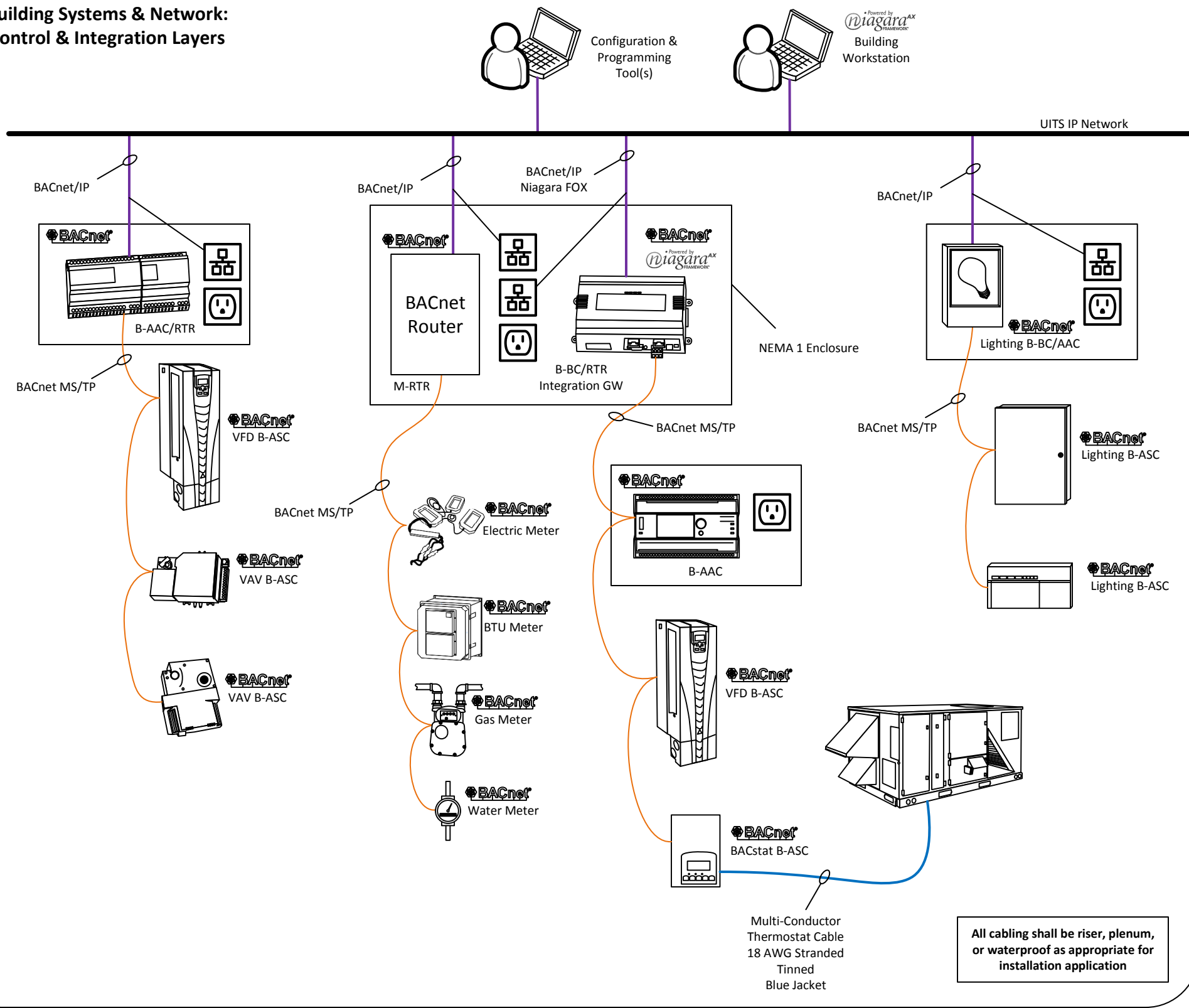


Modbus Device Schedule

Table with 14 columns: 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. The table is divided into two main sections: 'EMCS Contractor/Vendor' and 'University of Arizona UITS/Facilities Management'.



**Building Systems & Network:  
Control & Integration Layers**



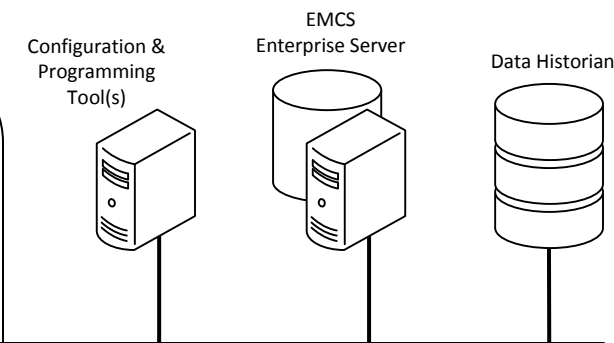
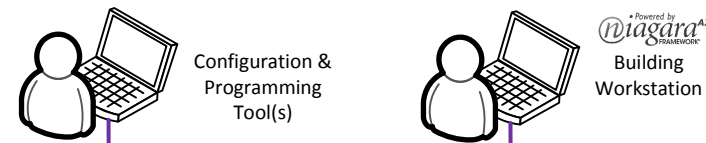
**REVISION LOG**

#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

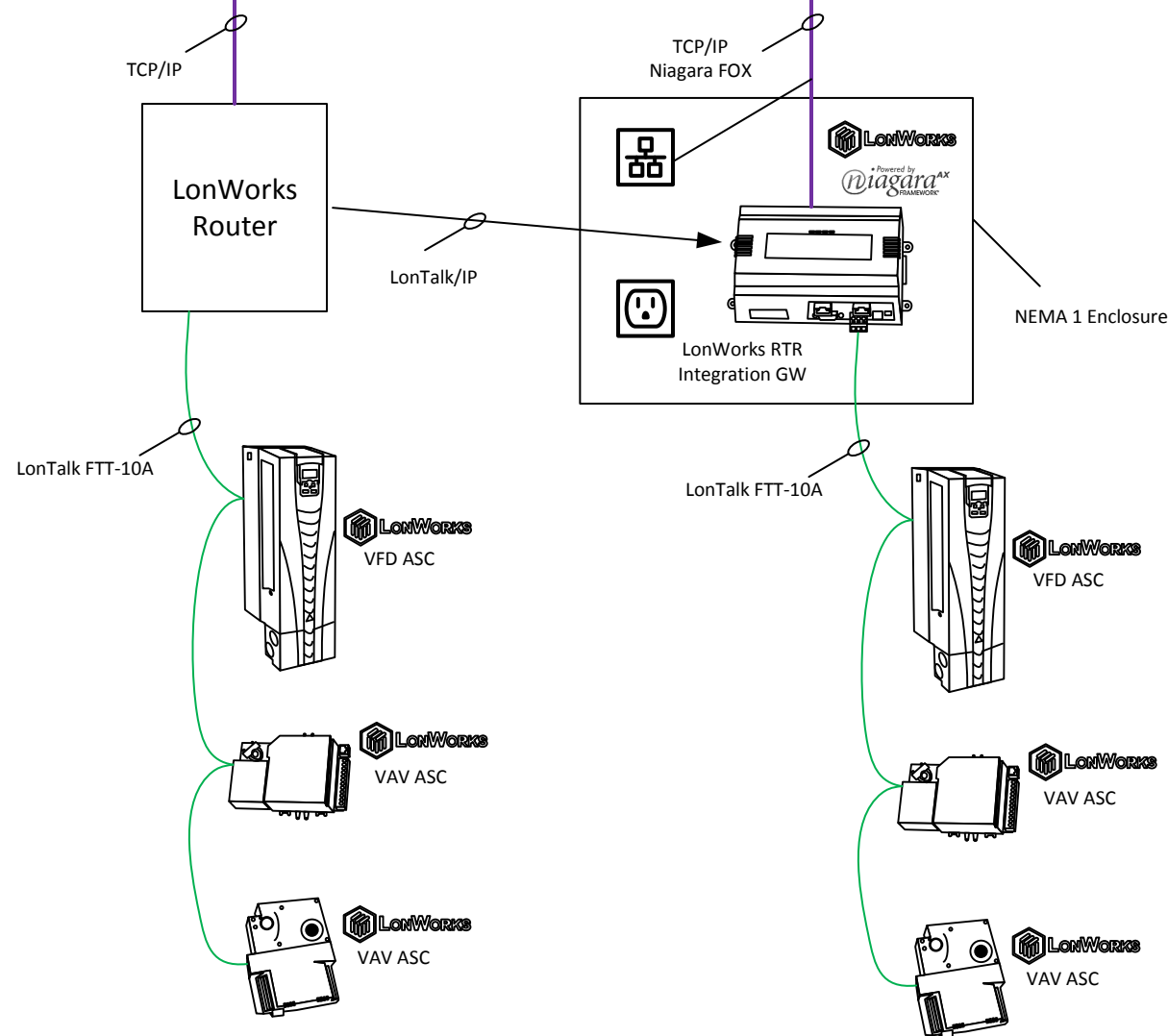
STATUS: Version 1  
 DRAWN BY: Mike Grush  
 REV. DATE: 04/17  
 SHEET TITLE & NUMBER:  
 1 of 1

**Building Systems & Network:  
Control & Integration Layers**

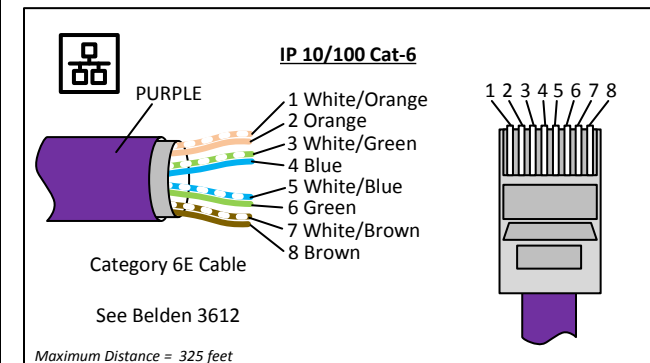
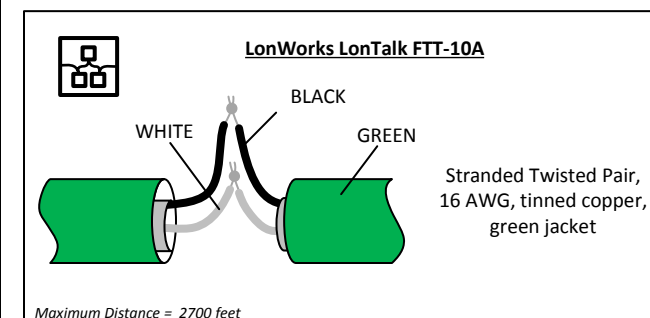
**Enterprise & Database Layer Resources**



UITS IP Network



**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

- UITS 10/100 Data (RJ45)
- Duplex outlet 120VAC 20A Dedicated Circuit
- Serial Data (RS485)
- Wireless (WiFi/ZigBee)

REVISION LOG		
#	DATE	DESCRIPTION
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

STATUS: Version 1  
 DRAWN BY: Mike Grush  
 REV. DATE: 04/17

SHEET TITLE & NUMBER: