March 1, 2016

Virginia Tech
Standards for Building Automation System

A. Existing Conditions:

The Campus Building Automation System is Siemens Apogee and controls all significant campus facilities. Virginia Tech’s central point of control is known as the Operations Control Center (OCC) located in the Sterrett Complex and the controls group is termed Instrumentation Control and Monitoring (ICM). The OCC room has several overhead monitors that can display alarms, weather conditions, news casts, energy data and any data pertinent to any point on the system. The ICM area houses the various servers and workstations for trunk interfaces to field equipment and has a UPS system to maintain all local computers until generator starts or power is restored. Each ICM member has his own workstation locally and the ability to remote desktop into the system via laptops or through smartphones. There are several departments on campus that have Remote Desktop capability to monitor their own areas for research and control purposes. The Residential and Dining Program (RDP) and the Alumni Center also have remote capability and point access is determined by system Log On according to the group the operator is assigned. There is an Apogee Web server that is restricted to Read Only information for field maintenance personnel. The Apogee system exists as a private network, firewalled by a software proxy server and has no routable addresses to the Internet nor to Va.Tech’s Intranet. All outside communication must come through this server. Many of the buildings are on a private wireless network spread across campus and these also use private IP addressing. APOGEE Software remains current through annual updates provided under a contract with Siemens. New construction facilities do not require a local workstation.

B. Building Automation System Standards:

The BAS Control System shall be an extension of the existing Siemens BAS System. System shall be specified under a separate division of the specifications. The control system standards defined below shall be specified under VT capital & renovation projects. The consulting design engineers for capital projects shall include the following standards under the BAS specifications:

1. Expansion of the existing Siemens BAS System shall comply with extension of the existing Siemens BAS system protocols. Integration paths with 3rd party equipment manufacturers (chillers, boilers, generators, switchgear, etc) shall be BACnet.
2. Spaces occupied by VT employees: Room Thermostats shall be Siemens # QAA2280.FWSC with local adjustment and local temperature readout. The BAS system shall be programmed to maintain 72 degree F (winter) and 74 degree F (summer).
AND 74, RESPECTIVELY) The local adjustment on the room thermostat will allow local adjustment between these setpoints. The room thermostat shall have a timed override button which will allow occupant 1 hour of occupied temperature setpoint. After the time override period is over, the system shall automatically resort back to the programmed time-of-day schedule.

3. Spaces in common areas / areas where students are not chaperoned: Thermostats shall be blank covered sensors Siemens # QAA2280.EWSC with no local adjustment or local temperature readout. The BAS system shall be programmed to maintain 72 degree F (winter) and 74 degree F (summer). No local adjustment possible. No temperature readout on the cover. No timed override locally.

4. Locate central DDC panels serving air handling units, rooftops, chillers, hot water systems, and other central systems on the plans. They may be located in the AHU equipment on the roof or in equipment rooms as approved by the owner. Prefer DDC panels be located indoors protected from the elements. Power (dedicated 120v circuit) serving each BAS control panels shall be the responsibility of Division 26 and clearly shown on the Division 26 electrical drawings. DDC panels shall on an emergency circuit.

5. In order to maximize throughput and system speed, one Siemens DDC control panel shall communicate through its dedicated trunk network to the existing OCC. Siemens shall furnish and install required wireless devices, wiring to existing network, hubs, switches, fiber / Ethernet converters, routers, and CAT6 cable for connection to the Siemens dedicated network. Depending on the location of the facility, network connection schemes will vary. VT does not allow external users to access the Siemens BAS Systems remotely. This includes commissioning agents, engineers, or other non-VT agencies.

6. Automatic control valves shall be Siemens. Non-spring return floating point Powermite MZ globe valves for terminal units and spring return Flowrite globe valves central systems such as sir handling units, chilled water systems, and hot water systems. Automatic isolation valves shall be 2-position ball or butterfly valves where appropriate. Any location for the 5 inch (or larger) isolation valve or 6 inch (or larger) control valve, provide a 120 volt power circuit to each valve. Power circuit shall be shown on the electrical plans to be provided by Division 260 power electrical subcontractor. Use no more than 5 control valves per 20 amp 120v circuit (independent of the power to the control panel).
7. Automatic control damper operators serving central systems shall be Belimo. Terminal equipment automatic valve and damper operators shall be Siemens electronic operators controlled from DDC application specific controllers. These systems include heat pumps, VAV boxes, fan coil units, unit ventilators, cabinet unit heaters, and other terminal systems serving rooms and common areas.

8. Laboratory Controls: All lab supply air valves, lab general exhaust air valves, fume hood exhaust air valves, fume hood controls (sash sensor, operator display panel, fume hood controller), and lab controller shall be furnished by Siemens as a direct expansion of the Siemens BAS / Lab Controls System. Exhaust air valves shall be constructed using galvanized or stainless steel. Supply air valves shall be Agion materials. Air valves shall be Siemens standard single blade design. Supply air valves shall be specified with coils and optional sound attenuation where applicable.

9. VAV & CV terminal box controls shall include a discharge temperature sensor for each terminal unit. VAV & CV Controllers and electronic damper operators shall be furnished by BAS vendor and factory mounted by box manufacturer. Clearly define circuits to power the terminal boxes on the Div 260 electrical plans. Each box requires 40va power. It is usually less costly for the BAS Company to install central large transformers and pull 24v LV power to about 7 boxes per transformer. This avoids the requirement for EMT above ceilings for 24 volt power of the box controllers. 120v – 24v transformers shall be located in a panel in the electrical equipment room. Electrical drawings shall show breaker panels that feed each circuit. Since room numbers change and other nomenclature used to describe BAS systems / point may change, the owner shall approved point names and terminal box identifiers before programmed into the BAS System.

10. Small PAC Units, split system units, Liebert Systems, Variable Refrigeration Systems, and small units may require factory BACnet controllers furnished and pre-wired by HVAC unit manufacturer at their factory. In these cases, all controls necessary to accomplish the sequence of operations shall be provided by the HVAC equipment manufacturer. Sequence of Operations for the HVAC unit manufacturer’s BACnet controller shall be located and highlighted in the responsible equipment manufacturer’s specifications (not the BAS specifications). The BAS shall integrate to these factory controllers via BACnet MS/TP interface. The consulting engineer shall list every “read/write” point and every “read only” point to be transferred from the equipment manufacturer’s BACnet controller to the
Siemens BAS System. This enables each equipment vendor to pre-program their BACnet points in their factory. See BACnet processes defined below.

11. Include $1500 allowance for BAS contractor to furnish one operating terminal per construction project. Turnover terminal at the end of the job to insure the hardware includes the latest equipment available.

12. VAV Air Handling Units and larger units with water coils shall be controlled by Siemens controllers. Sensors, Belimo damper operators, control valves, and controllers shall be furnished and wired by Siemens. Control valves mounted by mechanical contractor.

13. Chillers and Boilers manufacturers shall provide equipment with BACnet MS/TP integration to the Siemens BAS System (see BACnet interface requirements below). No hard wired points necessary for equipment status, alarm, or enable disable. These points are read and read/write through the BACnet interface.

14. Filters shall not be monitored through the BAS. VT changes their filters based upon time. Local DP gauge shall be supplied with a local readout of the filter DP value (indicating only devices furnished and installed by mechanical contractor).

15. All status proof points for fans and pumps shall be from current sensing relays. Air flow and water flow switches shall not be acceptable for status feedback points. Current sensing relays shall be setup locally to alarm whenever the current draw for each specific pump or fan is below its normal operating range.

16. Include thermostat guards for obvious hazardous locations only.

17. CO2 and humidity sensors shall be Vaisala. Temperature / humidity / CO2 room sensors that are under one packaged cover are not acceptable.

18. Lighting Control Systems: BAS interface with lighting controls shall be defined for each specific project.

19. Heat Trace: Heat trace is controlled independently and is not controlled or monitored by the BAS System. VT requires a cooling tower sump temperature sensor wired to the BAS for alarm.

20. If a chiller refrigeration monitoring system is required, specify this to be provided by Siemens in the BAS section of the specifications. Refrigerant monitor manufacturer shall be Bacharach. BAS shall include interlock wiring with the exhaust purge fans, wall dampers, door alarms, and BAS alarm inputs. Scuba provided if required.

21. The BAS shall alarm the domestic hot water pumps through current sensing relay and include hot water supply temperature sensor for domestic hot water supply.
22. Sump Pumps: Include sump high level alarm to BAS.

23. Generator: Include BACnet integration to generator control panel. Include a separate DI alarm point for the status of automatic transfer switch. If BACnet is not available, specify hard wired point to the generator for common alarm point (DI) and generator status (DI).

24. Freezers and refrigerators: Include monitoring for freezers or coolers through the BAS System in OCC.

25. All control system wiring in exposed equipment room locations shall be installed in EMT. Low voltage control wiring above accessible ceilings shall be installed in code approved plenum cable without EMT. Outdoor wiring shall be rigid conduit approved for outdoor use. Wall spaces are considered non-accessible and BAS wiring shall be installed in EMT. Flex connections to end devices shall not be longer than 12 inches.

26. Utility Metering (new projects): The following points shall be included for metering each new facility. OA sensors shall be located on the north side of the building and wired to the Siemens BAS. The utility metering is to be included under the Siemens BAS section. VT will need Siemens to push metering data to their VT Energy Platform. All metering points on the Siemens BAS shall be trended.

- One OA temperature per building
- One OA humidity per building
- Electrical energy via integration to switchgear (or VT electric utilities (see below)
- Steam flow (if on central steam system)
- Steam condensate flow (if on central system)
- CHW flow (only if on central plant)
- Domestic HW Flow Meter
- Newer buildings have a utility meter installed and connected to the VT electric utilities Wonderware system. Siemens shall be monitoring electrical usage through the existing Modbus integration to the Wonderware system currently in place. VT electric utilities map their new meter and we reflash our Modbus250 ISB file. This provides comparable data to the VT Energy Manager.

27. All exhaust fans shall have start/stop by zones listed on the schedule. Status is required.

28. New graphics for each central control system on all projects shall be created on the existing central workstation in accordance with the attached graphics for each system / facility. One graphic per system (air handling system, rooftop system, hot water
system, chilled water system, domestic hot water system, lighting system, etc) shall be included. Include floor plan graphic. Include energy dashboard for each new facility.

29. Variable Frequency Drives: VFDs for all pumps and fans shall be provided by Siemens and shall be manufactured by Square D (the VT standard). VFDs shall be furnished with APOGEE P1 integration. There shall be two hardwired points for controlling and monitoring each VFD (0-10v control signal and current relay status). All other control and monitoring shall be executed through the interface.

30. Humidifier manufacturer shall supply automatic control valve. Siemens shall provide space (or RA) humidity sensor, 2-position warm-up control valve, and control the humidifier. Humidity sensors shall be Vaisala. Humidifier high limit and proving switch shall be provided by humidifier manufacturer.

31. Testing and balancing contractors shall furnish their own laptop for balancing. Siemens shall furnish software at no additional charge for balancing contractor to setup terminal unit controllers.

32. Duct smoke detectors are furnished by Simplex under Div 26. Div 26 shall provide fire alarm wiring, power wiring, and mount duct detector. Siemens provides interlock wiring and BAS alarm wiring.

33. Fire Alarm System: Siemens BAS shall not be integrated to the Simplex fire alarm system.

34. BAS System as-built documents and operating and maintenance manuals shall be attached electronically and accessible on the main building graphic.

35. Each BAS system design submittal shall require owner approval of point name convention, space temperature setpoints, and graphics. New requirement on naming conventions: The prefix shall be the actual Va.Tech building number.

36. Sequence of Operations: VT is standardizing on sequence of operations for their systems. Standardized code enables VT maintenance personnel to more easily trouble shoot problems and better understand the operation of each HVAC system. The specifications shall include both the standard “English language” sequence of operations and the actual PPCL program (with comment statements) for each HVAC system. See sequences and PPCL for each system defined below.

Typical VAV with return fan:
Typical single zone unit (auditorium cafeteria):

Typical DX RTU / AHU:

Typical energy recovery unit:

Typical CHW (chiller & cooling tower system) and pumps:

Typical chiller with demand flow:

Typical HW Boilers and pumps:

Typical exhaust fan:

Typical VAV terminal unit:

Typical Unit Ventilator:

Typical FCU:

Typical Unit Heater:

Typical Variable Refrigeration System:

Typical lab control system:

C. BACnet Interface Standards; BAS and HVAC Equipment Suppliers:

VT has set into place the following process to insure BACnet integration occurs seamlessly between the BAS vendor (Siemens) and the various BACnet equipment suppliers for each project. The following process shall be specified in your specifications:

Include the following in each HVAC Equipment specifications requiring BACnet integration and in the BAS Specification Section:

BACnet integration option equipment shall be included to integrate to the existing Siemens BAS System for this project. Integration shall be via (BACnet MS/TP). The following requirements shall be executed for this project:
1. Equipment supplier and BAS vendor shall include in their design submittals the BACnet interface responsibilities for each piece of equipment specified for BACnet interface. Equipment manufacturer and Siemens shall provide the factory certified BACnet programmers that will locally program their respective systems to insure the BACnet interface is seamlessly installed. Siemens shall approve the HVAC equipment submittal in writing before the submittal is officially approved by the architect and engineer. Acceptance by the consulting engineer is not considered valid until Siemens has officially signed off on the BACnet interface requirements and submitted a report detailing the requirements of the HVAC equipment vendor to insure the BACnet integration information is complete. The specified BACnet point list for each HVAC equipment manufacturer shall confirm their BACnet controller is able to send all point data to the Siemens BACnet panel.

2. The attached BACnet integration startup checklist form shall be completed by the mechanical contractor and included in the HVAC equipment submittal before HVAC submittal is approved.

3. Startup: HVAC equipment manufacturer shall provide a factory certified BACnet programmer for their equipment startup. HVAC equipment manufacturer’s programmer must be fully capable of modifying any BACnet parameters on site to meet project requirements. Equipment manufacturer BACnet programmer shall program their equipment to send all read / write and read only points as specified to the Siemens BACnet controller. Programming the HVAC manufacturer’s BACnet points shall be performed before the actual startup begins on site. Siemens shall also supply a BACnet certified BAS programmer during startup to insure the specified read / write and read only points are properly setup and transferred to the BAS system BACnet controller as specified.

4. Verification: Upon completion of the BACnet integration, Siemens shall print a list of the read / write and read only points received from the HVAC equipment as specified to insure compliance with the specifications.

5. Each mechanical specification section of the various HVAC equipment manufacturer’s that require a BACnet interface shall have a specific “functional matrix” points list detailing those points required to be accessible from their factory BACnet controllers. The point list below defines the minimum points requirements for each system.

6. Sequence of Operations that are performed by the HVAC System BACnet controller shall be specified in the HVAC equipment manufacturer’s specifications (not BAS specifications).

End of Control System Standards