

### 5.23 Building Automation System

Protecting the stability and integrity of the University of Calgary's Building Automation System is a core responsibility of the BMS Group. New installations that may have an impact on our current BMS system must be approved by the BMS Group.

***Geographical Restriction:***

***All services, operations, and deliverables related to the BMS shall be performed exclusively within Canada. The Contractor/Service Provider shall not subcontract, outsource, or relocate any portion of the work to be conducted outside of Canada without the prior written consent of the University of Calgary.***

Consultants providing design services to the university must include the above statement in the Contract Documents to ensure compliance to this standard.

#### 1. General

- a. All digital control (DDC) systems on the University of Calgary campus must interface to one of the existing Siemens front-end. All new constructions should interface to Desigo. Renovations and expansions will be reviewed by the BMS Group on a case-by-case basis.
- b. Accessibility: All controllers and equipment must be physically easily accessible for repairs and future work. Panel location shall be approved by the BMS Group.
- c. Spare Capacity: Building panels should have a minimum 10% spare capacity at the end of a project for future implementation. In automation panels, DIN rails are for I/O modules only. Other devices such as DXRs should not be in automation panels.
- d. Licensing: Point count to be approved by the BMS Group.
- e. Provide each new building or major mechanical retrofit project where one does not exist with a dedicated OAT sensor.
- f. Provide terminal boxes with supply air temperature sensors.
- g. All thermostats are to be installed at 1500mm above finished floor.
- h. Siemens standard wiring is 20TP for all digital and analog inputs as well as analog output functions and 16AWG for digital output functions along with Class 2 power at 24VAC and increased to 14AWG as required. This is to allow proper voltage drop in accordance with Electrical codes.
- i. All BMS panels shall be served by a dedicated power circuit.
- j. Any equipment requiring an IP shall be coordinated with UCIT. The BMS Group shall be notified when a new IP device is added to the BMS network.

## 2. Communication

- a. New building automation systems are to be tied into the existing controls server through BACnet IP communication.
- b. Renovations and retrofits of existing buildings currently using proprietary communication protocol may continue doing so.
- c. If BACnet is added to a proprietary building all existing proprietary controllers in the building should be upgraded to BACnet controllers where feasible.
- d. All new building installations shall be BACnet for each level of new controller that is installed. Each controller shall be “native” BACnet in that there should be no converters from proprietary to BACnet language outside of the controller. Should a controller need a converter, a driver at the building panel should be developed rather than using a separate physical device. Third party converters shall not be used; conversion shall be in the BMS controller.
- e. Black boxes (ProtoNode, ICC, etc.) and third-party gateways shall not be used.
- f. Each main building controller (field panel) shall be connected through IP communication protocol. These controllers should each have a dedicated Ethernet network drop.
- g. DXRs can be daisy chained and shall follow the latest vendor standards for installation and number of devices on one trunk.
- h. All BACnet installations shall follow the BACnet Standard numbering available from the BMS Group.
- i. All BACnet installations shall use the required BBMD for their area subnet applications. This BBMD shall come from the existing BBMD (Provided by the University of Calgary BMS Group) in the subnet, or from a newly supplied BBMD controller specifically included in the new installation for that newly created subnet.
- j. All third party equipment shall be integrated with BACnet. TCP/IP shall be used. If BACnet IP is not available exceptions must be approved by the BMS Group.
- k. BACnet devices cannot use the COV service at the server level.
- l. Avoid mixing MS/TP devices from various vendors on a single MS/TP network. BMS Group approval is required if multiple communication protocols are required on an MS/TP network.
- m. MS/TP controllers from the primary BAS vendors may not be intermixed on MS/TP networks. All controllers installed must be accessible from the front end software for controller level changes, such as programming, schedules, point database management, etc.
- n. If there is no MS/TP network at the field panel, do not enable the MS/TP feature in the panel.
- o. At the end of the project, all panels shall have the latest firmware.



- p. Each mechanical room shall have a spare network drop for troubleshooting purposes in the event the wireless network is not available.
- q. VFD's and third party critical devices (chillers, boilers, etc.) Start/Stop, Status, fault and Speed connections to the BMS must be hardwired. Network communications for these specific points are not acceptable.

### 3. Graphics/Programming Standards

This section covers a list of basic requirements. BMS programming standards must be followed. The latest University BMS Programming Standards are located on the BMS server and accessible from the BMS front end.

All graphics on major projects shall be reviewed and signed off by a BMS technician before project completion.

- a. Basic Graphics requirements
  - i. A hierarchical linked graphic operator interface shall be provided for accessing and displaying all system data and equipment operation.
  - ii. Graphics shall include floor layouts with current room numbering.
  - iii. Each system shall fit onto one viewing page. Design scale factor shall be 1.0.
  - iv. All BMS monitored and controlled points shall be displayed on graphics.
  - v. Monitored value units shall be displayed. For BMS monitored temperature values an icon indicating temperature units shall be provided.
  - vi. Command-able points shall display command priority on the graphics.
    - i. Graphics shall display System Name and location.
    - ii. Equipment/devices/systems shall be color coded.
    - iii. Graphics associated with decommissioned devices shall be updated accordingly.
    - iv. Point symbols shall follow the University BMS Programming Standards.
- b. Facilities shall be provided with the ability to override the set point value via a graphical interface in the associated BMS System Graphic.
- c. Apogee Insight: Access group 1 shall be checked on all points displayed on the graphics and TEC devices to provide visibility to all users.
- d. Alarming and scopes for viewing graphics shall be enabled and configured.

### 4. List of preferred products.

Any equivalency to the specified products shall be approved by the BMS Group.



Temperature Sensors for Room Temp and Air Flow Applications	<ul style="list-style-type: none"> <li>Proprietary room controllers primary room temperature sensor shall be Siemens 2200 series thermostat or equivalent.</li> <li>BACnet VAVs shall use the Siemens QMX series for DXR VAV controllers or equivalent.</li> <li>When a room temperature sensor is connected to a VAV, the thermostat shall provide the ability for laptop communications with the VAV controller.</li> <li>Siemens 2200 series, Greystone TSRC series, or equivalent temperature sensors can be used when connecting directly to a main panel.</li> <li>All sensors that control individual rooms shall have enable/disable set point adjustment, a temperature display, and an occupancy override button.</li> </ul>
Humidity Sensors	<ul style="list-style-type: none"> <li>Room level humidity sensors shall always be a combination temperature /humidity sensor.</li> <li>Sensors shall be a minimum of plus or minus 2% accuracy for applications used to control space conditions and plus or minus 5% accuracy for applications only used as monitoring points.</li> </ul>
Air Differential Pressure Sensor Specification	Air pressure differential sensors shall be Setra Model 264 or equivalent.
Air Flow Sensors/Stations	Air flow stations shall be Ebtron, Paragon, Air Monitor, or equivalent.
Current Sensors	<ul style="list-style-type: none"> <li>All pumps and fans shall use current sensors with an output to the BMS for proofing the motor status.</li> <li>All devices shall be split core and shall have an adjustable range. Acceptable manufacturers are Veris, Senva or equivalent.</li> </ul>
CO2 Sensors	All CO2 sensors shall be Veris industries CDE/CWE series or equivalent.
Duct Humidity Sensors	All duct humidity sensors shall be Greystone, BAPI, or Siemens equivalent.
Air Flow Switches	All airflow switches shall be Cleveland Controls AFS-460 or AFS-222 or Siemens SW141 Differential Static Airflow switches.
Duct Temperature Sensors	<ul style="list-style-type: none"> <li>All VAV controllers shall have a discharge air temperature sensor.</li> <li>All duct temperature sensors shall be Siemens, Greystone, BAPI or equivalent.</li> </ul>



	<ul style="list-style-type: none"> <li>• Discharge, exhaust, and return air shall be a single point probe, 1000Ω platinum RTD.</li> <li>• All mixed air shall use an averaging type element that covers the duct area completely.</li> </ul>
<p>Low Temperature detectors (Freeze stat)</p>	<ul style="list-style-type: none"> <li>• Standard application low temperature detectors shall be Siemens Powers Controls 2 pole with manual reset, model 134-1504 or equivalent.</li> <li>• One set of contacts shall be wired directly to supply fan starter/VFD, the other shall provide status back to the BMS system as a DI.</li> <li>• If one single detector does not cover the full duct area, multiple detectors shall be used and wired in series.</li> <li>• The resets shall be mounted externally to the unit and/or plenum in an accessible location.</li> <li>• The sensor should be upstream of the equipment protected and after the heating coil.</li> </ul>
<p>Wet Differential Pressure Sensors</p>	<p>Sensor shall be Setra Model 230 with 3 valve manifold assembly or equivalent and shall be installed with gauges.</p>
<p>Control Valves</p>	<ul style="list-style-type: none"> <li>• All valves shall be electronically actuated with a voltage signal, which also may include floating point type actuators for some applications.</li> <li>• No valves shall be pneumatically actuated, except in the case where explosion hazard, etc. makes pneumatics imperative.</li> <li>• Acceptable control valve actuators manufacturers are Belimo and Siemens.</li> <li>• Terminal reheat valves shall be a normally open valve body and the actuator shall fail in place of last known signal.</li> <li>• Hot water radiation valves shall be a normally open valve body and the actuator shall fail open.</li> <li>• Chilled water valves shall be normally closed and the actuator shall fail closed.</li> <li>• Preheat valves shall be normally open and the actuator shall fail open.</li> <li>• Steam valves feeding heat exchangers shall be normally closed and the actuator shall fail closed.</li> <li>• Hot water valves feeding heat exchangers shall be normally open and the actuator shall fail open. Energy valves shall be connected through BACnet/IP to the BMS systems.</li> <li>• Energy valve control shall be hardwired to the BMS panel in all cases.</li> </ul>



<p>Damper Actuators</p>	<ul style="list-style-type: none"> <li>• All damper actuators shall be electronically actuated with a low voltage.</li> <li>• No damper actuators shall be pneumatically actuated, except in the case where explosion hazard, etc. makes pneumatics imperative.</li> <li>• Acceptable damper actuator manufacturers are Belimo and Siemens.</li> <li>• If end switch is required, then the actuator shall have an internal end switch integrated into the device.</li> <li>• All actuators shall be spring return, except for air terminal units (ATU, VAV, CAV, etc.)</li> </ul>
<p>Control transformers</p>	<ul style="list-style-type: none"> <li>• Control transformers shall have integrated breakers or fuses that can be reset.</li> <li>• Control transformers shall not be loaded more than 80% of rated load.</li> <li>• Control transformers shall be RIB, Lectro, or equivalent with resettable breaker.</li> <li>• Transformers shall be placed in a central location. This location shall be next to the main IP level panel in a separate cabinet.</li> </ul>
<p>External Control/Status Relays</p>	<ul style="list-style-type: none"> <li>• Relay control voltage shall be 24 volts.</li> <li>• Equipment control relays shall contain an LED status light that is installed so as to be easily visible and labeled.</li> <li>• Equipment control relays shall have integrated Hand/Off/Auto switch if equipment disconnect does not already have Hand/Off/Auto capability.</li> <li>• Relays for safety devices and fan status shall be general purpose compact power relays with status indicator lights.</li> <li>• Relays shall not have a manual override if used on safety circuits.</li> </ul>
<p>UPS</p>	<ul style="list-style-type: none"> <li>• When on emergency power, control panels shall be provided with an external UPS.</li> <li>• The UPS battery status shall be monitored through a point on the BMS.</li> <li>• UPS shall be mounted above floor level.</li> </ul>

**5. Alarms**

Alarms are used to quickly identify failures within our campus buildings.

- a. An alarm list must be provided to the University of Calgary Campus Engineering group during the design phase of a project and shall be reviewed in concert with the BMS Group.



b. The Director of Campus Engineering shall be the ultimate authority on assigning an alarm priority level. Upon approval, alarms shall be programmed in the BMS following these guidelines.

c. Alarm Categories

The three categories of alarms are:

- **High Alarms:** show up as red alarms which are immediate response alarms (P1 Insight, NC3 Desigo)
- **Medium Alarms:** show up as yellow alarms which are checked once a day (P3 Insight, NC4 Desigo)
- **Low Alarms:** in Desigo are informational and will be checked monthly (NC5 Desigo).

i) **High Alarms** are typically assigned to incidents with potential impact on human health or significant impact on assets or critical research. Examples are:

- Pump status on primary heating pumps that do not have redundancy
- Pump status on critical cooling pumps that do not have redundancy that serve data centers
- Space temperature in critical spaces/room to monitor space temperature and/or humidity and alarms if it drops or increases from a certain specified temperature (i.e. art galleries, museums, special collections storage, animal care, etc)
- Nitrogen (N2) dispensing areas. Monitored through fire alarm panel only
- Parking garages CO levels
- Chemical storage as designated by EH&S (temperature and fans status)
- Lift stations high level
- Sump pump high level
- Building heating water supply temperature and steam supply pressure
- Any other High alarms are to be approved by U of C prior to specifying

ii) **Medium Alarms** are assigned to the following:

- Cooling pumps
- Exhaust fans
- Fume hood exhaust fans



- Generator transfer switch status
  - Building static pressure when the building pressure goes negative in Laboratory buildings
  - Supply air and Return air fans
  - Vacuum pumps
  - UPS low Battery
  - All other points not on the High alarm list
- i) **Low Alarms** are assigned to the following:
- Automated Windows
  - Other informational points, to be approved by the BMS Group
- d. Alarm Reporting. All alarms shall appear on the Alarm Summary Screen for the entire campus. When an alarm is acknowledged, the alarm point shall remain on the Alarm Summary Screen until cleared. Clearing of an alarm point from the Alarm Summary Screen shall only be possible after the condition is returned to normal.
- e. Nuisance Alarms. Implementation work on the BMS shall be performed in a way that is non-disruptive to the operations of the University of Calgary campus. Alarms shall only be enabled to the Alarm Summary Screen once the work is complete.
- f. Any analog point on main mechanical systems with a setpoint shall be alarmed with a preapproved deviation variance. Alarms limits are set to ensure setpoints are maintained.
- g. All supply fans shall lock out during an alarm condition. Fans are to remain OFF, and alarm condition to remain on the Alarm Summary Screen, until the situation is back to normal and the operator has cleared the alarm.

## 6. Training and Handover

- a. A representative from the controls and zone maintenance groups shall witness the commissioning of major equipment.
- b. Proof of commissioning shall be provided to Campus Engineering and included in the owner's manual.
- c. After system commissioning, the contractor shall provide on-site operator instructions to the owner's operating personnel. Operator's instructions during normal working hours shall be performed by competent representatives familiar with the installed system.
- d. At the time mutually agreed-upon with the owner's representative, the controls contractor shall give instructions to the owner's designated personnel on the operation of all equipment in the system and describe its intended use. Hours of instruction to be determined with the Owner.



- e. Training shall be accomplished after commissioning is complete and include:
  - i. Training schedule and agenda sent to invitees with at least 5 business day notice.
  - ii. Scheduled time with the project engineer to explain the sequence of operation intent.
  - iii. Training with the controls vendor to explain sequence of operation for all major systems.
  - iv. A follow-up one month later with University's Controls Technician for controls fine-tuning.
  - v. Record attendance log for each training period and submit to engineer.
  - vi. A formal list of any deficiencies brought up during training. The list shall include a description of the issue, a responsible party to resolve the issue, and a timeline to fix the issue.
- f. Any calibration certificate (e.g. flow meters) shall be provided to the BMS Group for their records.
- g. An owner's manual prepared for the project by the controls contractor shall be used during instruction. Two (2) printed copies of the Owner's manual shall be provided to the Owner's representative as well as one electronic copy.
- h. Final copy of ABBsite DXR database to be loaded on the Desigo server.
- i. P2 files must be provided to the BMS Group.

## 7. Wiring

The quality of controls wiring for a BMS system can have a significant impact on the BMS reliability.

- a. Installation
  - i. All control wiring to be installed in conduit or cable tray.
  - ii. Only remote sensors and valves can run in 12mm ( $\frac{1}{2}$  ") conduit. All others in a minimum of 15mm ( $\frac{3}{4}$  ") conduit.
  - iii. BMS Communication line to be run in its own conduit.
  - iv. Communication lines shall never be spliced.
  - v. End of line resistors shall be in place where required.
  - vi. Ethernet cables must be following IT standards and tested.
- b. Decommissioning
  - i. Abandoned electrical/control devices shall be removed.
  - ii. Abandoned conduit and wiring shall be removed.



iii. Pneumatic mains no longer in use shall be properly capped.

8. Labelling

- a. Point identification to be coordinated with the MCC labelling.
- b. Refer to identification of mechanical system section.
- c. Identify each cable and wire at every termination point.
- d. Main BMS communication wire shall be yellow.
- e. TEC floor level control shall be yellow with a blue stripe.
- f. BMS junction boxes covers shall be painted orange.
- g. Conduits shall be marked by an orange band every 30 feet.
- h. All panels shall have point identification.
- i. Each panel IP must be clearly labeled inside the enclosure.
- j. End devices shall have luggage style identification containing the following information:

	<b>Example</b>
System Name:	EN.AHU125.HW.SAT
Description:	Heat wheel SAT
Type:	LAI
Controller:	ENPXCM209
Address:	0. 3.1
Controls company name and contact information for service should also be visible on the tag.	

9. University of Calgary Specific Items / Energy Saving Practices

- a. Vibration switches shall be installed on fans 15 kW (20 hp) or greater.
- b. All safety devices on fans shall have a status input to the BMS.
- c. All VFD start/stop, status, fault, and speed points shall be hard wired to the BMS. Communications networks can be connected to the VFD for monitoring purposes but not for control purposes.



- d. A general alarm point from fire alarm panel shall be tied to the BMS.
- e. All temperature controls for valves and dampers for heating and cooling shall be sequenced to avoid overlapping of heating and cooling modes.
- f. Heating and glycol systems supply temperature shall be reset based on outdoor air temperatures.
- g. Secondary heating and glycol systems shall shut down with predetermined outdoor air temperature or valve position.
- h. Outdoor Air economizer mode shall be implemented where feasible.
- i. Initial schedule shall be provided by facilities to conserve energy until full occupancy.
- j. Air handling and water differential static pressure points shall not be transferred across panels for control purposes.

**Revision History**

<b>Revision Date</b>	<b>Version</b>	<b>Description</b>
December 2025	1.0	Alarm section updated. Added geographical restriction clause.  Controls section extracted from 5.16 Mechanical Systems to create new standalone Building Automation System standard.