

Section 15900C BAS Engineering Design Criteria

Part 1 - General:

1.1 SUMMARY:

- A. Building Automation Systems (BAS) engineering design criteria are determined by the specific application requirements, by related requirements of the Brown University Design and Construction Guidelines, by this document, and in meetings with the Brown Project Manager, Users, Engineering Group, and Operations and Maintenance staff.
- B. Work within the Central Heat Plant (CHP), or impacting the campus High Temperature Hot Water (HTHW) systems, Chilled Water (CHW) systems and electrical systems (11.2 kV and 4,160 kV) requires controls compatibility and/or integration with the Campus Central Metering System (Section 16002C) and are not fully addressed in this section.
- C. Related Sections:
 - 1. Section 01301C – Design Guidelines for Energy and the Environment,
 - 2. Section 15002C – HVAC Design Criteria
 - 3. Other 15900 section guidelines
 - 4. Section 16002C – Campus Central Metering System Design criteria
 - 5. Section 16003C – Campus Metering Network Connections

1.2 CONTROL SYSTEM TYPES:

- A. All new building construction and significantly-renovated buildings shall have a web-accessible DDC (Direct Digital Control) system with at least one web-interfaced controller. This controller will be assigned an IP address and shall serve as the gateway device between the building DDC controllers and the campus Ethernet.
- B. Since existing buildings on campus have full, partial or no DDC control capability, the Design Team shall obtain guidance from FM Engineering or Operations staff prior to starting design work on a project within a building as to what type of control system to implement. For example, a small building may require a web-interfaced DDC controller to allow remote monitoring of some variables and alarms, but the building's fan-coils may be controlled by stand-alone thermostats.

1.3 MANUFACTURERS:

- A. HVAC DDC systems shall be either Johnson Controls or Andover. Prior to start of the design work, the Design Team shall confirm whether one or both of these manufacturers are acceptable for the project.

1.4 SUBMITTAL REQUIREMENTS:

- A. The project Engineer of Record shall submit Operational Narrative sequences by the Design Development submittal.
- B. The Controls Contractor shall include fully developed controls drawings and operational sequences with their shop drawings or other approval submittals.
- C. The Engineer of Record, along with Brown University Operations and Maintenance, shall review these submittals.
- D. Final as-built controls drawings and operational sequences shall be submitted prior to project substantial completion punch list, Commissioning or training, whichever is earliest. Drawings shall be Visio-compatible.
- E. O&M Manuals shall include a CD-ROM with complete text of all sequences, and additional information sufficient to document the controls system as turned over to the Owner before subsequent modifications. BAS software shall include all operating discs, recovery disc, system backup disc and program discs.

1.5 DETAILED WRITTEN SEQUENCES OF OPERATION:

- A. By the 90% submittal, the project design professional shall provide detailed written sequences of operation for the new BAS system, based on the Design Development Operational Narratives. These detailed sequences shall provide at a minimum:
 - 1. Sequences in all modes of normal operation: on, off, occupied, unoccupied, warm-up, cool-down, summer, winter, economizer, etc.
 - 2. Organization into logical groupings including: run/stop, pressure, economizer, coils, discharge air, humidification, dehumidification, hydronic temperature, etc.
 - 3. Fire/smoke control system interfaces and sequences.
 - 4. Schedule of operation.
 - 5. Details of system operation for abnormal conditions, such as during and after a power outage. Include details such that a loss of status associated with power outages are not indicated as failures with a subsequent alarm.
 - 6. Specific direction on failure scenarios for loss of signal and all safety device trips.
 - 7. Setpoints, trip points, and ranges. Initially these shall be the designer's intent, and eventually be the actual settings at the time of as-built submittal.

PART 2 – PRODUCTS AND SYSTEM DESIGN REQUIREMENTS:

2.1 GENERAL:

- A. For critical building applications, such as Animal Care, MRI Suites, Data Centers, etc. the BAS system shall be designed with 100% backup. Confirm with Brown FM Engineering if the project falls under this category.
- B. Building thermal and energy metering systems and devices shall be interfaced and integrated with the Siemens Campus Metering System.

2.1 DDC SYSTEM DESIGN REQUIREMENTS:

- A. Small fractional horsepower fans shall normally not require BAS start/stop.
- B. If any equipment with a Hand-Off-Auto switch is integrated into the DDC system, and when it is placed in “Hand” position, it shall not require a DDC enable for it to operate locally. All alarms; however, shall remain active through the DDC system.
- C. All equipment safety interlocks (ie. manual stop switch, smoke detectors, high/low limits, etc) shall be hardwired; if software interlocks are provided they shall be redundant to hard-wired safeties and not take the place of hardwired safety interlocks. Safety interlocks shall operate in both Hand and Auto positions.
- D. Provide Manual-Auto selector switch for all pneumatic control signals.
- E. Variable-Frequency Drives (VFD’s) shall be ABB or Toshiba and have “bypass” feature.
- F. When VFD’s are operated in bypass mode, all safety interlocks and DDC On-Off controls shall remain operational.
- G. All equipment starters and VFD’s shall be operable in the manual or bypass mode independent of DDC system control. When operating equipment in manual or local mode, the DDC shall display this operation as an alarm condition.
- H. DDC controllers provided for air handlers and heating/cooling systems shall have integral display and adjustment features.
- I. Life Safety Systems, such as smoke evacuation, stairwell pressurization, and AHU smoke detection shall be hard-wired to the building fire alarm system. The fire alarm system shall provide the outputs to the BAS.

2.2 DISPLAY AND NAMING CONVENTIONS:

- A. The BAS vendor is required to work with Brown FM Operations (Division 9) staff to organize and assign descriptions to DDC system variables displayed on the Operator Workstation.

2.3 TRENDING:

- A. Any variable monitored under DDC control shall have the capability of being trended and archived historically on the central DDC servers.

2.4 ALARM REPORTING:

- A. The BAS vendor or Engineer is required to work with Operations staff during the design phase to select alarm points. The BAS vendor is required to work with Operations staff during start-up phase to assign criticality to alarm points and to direct those alarms to their final destination(s).

2.5 HEATING CONTROLS:

- A. Setback of space temperatures and system curtailment during unused or unoccupied periods is required.
- B. Adequate control is required to maintain space comfort and avoid temperature ramping in accordance with ANSI/ASHRAE Standard 55.
- C. Where applicable in buildings heated by the Campus Central Heat Plant (CHP), control must provide sequences appropriate for both independent and district heating modes.

2.6 AIR-SIDE SYSTEM CONTROL:

- A. Economizer control based on dry bulb alone shall be subject to approval by FM Engineering.
- B. VAV systems require adequate controls and related components to provide appropriate ventilation rates in all spaces.
- C. Critical spaces calculations are required to control the most critical space under all foreseeable conditions so it will still receive adequate ventilation air, even when at lowest thermal load. These calculations determine the minimum outdoor air intake rates under various operating conditions, and are required to establish proper outdoor air control algorithms.
- D. Where occupancy in an auditorium or other space varies widely and an air handling unit is dedicated to that space, carbon dioxide based Demand-Controlled Ventilation (DCV) may be indicated to avoid energy costs to precondition outdoor air.

2.7 ACTUATORS:

- A. Actuators for valves over 2", and for all critical systems valves, shall be pneumatic and have manual override feature.
- B. Actuators on all steam and High Temperature Hot Water (HTHW) control valves shall be pneumatic.
- C. All control valves 2-1/2 inch and larger shall be furnished with manual override features on their actuators.
- D. Damper actuators may be either pneumatic or electric. Damper motors shall not be installed within equipment or plenums.
- E. Pneumatic pilot positioners shall not be used except for HTHW valves.
- F. Where a pneumatic actuator is not provided, electric actuators shall be rated for minimum 100,000 cycles.

- G. Preferred vendor for electric actuators is Belimo. Belimo actuators are required for all critical applications, such as Animal Care, Data, and MRI facilities. Confirm with Brown FM Engineering if the project is or is not a critical application.
 - H. In critical applications, as defined above, control valves shall be powered under the building's emergency power system.
- 2.8 SHARED POINTS:
- A. Critical equipment and large air handlers shall not share points (i.e. outside air temperature) with other similar units that could disrupt its sequence of operation if another unit's input variable signal failed.
- 2.9 POWER SUPPLY:
- A. In all critical buildings all BAS controllers and devices shall be connected to the standby power system. Division 16 will provide the emergency circuit(s) to the BAS panel(s). Confirm criticality of building with Brown FM Engineering.
 - B. In buildings without emergency or standby power generation, the BAS network controller and all critical controllers shall be connected to a UPS. The controls contractor shall provide the UPS.
 - C. Surge protection shall be external to the BAS equipment.
- 2.10 AIR HANDLING UNIT AIR FILTERS:
- A. Each air filter bank under 4,000 cubic feet per minute (cfm) requires a Dwyer Magnahelic differential pressure gage permanently installed.
 - B. Each air filter bank of 4,000 cubic feet per minute (cfm) and over in buildings with BAS requires a Dwyer Photohelic pressure switch/gage with integral transmitter. Maintenance alarming only is required except for critical spaces.
 - C. Trend logging capability on this signal is required.
 - D. Air-to-air heat exchangers or energy recovery ventilators of 4,000 cfm and over require a BAS with four temperature sensors on inlet and outlet of both process and regeneration air and a Dwyer Photohelic pressure switch with integral transmitter on each air pathway (one required for each rotary heat exchanger; two required for each flat plate or heat pipe).
- 2.11 SENSORS:
- A. Current sensors used for equipment status shall be adjustable.
 - B. Temperature sensors shall be PLATINUM or 10K THERMISTOR with +/- 0.36 % accuracy.

- C. In public spaces, temperature sensors shall be non-adjustable and mounted behind a flat stainless-steel faceplate.
- 2.12 OCCUPANCY SENSORS:
- A. If overall occupied/unoccupied control is not appropriate for the project, provide setback of temperature and ventilation through space occupancy sensors. Coordinate this with Division 16 occupancy sensor selection. Sensors with auxiliary contacts will be provided by Division 16.
- 2.13 FAN-COIL CONTROLS:
- A. Fan-coil units shall not be provided with the manufacturer-furnished electronic or DDC controls.
 - B. Fan-coil units shall have: electric or pneumatic spring-return valves, a local or remote thermostat, a local speed control switch, and a summer-winter changeover switch.
- 2.14 CONTROL VALVES:
- A. Shall have pressure and close-off ratings exceeding their maximum operating conditions.
 - B. Steam and HTHW valves shall be Normally-Closed.
- 2.15 FIELD PANELS:
- A. Must have minimum 36" clearance for access.
 - B. Not be installed in high humidity and high temperature environments.
 - C. Must contain: one duplex receptacle and a primary power disconnect switch. Incoming power supply source shall be labeled; all field wiring points shall also be labeled.
 - D. Cabinets over 48 inches in any dimension shall be furnished with an enclosed fluorescent light fixture.
- 2.15 COMPRESSED AIR SYSTEM:
- A. For pneumatic controls provide the following:
 1. Oil-less duplex compressor with integral receiver.
 2. Refrigerant dryer. Where air lines run outdoors or are used in low ambient temperature service, provide an automatic dessicant dryer.
 3. Filters, regulators and valves.
 4. Hard-pipe blowdown lines to nearest floor drain.
 - B. In Critical applications, connect compressor and dryer to emergency power.

PART 3 – EXECUTION

3.1 WIRING AND IDENTIFICATION:

- A. All BAS labeling and component designations shall match Brown labeling requirements. See Section 01701CPPR – Building Systems Identification & Labeling. All wiring shall be machine-labeled at each end for function.
- B. In addition, all BAS wiring conduits shall be painted yellow every 10 feet or conduit couplings painted yellow; all junction box covers shall also be painted yellow and labeled with the wiring contained within.
- C. System wiring shall generally conform to Division 16 (16100 sections) requirements of the Brown Standards, and applicable NEC requirements, in addition to the requirements noted herein.
- D. All wiring run exposed within building rooms, such as mechanical and equipment rooms shall be run in conduit. Conduit shall be EMT with steel (not die-cast) fittings, except where subject to damage, then rigid steel. Exterior conduits shall be rigid steel. Wiring run concealed above accessible hung ceilings may be run in type MC cable where specifically approved by Brown Operations staff. Low voltage signal and control wiring, where permitted by Code and Brown staff to be run as open wiring above accessible hung ceilings, shall be Plenum rated.
- J. All field panels shall have power source panel and circuit breaker location posted on them.

3.2 COMMISSIONING:

- A. New BAS system installations and expansions of existing systems shall be fully commissioned.
- B. The BAS contractor's responsibilities for commissioning and check-out include:
 - 1. Work with the selected commissioning agent to review the intended system operation, activate all control, alarm and monitoring points to verify intended system operation, and run trends for selected data points to verify intended system operation and functionality.
 - 2. Provide all controls logic, graphics, and trends for review prior to the start of field commissioning activities.
 - 3. Provide completed calibration and operational checks for each individual point and function contained within the BACS.
 - 4. Conduct the commissioning checkout with the use of point/function log sheets prepared by the commissioning agent. The Owner shall approve the log sheet format.
 - 5. Submit completed commissioning log sheets to the Owner prior to the commencement of any final acceptance testing.
- C. For minor projects that do not have a commissioning agent assigned to them, demonstrate proper operation of all alarm and control points with Operations staff.

3.3 TRAINING:

- A. Provide to the Owner completed as-built drawings and system documentation at least four (4) weeks prior to the commencement of any final BACS acceptance testing.
- B. Upon completion of the work and prior to system acceptance by the Owner, factory representatives of the control manufacturer shall provide instruction to the Owner's operating personnel who have responsibility for the mechanical and controls systems. The amount of training that shall be provided shall match the size of the project (e.g., no less than eight hours for small projects and up to 80 hours for large projects). Hours will be defined during the project design phase.

END OF SECTION