



Boise State University

Building Automation System (BAS) Guidelines

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Summary

The purpose of this document is to provide the design team with an easy to reference document containing Boise State University's guidelines for construction projects on campus and is intended as a resource to inform the design process. This document does not remove responsibility from the designer, preclude the use of engineering judgment, or relieve the designer from meeting all adopted code requirements. Questions, clarifications, or suggestions can be directed to the Boise State University Project Manager (PM).

These guidelines have been developed as a joint effort between the Facilities, Operations and Maintenance (FOM) team and the Architectural and Engineering Services (AES) team to help ensure the resiliency of Boise State's campus by considering maintenance needs, sustainability goals, future expansion, and responsible stewardship of our resources. These guidelines are created from both common industry standards and lessons learned through the practice of engineering and maintenance. They are arranged using the Masterspec Divisions to help facilitate a common language.

Related / Supporting Documents

In addition to this document, see the following Boise State University Guidelines:

1. *Division 23 - Mechanical Design Guidelines*
2. *Utilities and Metering Guidelines*

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BAS Requirements in addition to 230900

Design Requirements

BAS Systems

1. Authorized BAS Vendors:
 - a. Siemens Building Technologies building automation systems Desigo CC
 - b. Johnson Controls, Inc. Metasys system
 - c. Automated Logic Web CTRL building automated system
2. Existing Facilities:
 - a. Expansions or renovations to existing facilities shall extend the facility's existing BAS platform to the new / remodeled area. In the event the existing facility has multiple BAS platforms, request clarification from the agency regarding the appropriate BAS to be used in the new / remodeled area. Modifications to existing BAS programming and graphics must be performed by a factory authorized vendor of the facility's existing BAS product line.
 - b. In lieu of extending the existing BAS platform to the new / remodeled area, a JCI Metasys, Siemens Desigo, or Automated Logic WebCTRL system may be provided if the new system replaces controls for the entire building such that the entire building is served by the same system. All work must be performed by a factory authorized vendor of the system to be installed.
3. BAS systems shall be designed, installed, commissioned and serviced by factory trained employees of the BAS system manufacturer.
4. Materials and equipment shall be the cataloged products of manufacturers regularly engaged in production and installation of building automation systems and shall be manufacturer's latest standard design that complies with the specification requirements.
5. Software Analytics: On future new construction projects and significant remodel projects, consider including a system analytics package with the BAS software. Discuss the system with Boise State University FOM team.

BAS Network

1. All networked control products provided for this project shall conform to ASHRAE 135-2010 BACnet standard.
2. Networks and protocols proprietary to one company or distributed by one company are prohibited.
3. Any break in Ethernet communication from the server to the controllers on the Primary Network shall result in a notification at the server.
4. System controllers shall be native-BACnet/SC or shall be BACnet/SC-ready by future firmware upgrade to provide data:
 - a. Encryption utilizing secure Websocket protocol with TLS V1.3 (WSS) functioning on TCP/IP.
 - b. Device authentication of those BACnet/SC devices by utilizing the X.509 International Telecommunication Union standard defining the format of PKI certificates.
5. The BAS provider must provide software tools for Certificate Authority and Certificate Management.

Network Coordination:

- A. All instance numbers will be issued by the Boise State Facilities Operations and Maintenance (FOM) department.
- B. IP addresses will be issued by the Boise State Office of Information and Technology (OIT) representative.
- C. Equipment will use Dynamic Host Configuration Protocol (DHCP) and Domain Name System (DNS).
 - a. The Boise State OIT department will create reservations even when using DHCP so they have a database of BAS devices.
- D. **Do not use default passwords.** Coordinate with Boise State's BAS Administrator to set the appropriate password.

BACnet Communication

BACnet trunks:

1. All new work must be performed on the BACnet trunk, and not on older manufacturer proprietary communication trunks.
2. For future flexibility and to avoid communication bottlenecks, do not exceed 63 devices on a new BACnet trunk, or 50% of the maximum specified by the controller manufacturer. For work retrofitting existing trunks, this may be increased to 75 devices if it does not exceed 75% of controller manufacturer's maximum

BACnet MSTP Setup rules:

1. Addressing for the MSTP devices shall start at 00 and continue sequentially for the number of devices on the subnetwork.
2. No gaps shall be allowed in the addresses.
3. Set the MaxMaster property to the highest address of the connected device.
4. MaxMaster property shall be adjusted when devices are added to the subnetwork.

Device or System Failure Procedure

1. In the event of device or system failure, the system must revert to an operational condition that is not likely to damage the building or its contents.

Device and Point Configuration

1. All equipment will be named accordingly: Using building number, building acronym, equipment, sub-point. (i.e. 393_MCMR_AHU01_SF_CMD)
2. Whenever possible, use BAS points that are local to the building. Request approval from FOM on any global points or global share points.
3. Devices must be hardwired to their controlling panel, not to the panel physically closest to them.
 - a. Example: Duct and pipe pressure sensors $\frac{2}{3}$ down the run need to be wired back to the air handling unit (AHU) or pump controlling panel, not to the panel closest to those devices. This is to allow continuity of operations even if communication is lost between the two panels.

4. Signals to remote motor control centers (MCC), chillers, and boilers, are required to be hard wired to the control panel, not across the network. At the minimum the following points shall always be hard wired
 - a. Start / Stop command
 - b. Speed Setpoint
 - c. Temperature Setpoint
 - d. General Equipment Alarm
5. The following points for Variable Frequency Drives (VFDs) shall be wired direct through BACnet:
 - a. Start / Stop Command
 - b. Speed Setpoint

Graphics and Trends

Graphics

1. The Graphics application shall include a set of standard Terminal Equipment controller application-specific background graphic templates. Templates shall provide the automatic display of a selected Terminal Equipment controller's control values and parameters, without the need to create separate and individual graphic files for each controller.
2. Equipment graphics shall look similar to the actual equipment installed. (Example: Do not show a water tube steam boiler when a firetube condensing boiler is installed).
3. User shall be able to add/delete/modify system graphics for floor plan displays and system schematics for each piece of mechanical equipment (including, air handling units, chilled water systems, hot water boiler systems, and room level terminal units) from standard user interface without the need of any external or specialized tools.
4. Graphics shall be capable of displaying the status of points that have been overridden by a field HAND switch, for points that have been designed to provide a field HAND override capability.
5. All setpoints shall be adjustable through the control graphics by a user with operator (or higher) privileges.
6. Any system capable of being served by multiple sources (for example, heating systems that can be served by some combination of local boilers, central steam, and/or geothermal) must provide a virtual switch in the graphics giving operators a user-friendly way to command operational modes for maintenance purposes without affecting other portions of the sequence.
7. Any device with the capability to output power and energy data (such as VFDs, large equipment) shall output this data to the BAS. This BAS shall trend the energy data and display it graphically.

Trends

1. Create trends and initiate logging for all control points displayed in graphics. Default trending interval shall be 15 minutes minimum. Provide enough memory for all trends to run for at least one year. Upon reaching memory limits oldest data shall be overwritten first.
2. Trend data reports shall be provided to allow the user to view all trended point data.
3. All trends shall be named accordingly: Using building number, equipment, sub-point. (i.e. 393_AHU01_SAT)
 - a. Change of value trends shall be indicated with “_COV”.

Software Requirements

1. The software shall include all necessary tools and procedures for the user to create their own graphics.

2. The software shall provide the ability to add custom gauges and charts to graphic pages.
3. The software shall permit the importing of AutoCAD or scanned pictures for use in graphics.
4. The software must allow users to command points directly off graphics applications.
5. All graphics shall be available with the same look and functionality whether they are displayed at an installed client console or in a browser.

Electrical Requirements

All wiring, conduit and devices shall comply with requirements of Division 260000.

Power Wiring:

All power wiring shall be provided under Division 26, Electrical. Power wiring shall be defined as:

1. All wiring from the power source panelboards (or switchboards) to the disconnect switch or disconnect switch and starter, including wiring from these switches to the equipment, and final connections to the equipment.
2. All wiring to control panels as indicated on the Electrical Drawings.
 - a. All control panels not indicated on the Electrical Drawings as receiving power shall do so by jumpers from other control panels; this wiring shall be considered control wiring as defined below.

Control Wiring

All other wiring, conduit, and raceways that are required and not identified above, whether line voltage or low voltage, internal or external, to provide for the operation of the BAS equipment shall be considered as control wiring.

1. Installation: In general, all conduit systems shall be routed as high as possible. Where practicable, provide separate raceways for BAS, power, lighting IT, etc. Conduit Systems shall be color-coded dark blue for BAS systems.
2. Identification: All junctions, j-boxes and connectors will be color-coded dark blue (for BAS) and labeled with the circuit designation.
3. The Contractor shall provide all controls and control devices, all mountings for controls and all other electrical devices as specified and necessary for the complete installation and satisfactory operation of all electrically operated controls furnished under this division.

Labeling

1. Control wires shall be tagged with a common identifier on each end of the wire, such as in the control panel and at the device termination.
2. Network wires shall be tagged with a common identifier on each end.
3. Tag each 120V power source with the panel and breaker number it is fed by.

Commissioning

The following shall apply for construction projects with commissioning of the building and its associated systems.

1. While the commissioning agent shall be responsible for the building commissioning, the BAS Contractor shall be required to cooperate with the commissioning agent during their duties.
2. The BAS Contractor shall provide access to control equipment after it is installed and guide the commissioning agent through the control systems for a complete and thorough checkout of the system.

Documents

Control Drawings

1. The Points list, controls matrix, and control isometrics listed on the control drawings in the construction documents shall control the final settings.
2. Control drawings shall include:
 - a. Points list
 - b. Control matrix
 - c. Control isometrics
 - d. Verbal summary of control sequence and control logic by the engineer.

Sequence of Operations

1. The controls vendor shall provide a visual printout of the programming based on the engineers sequence of operations for Boise State's Review and approval prior to installation.
2. Where applicable to a project's system types, sequences shall follow ASHRAE Guideline 36-2021 "High-Performance Sequences of Operation for HVAC Systems." Deviations from these sequences must be approved by Boise State.

Submittals

1. A complete submittal with all controls system information shall be provided to Boise State for approval before construction starts. Include the following:
 - a. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, control devices, etc.
 - b. Written description of the Sequence of Operations.
 - c. Network riser diagram showing wiring types, network protocols, locations of floor penetrations and number of control panels.
 - i. Label control panels with network addresses and BACnet device instance numbers. Show all routers, switches, hubs and repeaters.
 - d. Product Data: Include manufacturer's technical literature for each control device indicated, labeled with setting or adjustable range of control. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
 - e. Submit a write-up of the application software that will be used on the operator workstation including revision level, functionality and software applications required to meet the specifications.
2. After the BAS system is approved for construction, submit sample operator workstation graphics for typical systems for approval. Print and submit the graphics that the operator will use to view the systems, change setpoints, modify parameters and issue manual commands. Programming shall not commence until typical graphics are approved.
3. System drawings shall be submitted on paper size of 11 x 17 inches.
4. In addition to other submittals, submit a block diagram of proposed control sequence implementation (Visio or similar).
5. Provide digital submittals for design review purposes. For final closeout / O&M documents, provide (2) hard copies and a digital copy. Provide binders of 11x17 hard copies of diagrams and 8.5x11 copies of text-based documentation (sequences etc).

Contractor Qualifications

1. Control systems shall be furnished and installed only by approved building automation system manufacturers, whose principal business is BAS control work, using only skilled mechanics directly employed by the control manufacturer. No “supervised” work will be considered. These systems shall be installed, calibrated, and adjusted by competent personnel with at least five years control experience.
2. Control systems shall be engineered, programmed and supported completely by the representative's local office and must be within 100 miles of the project site.
3. Bidders shall have an in-place support facility within 2 hours response time of the site with technical staff, spare parts inventory and necessary test and diagnostic equipment. Distributors or licensed installing contractors are not acceptable.
4. The Bidder shall be regularly engaged in the manufacturing, installation and maintenance of BAS systems and shall have demonstrated technical expertise and experience in the manufacture, installation and maintenance of BAS systems similar in size and complexity to this project. Bidders shall provide a list of at least 5 projects, similar in size and scope to this project completed within the past 3 years.
5. The BAS system manufacturer must have a Dealer or Customer Support call-in center located at the corporate headquarters or corporate manufacturing facilities. The Customer Support call-in center will be staffed by fully trained and certified technicians.

Contractor Responsibilities

Clean-Up

1. The BAS contractor shall be held responsible for the general clean up of all areas affected by the work in the Contract.
2. All rubbish and accumulative material shall be removed from the premises and the premises left “broom clean” upon completion.
3. All affected equipment - both new and existing - shall be wiped down (all angles) from construction debris and dust.

Product Handling

1. Responsibility for care and protection of BAS work rests with the Contractor until it has been tested and accepted.
2. After delivery, before, during and after installation, protect equipment and materials against theft, injury and damage from all causes.
3. The Contractor shall receive, properly house, handle, hoist and deliver to the proper location, equipment and other materials required for this contract.
4. In the event of damage, immediately make all repairs and replacements necessary, to the approval of the architect, engineer, or design professional and at no additional cost to the Owner.

Service and Guarantee

1. The building automation system, including all hardware and software components, shall be under warranty for a period of one (1) year following the date of beneficial use. Any manufacturing defects arising during this period shall be corrected without cost to the Owner.

2. During the one (1) year building warranty period, the BAS Contractor may be directly contracted by the owner for warranty related issues during which the response time begins at the time of owner notification. In addition, a full record of the warranty issue will be routed through the project Architect for proper documentation.
3. The system guarantee shall include re-calibration or replacement of all controllers, sensors, actuators or services, etc., that deviates from the design setpoint or control in an unstable manner.
4. Warranty shall extend to material that is supplied and installed by the BAS Contractor. Material supplied but not installed by the BAS supplier shall be covered per the above to the extent of the product only. Installation labor shall be the responsibility of the trade Contractor performing the installation.

System Start-up and Calibration

1. The BAS Contractor shall be responsible for start up, check out and calibration of the entire BAS system. All setpoints shall be input, and the system shall be operated and readjusted, as required, to provide satisfactory operation as to the intent of the plans and specifications during the warranty period.
2. The BAS Contractor shall provide the labor and test apparatus required to calibrate and prepare for operation of all instruments, controls and accessory equipment furnished under this specification.
 - a. This work includes; zero, span and re-calibration checks of all instruments, devices, equipment and accessories both field and panel mounted.
 - b. In addition, the Contractor shall check all control valves and automatic dampers to ensure proper action, stroke each valve and automatic damper, and make all necessary adjustments to stem and blade travel.
3. The BAS Contractor shall furnish labor and test apparatus required to check the operation of all control loops, setpoints and interlocks. All testing shall be witnessed and accepted by the owner's representative, and the Contractor will be responsible for correcting any work unacceptable to the owner.

Warranty:

- A. The contractor's warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of 12 months from completion of system demonstration.
- B. Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the vendor. The maximum acceptable response time to provide this service at the site shall be 24 hours.
- C. During normal building occupied hours, failure of items that are critical for system operation shall be provided within 4 hours of notification from the Owner's Representative.

Project Close-out

As-Built Drawings

1. Record all changes from installation originally indicated.
2. Where work appears on two or more drawings, BAS Contractor shall mark changes on all drawings.

Customer Training

1. Coordinate with Boise State for owners training requirements specific to each project.

2. The BAS Contractor shall be responsible for coordinating and implementing the required owner training.
3. Owner training will be conducted at the owner's site using the project equipment or equipment identical in type, application and configuration to the project.
4. Owners Training will be performed during normal business hours (7:00 a.m. - 3:30 p.m.). Instructions or familiarization sessions given to the Owner informally, during the course of the construction project, will not count against the formal training period.
5. The BAS Contractor shall submit to the Architect, for approval, a proposed training schedule and format. This shall be submitted a minimum of 60 days prior to the schedule construction completion date. The training shall start no later than 30 days prior to the scheduled construction completion date.
6. The formal training shall, as a minimum, cover the following:
 - a. System Architecture.
 - b. System Configuration.
 - c. Logging On/Logging Off.
 - d. Password Security Procedures.
 - e. Adjusting/Changing Set points.
 - f. Polling Graphics.
 - g. Making/Changing Graphics.
 - h. Using the Sequence of Operation.
 - i. Running 3rd Party Software.
 - j. Modifying Hardware.
 - k. Modifying Firmware.
 - l. Modifying Software.