23 09 13 – Instrumentation and Control for HVAC

1. Introduction

   A. This section contains guidelines and requirements for all Duke University Facilities Building Automation Systems (BAS) and Controls.

   B. For utility plant projects coordinate specific requirements and installations with DUES Engineering.

   C. The Building Automation System shall be fully compatible with the existing campus BAS. The existing system is Siemens Building Technologies.

   D. Any new systems shall have full control capability from the existing server and workstations located in the Duke University Facilities Management Department (FMD). All systems must be completely and seamlessly programmable through the existing graphical workstations through use of open protocol controllers or gateways. Any system that requires additional computers or software to program and control will not be acceptable.

   E. Designers should coordinate with Duke's Facilities Management Department (FMD) to coordinate selection and execution of requirements for Building Automation System, components, and controls.

   F. Any deviations from control standards requires prior approval from Duke FMD.

2. References

   A. North Carolina Building Code (Latest Edition)

   B. Duke University Construction Standards, Section 23 09 23 Sensors and Instruments

   C. Duke University Construction Standards, Section 23 09 23.11 Pressure Independent Control Valves

   D. Duke University Construction Standards, Section 23 09 23.13 Thermal Utility Metering

   E. Duke University Construction Standards, Section 23 09 93 Sequences of Operations HVAC

   F. Duke University Construction Standards, Section 23 09 93.10 HVAC Control Schematics

3. Design Standards

   A. The Building Automation System (BAS) manufacturer shall furnish and install a fully integrated building automation system, incorporating direct digital control (DDC) for energy management, equipment monitoring and control.

   B. All new equipment or systems installed in any building project (new building or space renovation) shall be integrated and controlled or monitored by the Building Automation system.

C. The building automation equipment and installation practices listed in this guideline are the only devices currently approved by Duke FMD for use in existing and new construction. Any variance in design, hardware, or equipment, other than those provided in this guideline must be approved by Duke FMD.

D. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed especially for the project.

E. For all applications, designers and installers shall follow manufacturer instructions for installation, grounding, termination, and maintenance.

F. Design and installation teams must coordinate with existing control systems and conditions during new projects or renovations to ensure upgrades meet current building automation standards, working in collaboration with Duke FMD.

G. When removing existing pneumatic devices, all pneumatic tubing that will not be reused should be carefully dismantled. The tubing should be traced back to its source, with any sections that will no longer be in service properly capped as close to the source as possible. This ensures that the system remains sealed, prevents air leaks, and maintains the integrity of the remaining pneumatic infrastructure. Proper removal and capping are essential to avoid future maintenance issues and to keep the system efficient and secure.

H. All equipment must be supported directly by structural members with adequate load-bearing capacity and material integrity, using appropriate anchoring/connection hardware. Under no circumstances may equipment be supported by connections to finish materials. For example, equipment hung from toggle bolts through plaster-on-lath, gypsum board or ACT ceilings is not acceptable.

I. For small equipment replacement projects within an existing older BAS system, the contractor shall utilize the most up to date equipment and software to interface with Desigo control system. Coordinate with Duke FMD for any specific requirements or questions.

J. All BAS point and software license(s) will be included in all the project costs.

K. Design and contractor shall provide 10% spare capacity on all system controllers. For specific applications or exception required coordinate with Duke FMD

L. Building Automation System Interface:

   a. All the systems under BAS Monitoring and control shall have a Graphics User Interface (GUI) within the campus BAS system. Prior to programming any graphic displays, the BAS system architecture and GUI templates shall be submitted for approval by the Duke FMD. Reference GUI Standards for guidance.

   b. All system graphics shall display all controlled points, system modes of operation, virtual points and alarms referenced or inferred listed in sequences of operation.

   c. All BAS points shall be capable of being trended. Trending intervals and storage retention shall be adjustable by authorized users. Coordinate all initial trending, required storage capacity, storage redundancy and scalability with Duke FMD.

M. General Requirements for Control Panel and System Installation

a. Panel Installation:

   i. The control panel is typically 24 inches by 36 inches. This dimension may need confirmation depending on the specific application requirements. Coordinate any deviations with Duke FMD.
   ii. Mount panels on wall with suitable brackets or on self-supporting stand. Mount top of panels no higher than 6 ft above floor. Install panels so front cover door can swing fully open without interference.
   iii. Control Panels to be mounted on uni-strut on any walls to add separation from wall.
   iv. All control panels located in accessible areas be provided with keyed locks. Locks shall utilize the master key already in place on campus. Provide 2 spare key sets to Owner.
   v. Control Panel locations shall be indicated on all design drawings for review. Panels are not to be mounted under any hydronic or drain piping.
   vi. Any re-use of existing control panels requires approval by Duke FMD.
   vii. Utilize Panduit wiring material without rails inside the control panel. All wiring shall be neatly organized within each panel. This setup allows for efficient cable organization without additional support structures, optimizing space and accessibility.
   viii. A standard 6x6-inch wire trough (or gutter) should be positioned above the panel(s). This provides a clean path for wire routing above the control panel for easy access and maintenance.
   ix. Buildings connected to emergency power shall be provided individual UPS for each control cabinet. Provide each panel with an Emerson UPS with a bypass switch. The bypass switch allows for uninterrupted power maintenance by enabling power flow around the UPS, facilitating maintenance without downtime.
   x. All terminal level control devices shall be powered by centralized control transformers located in accessible locations.
   xi. All BAS control panels shall communicate via BACNET IP.

b. Control Panel UPS:

   i. New Critical full building or renovations projects connected to emergency power loop shall utilize a centralized UPS system to power all BAS panels. A bypass switch shall be provided to allow for uninterrupted power flow around the UPS, facilitating maintenance without downtime.
   ii. Critical buildings or small projects connected to emergency power shall be provided individual UPS for each control cabinet. Provide each panel with an Emerson UPS with a bypass switch. The bypass switch allows for uninterrupted power flow around the UPS, facilitating maintenance without downtime.

c. Conduit and Wire Requirements:

   i. Use blue conduit with a minimum diameter of 3/4 inch, though larger sizes are acceptable if needed to accommodate more cables or thicker wiring.
   ii. Compression fittings are the only allowed conduit connections. EMT and screw type fittings are not acceptable.
   iii. Use blue J-Boxes, maintaining color uniformity across the control panel setup for easier identification and troubleshooting. If open ceiling, J-box must be labeled as controls and doesn't have to be painted Blue.
   iv. Use a 1.5-pair (3-wire) shielded cable that complies with the MSTP (Master-Slave/Token-Passing) protocol. Shielding provides noise reduction, and MSTP ensures reliable communication between devices.

v. Terminate CAT 6E cables with biscuit jacks at the panel end, supporting structured Ethernet connectivity and allowing for organized data communication infrastructure.

d. Control Panel Labeling and Identification:

i. Label all wires inside the control panel according to their function, connection point, and destination.
ii. Attach a label inside the door, on the upper left corner, that includes critical network information for quick reference, such as:

a) Record the IP address, subnet, and gateway to streamline network connectivity checks and configurations.
b) Specify the room number where the network switch is located, aiding in physical network infrastructure mapping.
c) Include the network switch ID and port number to clearly identify the specific network connection.

iii. Label the control panel's outer door with an identifier, making it easily recognizable from outside.
iv. Include a unique panel name, ideally based on its function, area served, or a location-based identifier.
v. Label the service box with the corresponding electrical panel name for easy cross-referencing.
vi. Clearly mark the breaker number to simplify troubleshooting and maintenance in case of power issues.
vii. Label each sensor with its unique identifier, describing its function or location.
viii. Clearly mark all thermostats with appropriate unique identifier.
ix. Label the ceiling grid location below static sensors and all terminal unit to facilitate quick access and maintenance.
x. Documentation Inside Panel:

a) Leave a concise summary report inside the panel that outlines key information, settings, and any recent maintenance actions or changes.
b) Place a Field Level Network (FLN) riser drawing inside the panel to visually represent wiring and device connections, supporting efficient troubleshooting and updates.

N. Migration Projects:

a. For migration projects, ensure that all modules and controllers are properly turned over to Duke.

b. Include comprehensive migration documents detailing configurations, wiring diagrams, and setup instructions. This documentation supports future maintenance, troubleshooting, and upgrades.

O. BACNET Control Guidelines:

a. Use BACNET MSTP as the primary protocol for communication.

b. Limit BACNET integration strictly to monitoring functions. Avoid using BACnet for direct control of equipment to ensure that critical systems remain independently controlled and that the BAS only observes performance and status without interference.

c. Use BACNET to gather data on system status, performance, alarms, and operational conditions for centralized visibility in the BAS.

d. BAS contractor shall confirm connectivity, latency, and integrity of network from each switch to each BAS controller and BAS server switch and from switch-to-switch.

e. Applicable Equipment for BACNET Monitoring:

i. Pump Skids: Monitor the pump skid's operating status, flow rates, pressures, and any alerts or alarms related to performance.
ii. Standalone RTU (Roof-Top Unit): Monitor standalone RTUs for parameters like supply/return air temperatures, filter status, and fan operation.
iii. Cold Boxes: Monitor temperature, humidity, or other environmental factors within cold boxes to ensure they operate within specified parameters for sensitive storage.
iv. Humidifiers: Monitor humidifiers for humidity output, water levels, and fault status to maintain proper humidity levels in spaces where environmental control is critical.
v. Domestic Water Mixing Stations: Track temperatures and pressures in domestic water mixing stations to ensure a consistent, safe water supply at desired temperature settings.
vi. Domestic Water Heat Exchangers: Monitor temperatures, pressure levels, and any potential issues in domestic water heat exchangers to ensure efficient operation and water temperature regulation.
vii. User Equipment Requiring Monitoring: Monitor any additional user-specific equipment that requires oversight but does not need direct control. This could include specialized manufacturing or lab equipment. Coordinate with Duke FMD during design phase.
viii. Secondary Alarm Contacts: All equipment should include one set of remote alarm contacts, providing a redundant (secondary) alarm in case of communication issues with the primary BACnet-based monitoring. Connect remote alarm contacts to the BAS or a separate monitoring system to alert the team of specific fault conditions, such as power failures, temperature excursions, or equipment malfunctions.

P. Alarms:

a. Safety and sequence alarms are to be set-up and enabled as part of the project. All other alarms will be set-up by Duke FMD.

b. All BAS points shall have the capability of being alarmed.

4. Documentation and Review Requirements

A. Design team shall document all control equipment, systems, intents, sequence of operation, and all intended points lists for any system connected to Building Automation System. This information must be submitted and reviewed by FMD at early construction documentation phase of any project.

B. Control drawings shall indicate all control system architecture including new and existing panels for Duke FMD review for any project.

C. Final As-builts of all control valve selections, O&M data and applicable product criteria shall be documented in the final Controls As-Built documents.

D. Contractor shall turnover and provide electronic data bases of all applicable project information.

E. Contractor shall provide all applicable system and equipment training per Duke Standard section 01 79 00.