23 09 23 – Sensors and Instruments

1. Introduction

   A. This section contains guidelines and requirements for all Duke University Facilities Building Automation System (BAS) Sensors and Instruments.

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

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

   D. 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 13 Instrumentation and Control for HVAC

   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.

4. Design and Installation Standards of BAS Control Instruments

A. All BAS control devices shall have a permanent label affixed with applicable point name.

B. Control Valves:

a. All control valves installed onto the campus chilled water and heating hot water systems and new process water systems are to be pressure independent. Refer to dedicated Duke standard for additional requirements.

b. For small or localized heat exchangers or existing systems contact Duke FMD to coordinate appropriate control valve selection.

C. Control Dampers:

a. This section only pertains to general supply, return, relief, and exhaust HVAC system control dampers and does not pertain to fire smoke or life safety HVAC control dampers.

b. Modulating control dampers shall be opposed blade and 2 position (open/close) dampers shall be parallel blade type.

c. Damper frames shall be minimum of 16 gauge galvanized steel or 14 gauge extruded aluminum. Blades shall be minimum of 16 gauge galvanized steel or 14 gauge aluminum. Blades shall have maximum blade width of 8 inches with steel trunnions mounted in bronze sleeve, nylon or ball bearings.

d. Blade linkage hardware shall have corrosion-resistant finish and be readily accessible for maintenance.

e. Furnish dampers with blade seal and stainless-steel side seals. Dampers and seals shall be suitable for maximum system temperature, pressure differential and approach velocity based on intended system pressures, temperatures and approach velocity.

f. AHU return and outside air dampers are to have separate control actuators and cannot be mechanically linked.

g. Control dampers used for outside, relief, or exhaust air shall be installed a minimum of 6” away from wall penetrations to allow for external mounting of actuators.

h. Locate all dampers actuators outside airstream with positioning relays as required.

i. Design Team to coordinate with Duke FMD for any specific corrosive environments or applications for Marine Lab.

j. Fume Hood Exhaust Fan Shut-Off Dampers:

i. Damper to be constructed of 304 stainless steel construction, flanged connection, grease lubricated ball bearings, continuous shaft with seal suitable for maximum temperature, approach velocity and differential pressure.
ii. Furnish dampers with neoprene blade seals.
iii. Damper actuators shall be fail-open, electric type, applicable torque requirements, heavy duty industrial quality.

k. Damper Position Switches:

i. For any damper required to be in open/closed positions, install a position switch directly on the damper shaft.
ii. Integral damper position feedback is not required or necessary.

D. Liquid Temperature Sensors:

a. Use temperature sensors with a high degree of accuracy (+/- 0.5 DEG F) suitable for HVAC systems.

b. Utilize thermistor-based or RTD-based sensors (e.g., 100 Ohm RTDs) with built-in transmitters.

c. Installations should have corrosion-resistant housings if exposed to potentially corrosive liquids.

E. Air Temperature Sensors:

a. Zone:

i. Space temperature type with setpoint adjustment range of 69ºF to 75ºF. The setpoint adjustment shall be locked out, overridden, or limited as to time or temperature in software from a central or remote operator's terminal.
ii. Use standard temperature sensors that display all applicable readings. In common or high-traffic areas, use sensors without a user interface to avoid tampering.
iii. Design team shall coordinate all thermostat locations to be in optimal areas, preferable by return grille and NOT next to heat generating equipment.
iv. Do not install space thermostats/sensors located on exterior walls. If no other choice device shall be mounted on thermally insulated sub-base.

b. Duct Mounted: Use 100 Ohm RTD sensors with integrated transmitter.

c. Terminal Unit Discharge Air: 10K Ohm Thermistor sensor.

d. Averaging Duct or Unit Mounted Temperature Sensor: Shall consist of an averaging element, junction box for wiring connections and gasket to prevent air leakage. Provide sensor lengths and quantities to result in one lineal foot of sensing element for each three-square feet of cooling coil/duct face area.

F. Humidity Sensors:

a. Zone: Use Combination Vaisala temperature and humidity sensors.

b. Duct Mounted: Use Combination Vaisala temperature and humidity sensors.

c. Duct High Limit:

i. Control signal to humidifier control valve shall be passed through normally closed (NC) contacts that open when humidity level exceeds high limit setpoint to interrupt the control signal to the humidifier control valve and fails it closed. Set point at 85%.
ii. Reset of the high limit humidistat will enable the humidifier control valve to operate again.

G. Airflow Measuring Stations (AFMS) Devices:

a. Approved manufacturer: Ebtron Gold Series duct mounted airflow sensor or approved equal by Duke FMD.
b. Duct mounted airflow measuring station only allowed installation, fan inlet or vortex type are not acceptable.
c. Outside airflow measuring stations to be sized to function for minimum airflow range to accommodate the expected minimum flow range. Example: If unit is sized for economizer mode, and minimum outside air is fraction of outside air consider utilizing min and maximum outside air damper control strategies.
d. Airflow measuring stations for control shall only be on outside air flow measuring. Fan tracking based on AFMS/fan airflows is **NOT** an approved control strategy.
e. AFMS Control panels to be mounted in accordance with manufacturers guidelines and no higher than 5 Feet off finished floor.
f. AFMS sensing tubes shall be installed in accessible locations and with access doors for cleaning and service.
g. AFMS Stations shall be installed in strict accordance with manufacturer's published requirements.

H. Space CO2:

a. Approved Manufacturer: Vaisala
b. The sensor shall be a complete package with integral sensor, monitor, alarm contacts, local indication of current measured value for sensor. Certified by manufacturer to require calibration no more frequently than once every 5 years.

I. Freeze stats:

a. Electric 2 position type with temperature sensing element and manual reset. Controls shall be capable of opening circuit if any one foot length of sensing element is subject to temperature below setting. Sensing element shall not be less than one lineal foot per square foot of coil surface areas.
b. Install controls at accessible location on outside of air handling unit no higher than 6'-0" above finished floor with suitable mounting brackets and element duct collars where required.
c. Unless otherwise indicated by Duke FMD, calibrate temperature switch setpoint to 38°F. Installation of freeze stat shall provide adequate coil coverage based on manufacturer's instructions.

J. Maintenance Switch:

a. Mount on face of control panel for controlled shutdown of each AHU. Coordinate location with Duke FMD.

b. Utilize Safety Technology International Switch Model No. SS2331HV-EN

K. Pressure Sensors and Switches:

a. Pressure Safety Switches:

i. Air Systems: Install both low and high static pressure switches on each side of any 7.5 HP or above AHU fan systems, as well anywhere in a system where excessive pressure could build up and cause damage.
ii. Water Systems: Install low or high pressure safety sensors based on correct alarming range where applicable based on system and hard wire back to BAS panel.
iii. Do not wire these switches in series; each switch should have an independent control point to identify specific alarm point.

b. Static Pressure Sensors:

i. Supply Fans: Position sensors approximately two-thirds down the ductwork for supply fans to monitor distribution pressure.
ii. Relief & Return Fans: Install sensors at the inlet of fans.
iii. Static pressure sensors should have proper calibration and stability to handle expected duct pressures.

c. Pressure Differential Sensor:

i. Air systems: Use analog Differential Pressure sensors in areas with variable air volume (VAV) systems or across filters to monitor for cleanliness.
ii. Utilize Differential Pressure sensors for pump and critical fan status.
iii. Water Systems: Utilize either single Differential Pressure sensor or two separate sensors for measuring Differential pressure:

a) If a differential pressure sensor with tubing is utilized provide sensor and distribution block in accessible location. Each sensing location shall have a isolation valve and be installed and provided with copper tubing.
b) Two separate sensors, one provided in supply and return piping with isolation valves for each and DP calculation done in BAS.
c) Acceptable Manufacturer: Setra Sensors

L. Current Transducers (CT): Utilize CT's for non-critical pump and fan status input to BAS.

M. Condensate Switches:

a. Provide appropriate overflow type float safety switch for correct purpose. Applications differ based on size, configuration, and location of drain pan. Example: AHU pans, fan coil or auxiliary drain pans.

b. All AHU's, Fan coils or Auxiliary drain pans shall be equipped with overflow switch which shall be hard wired in series to shut down unit if triggered.

N. Weather Outdoor Air Station or Pressure Station:

a. For Temperature and Humidity utilize campus outside air weather station.

b. Building Pressure Sensor Outside Air Reference:

i. Reference two building pressure sensors. Coordinate number and location in design phase of project with Duke FMD.
ii. Sensor Type: Dwyer Outdoor Static Pressure Sensor Model A-306 or 306-A

O. Occupancy Sensors:

a. Utilize Dual Tech Sensors that couple passive infrared (PIR) detection with acoustic or motion detection so even in situations where movement is limited space continues in occupancy mode.

b. Coordinate any integration into BAS System with Duke FMD.

5. 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.