FACILITIES PLANNING, DESIGN, AND CONSTRUCTION
Illinois State University

ILLINOIS STATE UNIVERSITY
EXHIBIT FS-23.3: BUILDING AUTOMATION SYSTEM STANDARDS
Effective February 1, 2023

TABLE OF CONTENTS

I. General

A. The Building Automation System Standards, created by the Office of University Building Automation Team, Heating Plant Operations and Facility Utilities. This standard was established October 2022.

II. Overview

A. The intent of this document is to outline the site-specific requirements to facilitate the complete installation of a Building Automation System (BAS) which addresses the needs of multiple stakeholders on campus. The Facilities Services team requires standardized system platforms and applications. The Designer is responsible for identifying in detail the design of alterations to an existing system or new system for competitive pricing.

B. **Submission Requirements**

1. Shop Drawings:

a) Shop drawing submittals must include a communication riser "system architecture" diagram depicting locations of all controllers and workstations, with associated Intra-Building network wiring.

C. **Operating and Maintenance Manuals (O&M)**

1. O&M shall contain all information necessary for the operation, maintenance, replacement, installation, and parts procurement for the entire BAS. This documentation shall include specific part numbers and software versions and dates. A complete recommended spare parts list shall be included.

D. **Color Graphic Slides**

1. For each system or floor plan, the color graphic display shall contain the associated points identified in the point list and allow for set point changes as required and as standardized by the University. For the purpose of testing and ongoing commissioning, summary graphic pages shall display all unitary and zone controls (such as VAV boxes) in a text only format. The summary graphics shall list in real time the point values from space temperature, temperature set point, airflow minimum and maximum set point, actual CFM, discharge air temperature, valve, and damper position, etc.

E. **Software Documentation**

1. As-built software documentation shall include the following:
   a) Descriptive point lists
   b) Application program listing
   c) Operation and Maintenance Manuals for all equipment
   d) Application programs with comments
   e) Printouts of all reports
   f) Alarm list
   g) Printouts of all graphics
   h) Point to Point Checkout

F. **Data Backup**

1. At completion of the project, a data/database backup of all programming and graphic files shall be provided to the University both on the server and in digital format such as a USB Thumb Drive.

G. **Quality Assurance**

1. The Designer shall require as part of any bid involving new system, impacts to existing or replacement of a Building Automation System, that the bidder must identify what system is included in their bid, who the subcontractor is for the Installation and programing of the Building Automation System and their certification as an accepted installer by the manufacturer of that system. Other installer qualifications shall include the following:
   a) The Installer must be an authorized distributor of the manufacturer.
   b) The Installer must be in the business of installing building automation systems for at least 5 years.
   c) The Installer must have personnel dedicated to application software generation.
   d) The Installer shall have the necessary facilities and personnel to provide training and service of the system.

e) Fiber optic cable shall only be installed and terminated by an experienced contractor.

2. The installer must demonstrate their ability to respond to emergency repair service inclusive of 24 hours/day, seven days/week for the period of specified warranty period. Third party service or service only during specific working hours is not acceptable.

3. The equipment and software proposed by the supplier shall be currently manufactured and supported. All hardware and software must be fully compatible with each other and must be approved by the Building Automation System manufacturer. No custom products shall be allowed.

III. Products of a Building Automation System

A. BAS controller manufacturers should not be mixed within a building. If renovating a building, utilize the same manufacturer of the existing system in the building. Exceptions may apply for specialized applications but must be approved by the Facilities Services Director or the Building Automation Supervisor.

B. Acceptable Building Automation Systems software and hardware platforms shall be Siemens, Schneider, and Delta Controls.

C. The University recognizes laboratory room pressure and fume hood controls manufactured by Siemens as the quality standard we expect. Designer shall provide a minimum of two other comparable manufacturers of room pressure and fume hood controls for the University to review prior to including into the specifications. Sole source of room pressure and fume hood controls is prohibited.

D. The University recognizes control dampers manufactured by Tamco as the quality standard we expect. Designer shall provide a minimum of two other comparable manufacturers of control dampers for the University to review prior to including into the specifications. Sole source of control dampers is prohibited.

E. The University recognizes control valves manufactured by Belimo as the quality standard we expect. Designer shall provide a minimum of two other comparable manufacturers of control valves for the University to review prior to including into the specifications. Sole source of control valves is prohibited.

F. The University recognizes control valve and damper actuators manufactured by Belimo as the quality standard we expect. Designer shall provide a minimum of two other comparable manufacturers of control valve and damper actuators for the University to review prior to including into the specifications. Sole source of control valve and damper actuators is prohibited.

G. The Designer must include a note that the Contractor must coordinate between the BAS contractor's scope of work and the electrical and mechanical contractors to clearly delineate the roles and responsibilities of each party.

H. The Designer shall require the BAS, Mechanical, or Electrical contractor to provide field supervision and verification of proper installations of the following:

1. Automatic control dampers
2. Fire/smoke dampers
3. Pressure and Differential pressure transmitters
4. Airflow and water flow measuring stations
5. Blank-off plates for dampers that are smaller than the duct size
6. Sheet metal baffle plates to eliminate stratification

IV. BAS Requirements

A. Except as otherwise noted, the control system shall consist of all Ethernet Network Controllers, Standalone Digital Control Units, workstations, software, sensors, transducers, relays, valves, dampers, damper actuators, switches, control panels, all pneumatic control devices, and other accessory equipment, along with a complete system of electrical interlocking wiring and pneumatic piping to fill the intent of the specification and provide for a complete and operable system. Unless otherwise noted, contractor shall provide actuators when not included with the equipment.

B. All low voltage control or interlock wiring (120VAC or less) and installation of control devices associated with the equipment list shall be provided under the Mechanical contractor. When the BAS system is fully installed and operational, the Mechanical contractor in conjunction with the BAS contractor will review and verify the system functions with the Engineer of Record and University Representative in accordance with the drawings and specifications. The Contractor is required to provide services and manpower necessary for commissioning of the system.

C. **Support for Open Systems Protocols**

1. The BAS system design must include solutions for the integration of the following "open systems" protocols: BACnet, ModBus, OPC and digital data communication to all third-party microprocessors such as chiller controllers, fire panels and Variable Frequency Drives.

2. The University recognizes 3rd Party Protocol Convertors manufactured by Contemporary Controls as the quality standard we expect. Designer shall provide a minimum of two other comparable manufacturers of Protocol Convertors for the University to review prior to including into the specifications. Sole source of Protocol Convertors is prohibited.

3. All buildings shall be provided with the appropriate hardware to establish a BACnet communication gateway to the Campus for the University's future use to facilitate either a standardized third-party alarm mapping station, graphics workstations, historian data server or other platforms. BAS shall be provided with the capability of integrating all point data from within the building to third-party devices or external systems via BACnet/IP protocol without having to purchase additional equipment, software, or software licenses.

D. **BAS Controller Hardware Requirements**

1. Hardware Override Switches: All system level controller output modules shall include three position manual override switches to allow selection of the ON, OFF, or AUTO output state. These switches shall be built into the unit and shall provide feedback to the controller so that the position of the override switch can be obtained through software. In addition, each analog output shall be equipped with an override potentiometer to allow manual adjustment of the analog output signal over its full range, when the 3-position manual override switch is placed in the ON position.

2. **Local Status Indicator Lamps**

   a) Provide as a minimum LED indication of CPU status, Ethernet LAN status, and field bus status. For each output, provide LED indication of the value of the output (On/Off). For each output module provide an LED which gives a visual indication of whether any outputs on the module are manually overridden.

3. **Automatic Restart after Power Failure**

   a) Upon restoration of power after an outage, the BAS system shall automatically and without human intervention: update all monitored functions; resume operation based on current, synchronized time and status, and implement special start-up strategies as required.

4. **Battery Backup**

   a) Each Network Control Unit ("NCU") with the standard 120-220VAC power supply shall include a programmable DC power backup system rated for a minimum of 24 hours of battery backup to maintain all volatile memory or, a minimum of 2 hours of full UPS including modem power. This power backup system shall be configurable such that at the end of a settable timeframe (such as 1 hour) of running on full UPS, the unit will shut off full UPS and switch to memory retention-only mode for the remainder of the battery power. The system shall allow the simple addition of more batteries to extend the above minimum battery backup times.

E. **BAS Software Requirements**

1. The NCU shall contain flash ROM as the resident operating system. Application software will be RAM resident. Application software will only be limited by the amount of RAM memory. There will be no restrictions placed on the type of application programs in the system. Each NCU shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.

F. **Standalone Digital Control Units (SDCUs)**

1. Standalone Digital Control Units shall provide control of HVAC and lighting. Each controller shall have its own control programs and will continue to operate in the event of a failure or communication loss to its associated NCU.

2. **Communication Ports**

a) SDCUs shall provide a communication port to the field bus. In addition, a port shall be provided for connection of a portable service tool to support local commissioning and parameter changes with or without the NCU online. It shall be possible from a service port on any SDCU to view, enable/disable, and modify values of any point or program on any controller on the local field bus, any NCU or any SDCU on a different field bus.

3. **Input/Output**

a) Each SDCU shall support the addition of the following types of inputs and outputs:

(1) Digital Inputs for status/alarm contacts
(2) Counter Inputs for summing pulses from meters
(3) Thermistor Inputs for measuring temperatures in space, ducts and thermowells
(4) Analog inputs for pressure, humidity, flow, and position measurements

4. **Networking**

a) Each SDCU will be able to exchange information on a peer-to-peer basis with other Standalone Digital Control Units during each field bus scan. Each SDCU shall be capable of storing and referencing global variables (on the LAN) with or without any workstations online. Each SDCU shall be able to have its program viewed and/or enabled/disabled either locally through a portable service tool or through a workstation connected to an NCU.

5. **Real Time Clock (RTC)**

   a) An SDCU shall have a real time clock whenever possible in either hardware or software. The accuracy shall be within 10 seconds per day. The RTC shall provide the following information: time of day, day, month, year, and day of week. Each SDCU shall receive a signal, every hour, over the network from the NCU, which synchronizes all SDCU real time clocks.

6. **Automatic Restart after Power Failure**

   a) Upon restoration of power, the SDCU shall automatically and without human intervention, update all monitored functions, resume operation based on current, synchronized time and status, and implement special start-up strategies as required.

7. **Battery Back Up**

   a) Each SDCU shall have at least 3 years of battery back up to maintain all volatile memory.

G. **Air Handler Controllers**

1. An LCD display shall be optionally available for readout of point values and to allow operators to change setpoints and system parameters. The display must be password protected to prevent unauthorized access.

2. A manual override switch shall be provided for all digital and analog outputs on the AHU Controller. The position of the switch shall be monitored in software and available for operator displays and alarm notification.

H. **VAV Terminal Unit Controllers**

1. VAV Controllers for single duct applications will have an optionally available built-in actuator for modulation of the air damper. The actuator shall have a minimum torque rating of 35 in.-lb. and contain an override mechanism for manual positioning of the damper during startup and service.

I. **Operator Workstation Requirements**

1. The BAS workstation software shall be configurable as either a single workstation system (with a local database) or multi-workstation system where the database is located on a central file server. The client software on multi-workstation system shall access the file server database program via an Ethernet TCP/IP network running at either 10MBPS or 100MBPS.

J. **Color Graphic Displays**

1. The system shall allow for the creation of user-defined, color graphic displays for the viewing of mechanical and electrical systems or building schematics. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition, operators shall be able to command equipment or change set points from a graphic using a mouse. The Contractor shall submit for review during installation the systems graphics and software for review and comments. System graphics and software will be made available at 50%, 75%, and 90% completion. System will not be deemed complete until reviewed and accepted by the University's representative. Requirements of the color graphic subsystem include the following:

    a) SVGA, bit-mapped displays. The user shall have the ability to import AutoCAD generated picture files as background displays.
    b) A built-in library of animated objects such as dampers, fans, pumps, buttons, knobs, gauges, and graphs which can be "dropped" on a graphic through the use of a software configuration "wizard". These objects shall enable operators to interact with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels. Using the mouse, operators shall be able to adjust set points, start or stop equipment, modify PID loop parameters, or change schedules.
    c) Status changes or alarm conditions must be able to be highlighted by objects changing screen location, size, color, and text, blinking, or changing from one display to another.
    d) Graphic panel objects shall be able to be configured with multiple "tabbed" pages allowing an operator to quickly view individual graphics of equipment, which make up a subsystem or system.
    e) Ability to link graphic displays through user defined objects, alarm testing, or the result of a mathematical expression. Operators must be able to change from one graphic to another by selecting an object with a mouse - no menus will be required.
    f) Graphic floorplans should include color coded mapping that identifies what areas an AHU serves

K. **Alarm Management**

1. Individual alarms shall be able to be re-routable to a workstation or workstations at user-specified times and dates. For example, a critical high temperature alarm can be configured to be routed to a Facilities Dept. Workstation during normal working hours (7am-6pm, Mon-Fri) and to a Central Alarming workstation at all other times.

L. **Scheduling**

1. The BAS shall have the ability to configure and download from the workstation schedules for any of the controllers on the network.

2. Occupancy schedules should be configured per the software standards. Schedules shall be configured to group equipment by building (standard) or by AHU or floor (for larger buildings). Individual equipment schedules shall only be configured by exception to meet a specific space need.

M. **Programmer's Environment**

1. All systems shall be provided with the necessary program editing software so that system configuration modifications and changes to application preprograming, graphics, alarm configurations, user security, etc. can be performed by the University's trained representative without requiring the contractor to return to the site.

2. Source graphic files shall be provided to the University if the files are needed to make modifications to the system graphics.

N. **Data Logging**

1. The workstation software shall have the capability to easily configure groups of data points with trend logs and display the trend log data. The trend log data shall be displayed through a simple menu selection. This data shall be able to be saved to file and/or printed.

2. Standard Logging – Hardwired inputs should be logged at an interval of 15 minutes for a minimum of 96 samples (24 Hours).

3. Extended Logging – Long term historical data should be downloaded to the server for key input and output points which are indicative of overall system performance (VFD Speed, meter data, energy data, etc.). Long-term data shall be maintained on the server for a minimum of 13 months.

O. **Audit Trail**

1. The workstation software shall automatically log and timestamp every operation that a user performs at a workstation, from logging on and off a workstation to changing a point value, modifying a program, enabling/disabling an object, viewing a graphic display, running a report, modifying a schedule, etc.

P. **DDC Sensors and Point Hardware**

1. Temperature Sensors: Standard space sensors shall be available in an enclosure for mounting on a standard electrical box. Where manual overrides are required, the sensor housing shall feature a push button for selecting after hour's operation. Where a local display is specified, the sensor shall incorporate either an LED or LCD display for viewing the space temperature, set point and other operator selectable parameters. Using built in buttons, operators shall be able to adjust set points directly from the sensor.

2. **Occupancy Sensors**

   a) The University utilizes space occupancy sensors for HVAC control where the application of such sensors provides a reasonable simple payback period of approximately 4 years or less. Examples of a typical application are high occupant dense spaces such as auditoriums, classrooms, and seminar rooms, gymnasiums, larger conference spaces, laboratories, etc. Occupancy Sensors may be installed for HVAC only purposes or integrated with the local space lighting control, where appropriate. When occupancy sensors are integrated with the local space lighting control, the occupancy sensor shall continue to monitor the space occupancy when the lighting wall switch or other lighting control is turned to the off position.

3. **Humidity Sensors**

   a) Humidity sensors shall be provided as required by the sequence of operation and shall be accurate up to 3 % RH.

4. **Pressure Sensors**

   a) Space pressure sensors must be selected with the appropriate range to provide both adequate resolution accuracy and display range of the controlled variable.

      (1) Air pressure measurements in the range of 0 to 10" water column will be accurate to +/-1% using a solid-state sensing element.
      (2) Differential pressure measurements of liquids or gases shall be accurate to 0.5% of range. The housing shall be NEMA rated as code requires by the space it occupies.

5. **Current and KW Sensors**

   a) Current status switches shall be used to monitor fans, pumps, motors, and electrical loads. Current switches shall be available in solid and split core models and offer either a digital or an analog signal to the automation system. Acceptable manufacturer is Veris or an approved equal.

b) Measurement of three-phase power shall be accomplished with a kW/kWh transducer. This device shall utilize direct current transformer inputs to calculate the instantaneous value (kW) and a pulsed output proportional to the energy usage (kWh). Provide Veris Model 6000 Power Transducer or approved equal.

6. **Instrumentation**

a) BAS Contractor shall be responsible for control wiring and integration of all meters, liquid and steam flow sensors and utility monitoring points to the BAS to meet any requirements outlined in the sequence of operations. All sensors shall be installed with the ability to isolate the sensor to allow for servicing and replacement without process shutdown.

Q. **Automated Control Valves**

1. Provide automatic control valves suitable for the specified controlled media (steam, water, or glycol). Provide valves, which mate and match the material of the connected piping. Equip control valves with the actuators of required input power type and control signal type to accurately position the flow control element and provide sufficient force to achieve required leakage specification.

2. Control valves shall meet the heating and cooling loads specified and close off against the differential pressure conditions within the application. Valves should be sized to operate accurately and with stability from 10 to 100% of the maximum design flow. Hydraulic actuators are not permitted.

3. Trim material shall be stainless steel for steam and high differential pressure applications.

4. Steam control valves used for modulating applications larger than 1-1/4 pipe size shall utilize multiple valves in 1/3 and 2/3 tandem arrangement to limit wear on the valve seats.

R. **Automatic Control Dampers**

1. Dampers shall be custom made when required and designed for operation in temperatures ranging from -40°F (-40°C) to 212°F (100°C).

2. Dampers shall be opposed blade or parallel blade action, as indicated on the plans. All dampers shall be sealed blade type.

3. In an effort to maximize energy savings, outside air damper leakage rates should be factored into the control strategy.

4. Installation of dampers must be in accordance with manufacturer's current installation guidelines.

5. **Automated Control Valve and Damper Actuators**

   a) All actuators shall be electric driven. Pneumatic actuators are not acceptable.

S. **CO2 Sensors**

1. CO2 sensors may require to be located in the return duct or in the occupied spaces to achieve the outlined sequence of operation.

2. CO2 sensors shall a) Provide accuracy of ±30 ppm ±2% of measured value, b) Operate in measured range of 0-2000 ppm, and c) Provide repeatability of ±20 ppm ±1% of measured value.

T. **Airflow Measuring Stations**

1. For low flow velocity applications (less than 500 fpm) the University recognizes Ebtron airflow measuring stations as the quality standard we expect. The designer shall provide a minimum of two other comparable manufacturers of Airflow Measuring Stations for the University to review prior to including into the specifications. Sole source of Airflow Monitoring Stations is prohibited.

U. **Airflow Measuring Stations (Fan or Duct Applications)**

1. For normal flow velocity applications (greater than 500 fpm) the University recognizes Air Monitor airflow measuring stations as the quality standard we expect. The designer shall provide a minimum of two other comparable manufacturers of Airflow Measuring Stations for the University to review prior to including into the specifications. Sole source of Airflow Monitoring Stations is prohibited.

V. EXECUTION

A. **Wiring and Conduit Installation**

1. The 120VAC power wiring to each Ethernet or Remote Site controller shall be a dedicated run, with a separate breaker. Each run will include a separate hot, neutral, and ground wire. The ground wire will terminate at the breaker panel ground. This circuit will not feed any other circuit or device. Safety circuits must be 24v hard wired.

2. Conduit in finished areas will be concealed in ceiling cavity spaces, plenums, furred spaces, and wall construction. For masonry walls, metallic surface raceways maybe used. All surface raceway in finished areas must be color matched to the existing finish within the limitations of standard manufactured colors.

3. Wiring is to be kept a minimum of six (6) inches from hot water, steam, or condensate piping. Where sensor wires leave the conduit system, they are to be protected by a plastic insert.

4. Control air tubing shall be run concealed wherever possible, properly supported, and installed in a neat and workmanlike manner. Piping drooped across building structure or laid on ceiling will not be permitted. Copper or plastic tubing may be run exposed in occupied areas only with University approval.

5. All Power, input/output wiring, and Communication wiring must be stranded and conform with the equipment manufacturers specifications. VFD's may utilize BACnet communications but input/output wiring must be hard wired.

6. All input/output wiring must use a WHITE insulation jacket.

7. All MSTP Communication wiring must use an ORANGE insulation jacket.

8. All Ethernet Cable must be at least CAT6 and must use a BLUE insulation jacket.

9. All Modbus Communication wiring must use a YELLOW insulation jacket.

B. **Installation Practices for Field Devices**

1. Well-mounted sensors will include thermal conducting compound within the well to insure good heat transfer to the sensor.

2. Actuators will be firmly mounted to give positive movement and linkage will be adjusted to give smooth continuous movement throughout 100 percent of the stroke.

3. Relay outputs will include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.

4. Water line mounted sensors shall be removable without shutting down the system in which they are installed. For duct static pressure sensors, the high-pressure port shall be connected to a metal static pressure probe inserted into the duct. The low-pressure port shall be left open to reference the open area where the transmitter is installed.

5. For building static pressure sensors, the high-pressure port shall be inserted into the space via a metal tube. Pipe the low-pressure port to the exterior of the building. All exterior static pressure ports must include a weather head to protect from wind, rain, and ice.

C. **Enclosures**

1. For all I/O requiring field interface devices, these devices where practical will be mounted in a field interface panel (FIP). The Contractor shall provide an enclosure, which protects the device(s) from dust & moisture and conceals integral wiring and moving parts.

2. Field panels shall contain power supplies for sensors, interface relays and contactors, safety circuits, and I/P transducers.

3. The FIP enclosure shall be of steel construction with baked enamel finish, NEMA1 rated with a hinged door and keyed lock. All enclosures will be sized for twenty percent spare mounting space. All locks will be keyed identically.

4. All wiring to and from the FIP will be to screw type terminals. Analog or communications wiring may use the FIP as a raceway without terminating. The use of wire nuts within the FIP is prohibited.

5. All outside mounted enclosures shall meet the NEMA-4 rating.

6. Tubing and wiring within all enclosures shall be run in plastic track. Wiring within controllers shall be wrapped and secured.

D. **Component Identification**

1. Identify all control wires with labeling tape or sleeves using either words, letters, or numbers that can be exactly cross-referenced with as-built drawings.

2. Identify all pneumatic tubing with labeling tape or sleeves using either words, letters, or numbers that can be exactly cross referenced with as-built drawings.

3. All field enclosures shall be identified with a label.

4. Junction box covers will be marked to indicate that they are a part of the BAS system.

5. All field devices (including space sensors) that are not mounted within field panels shall be identified with name labels.

6. All I/O field devices inside FIP's shall be labeled. Transformers will be labeled according to the device(s) they power.

7. Devices should not be located in ceilings unnecessarily. All devices located within false ceilings shall be labeled on the ceiling grid. VAV boxes must also include a block dot at least 1/2” in diameter for ease of location.

8. All labeling shall have black lettering against a white background and whenever possible shall use the BAS Point naming convention for easy identification. Example: **Building.Equipment.Device.Point**

E. **Existing Controls**

1. Existing controls, which are to be reused, must each be tested and calibrated for proper operation. Existing controls, which are to be reused and are found to be defective requiring replacement, shall be noted to the University.

F. **Location**

1. The location of sensors shall be coordinated with the mechanical, electrical, and architectural drawings.

2. Space humidity or temperature sensors will be mounted away from machinery generating heat, direct light, and diffuser air streams. Discharge (supply) Air Sensors should be a minimum of 3 feet from heating coils in VAV or branch ducts and 5 feet from heating & cooling coils in main ducts and at Air handling units whenever possible.

3. Outdoor air sensors will be mounted on the north building face directly in the outside air when possible. Install these sensors such that the effects of heat radiated from the building or sunlight is minimized.

4. When possible, field enclosures shall be located immediately adjacent to the controller panel(s) to which it is being interfaced.

G. **Training**

1. The BAS Contractor shall provide on-site training for all newly installed or updated systems to the University's representative and maintenance personnel. Classroom training must be made available at Owner’s expense upon request. All training shall be done by personnel with administrator level factory experience.

H. **Warranty**

1. The system shall be warranted for a minimum of 12 months (labor and material) and five (5) years on all material after system acceptance and beneficial use by the University, including all necessary revisions to the software as required to provide a complete and workable system.

2. Updates to the manufacturer's software shall be provided at no charge during the warranty period.

I. **Measurement and Verification Requirements**

1. When identified as part of the LEED certification for a project, the BAS contractor shall provide the controls and monitoring on all measurement and verification devices.

J. **Controller and Workstation Checkout**

1. Provide a field checkout equipment and system for all controllers and front-end equipment (computers, printers, modems, etc.). The BAS contractor shall verify proper operation of both hardware and software of all system components. A checkout sheet shall be provided itemizing each device and a description of the associated tests shall be prepared and submitted to the University representative at the completion of the project.

K. **System Startup and Commissioning**

1. Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BAS will be tested against the appropriate sequence of operation specified herein. A written report will be submitted to the University indicating that the installed system functions in accordance with the plans and specifications.

2. The BAS contractor shall commission in operating condition all major equipment and systems, such as the chilled water, hot water, and all air handling systems. Commissioning shall be done in the presence of the equipment manufacturer's representatives, and the University's and Architect's representatives when requested in the scope of the project.

3. Occupancy sensors shall require a trend report with a minimum of 48 hours for each sensor input, showing the occupancy patterns of the space upon project completion.

L. **System Acceptance Testing**

1. All application software will be verified and compared against the sequences of operation. Control loops will be exercised by inducing a set point shift of at least 10% and observing whether the system successfully returns the process variable to set point. Submit a Test Results Sheet to the University representative.

2. Test each alarm in the system and validate that the system generates the appropriate alarm message, that the message appears at all prescribed destinations (workstations or printers), and that any other related actions occur as defined (i.e., Graphic panels are invoked, reports are generated, etc.). Submit a Test Results Sheet to the University representative.

3. Perform an operational test of each unique graphic display and report to verify that the item exists, that the appearance and content are correct, and that any special features work as intended. Submit a Test Results Sheet to the University representative.

4. Perform an operational test of each third-party interface that has been included as part of the automation system. Verify that all points are properly polled, that alarms have been configured, and that any associated graphics and reports have been completed. If the interface involves a file transfer over Ethernet, test any logic that controls the transmission of the file, and verify the content of the specified information.

M. **Building Name and Instance Numbering**

1. Due to the complex nature of existing instance numbers on ISU campus all instance numbers must be cleared with the Automation Team before execution of the project.

N. **Point Naming Convention**

1. Each point shall be clearly identifiable by viewing its point name. Room numbering that is shown on the design documents should be followed, the BAS contractor should confirm same with the University prior to naming all points and controllers. The naming convention should follow the **Building.Equipment.Device.Point** format.

2. All Equipment will be identified in the submittals, graphics and system points names shall use the Acronyms found in this guide.

3. All Building names will be identified in the submittals, graphics and system point names shall use the acronyms found on page 19.

4. Any equipment building or point names that are not identified in this guide must be cleared with the Automation Team before execution of the project.

HVAC COMPONENT	Acronym	
AIR	A	
AIR HANDLING UNIT	AHU	
BOILER	BLR	
BUILDING	BLDG	
CABINET UNIT HEATER	CUH	
CABINET UNIT VENTILATOR	CUV	
CARBON DIOXIDE	CO2	
CARBON MONOXIDE	CO	
CHILLED WATER	CHW	
COMMAND	CMD	
CONDENSATE	COND	
CONDENSER WATER	CW	
COOLING	CLG	
COOLING COIL	CC	
COOLING TOWER	CT	
DAMPER	D	
DEDICATED OUTDOOR AIR SYSTEM	DOAS	
DETECTOR	DET	
ECONOMIZER	ECON	
ELECTRIC HEAT	EH	
ENABLE (SYSTEM ONLY)	EN	
END SWITCH	ES	
ENERGY RECOVERY VENTILATOR	ERV	
ENERGY RECOVERY WHEEL	ERW	
ENTHALPY	ENT	
EXHAUST AIR	EA	
FACE & BYPASS	FB	
FAN	F	
FAN COIL UNIT	FCU	
FILTER	FLT	
FIN TUBE CONVECTOR	FTC	
GENERATOR	GEN	
HEAT EXCHANGER	HX	
HEATING	HTG	
HEATING COIL	HC	
HOT WATER	HW	
HUMIDISTAT	HSTAT	
HUMIDITY	HUM	
LEVEL	LVL	

HVAC COMPONENT	Acronym	
LOW TEMPERATURE DETECTOR	LTDE	
MAKE UP AIR UNIT	MAU	
MAKE UP VALVE	MV	
MIXED AIR	MA	
NATURAL GAS	NG	
OUTOUT	O	
OUTDOOR AIR	OA	
PUMP	P	
REHEAT	RH	
RETURN	R	
RETURN AIR	RA	
RETURN FAN VFD	RFVFD	
ROOF TOP UNIT	RTU	
ROOM	RM	
SETPOINT	SP	
SMOKE DETECTOR	SD	
SPEED	SPD	
STAGE	STG	
STATIC PRESSURE	STP	
STATUS	STS	
STEAM	STM	
SUPPLY	S	
SUPPLY AIR	SA	
SUPPLY FAN VFD	SFVFD	
SWITCH	SW	
SYSTEM	SYS	
TEMP	T	
TERMINAL AIR BOX (CONST VOLUME)	TAB	
TERTIARY PUMP	TERP	
THERMOSTAT	TSTAT	
UNIT HEATER	UH	
UNIT VENTILATOR	UV	
VALVE	V	
VARIABLE AIR VOLUME BOX	VAV	
VARIABLE FREQUENCY DRIVE	VFD	

VI. Sequence of Operation

A. Room Setpoints, Modes, and Occupancy

1. All VAV terminal boxes capable of both heating and cooling shall be programmed with a minimum of 4 temperature set points as follows:
   a) Unoccupied Cooling Set point (Default 82 °F)
   b) Occupied Cooling Set point (Default 72 °F)
   c) Occupied Heating Set point (Default 68 °F)
   d) Unoccupied Heating Set point (Default 60 °F)

2. All VAV terminal boxes furnished with reheat coils shall be furnished with a reheat coil discharge air temperature sensor.

B. Optimal Start/ Morning Warmup/Cool down Mode

1. All Vav terminal units shall be programmed to operate with an optimal start mode, morning warmup and morning cool down sequences that are programmed at the air handler.

C. Night Mode

1. All Vav Terminals shall be programmed with a night mode that will activate the air handler when the unoccupied temperature set points have been exceeded.

D. Occupancy Sensors

1. Medium size spaces designed for between 3 and 12 occupants shall be equipped with dual technology occupancy sensors that will be used to lower ventilation rates and reset the space temperatures when the space is unoccupied.

E. Thermostats

1. Except in common areas such as hallways and lobbies, all thermostats shall be equipped with adjustment and override feature.

F. Demand Control Ventilation

1. Large capacity spaces (example: classrooms, large conference rooms) designed for more than 12 occupants shall be equipped with CO2 sensors for monitoring and resetting the minimum ventilation rates in the space. Very large spaces designed for more than 20 occupants shall be equipped with both CO2 sensors and occupancy sensors. The default CO2 set point for the campus is 800 ppm.

VII. Summary Statement:

A. All Contractors will be responsible for following the guidelines in this Standard. Any exceptions require written or electronic mail copies from an authorized University Representative. You may contact the following Building Automation Technicians for a Digital copy or for any questions regarding the Automation System.

VIII. Contact Information:

A. ISU Building Automation Supervisor: 309-438-2561