

INSTRUMENTATION AND CONTROL FOR HVAC

GENERAL INFORMATION

1.1 BUILDING AUTOMATION SYSTEMS

Acceptable systems for Morningside Campus building automation systems are:

- a. Ecostruxure by Schneider Electric
- b. Siemens Building Technologies Apogee Series.
- c. Automated Logic

No substitutions are permitted.

1.2 CRITICAL ENVIRONMENTAL SYSTEMS

Critical Environments are spaces with temperature requirements more stringent than + or – 2F and/or humidity requirements more stringent than +or - 5%. Relative Humidity shall have industrial grade components and a SCADA (Supervisory Control And Data Acquisition) based control system. Acceptable systems for Morningside Campus are:

- a. Allen Bradley (AB) developed by Rockwell Automation with RSLogix 5000 programming software
- b. AB ControlLogix PLCs.

No substitutions are permitted.

1.3 UTILITY METERING

All utility metering on the Morningside Campus shall be integrated into the Allen Bradley SCADA system and incorporated into the Wonderware Archestra SCADA software including building screen shots and tabulation tables. Acceptable Utility metering systems for the Morningside Campus are:

- a. AB CompactLogix
- b. MicroLogix PLC's

Access to the CU SCADA system shall be coordinated through CUF Plant Engineering.

DESIGN REQUIREMENTS

2.1 For renovation work in existing buildings, the existing BAS shall be utilized. A second system shall not be installed, except by prior written authorization by CUF operations. Coordinate expansion and programming requirements with the respective vendor coordinate with CUF Physical Plant Operations. CUF Physical Plant Operations shall determine future expansion provisions on a project-by-project basis.

2.2 The design of the BAS shall network operator workstations and stand-alone direct digital control (DDC) panels on a peer-to-peer communications network.

- 2.3 Operator workstations and DDC panels shall directly reside on a local area network (LAN) such that communications may be executed directly between controllers, directly between workstations, and between controllers and workstations on a peer-to-peer basis at a minimum speed of 10) Mbps (megabits per second).
- 2.4 All operator devices, either network resident or connected via dial-up modems, shall have the ability to access all point status and application report data, or execute control functions for any and all other devices via the local area network. Provide ability to have user level configured by user and protected by local passwords.
- 2.5 General network design shall provide for the following:
- a. High speed data transfer rates for alarm reporting, quick report generation from multiple controllers, and upload/download efficiency between network devices, support of any combination of controllers and operator workstations directly connected to the local area network.
 - b. Detection and accommodation of single or multiple failures of either workstations, DDC panels or the network media. The network shall include provisions for automatically reconfiguring itself to allow all operational equipment to perform their designated functions as effectively as possible in the event of a single or multiple failures.
 - c. Message and alarm buffering to prevent information from being lost.
 - d. Error detection, correction, and retransmission to guarantee data integrity.
 - e. Default device definition to prevent loss of alarms or data.
 - f. Automatic synchronization of the real-time clocks in all DDC panels.
 - g. Distributed controls architecture that allows the individual systems to operate in the event of a loss in network communications.
- 2.6 Auto-dial/auto-answer communications shall be provided to allow stand-alone DDC panels to communicate with remote operator devices on an intermittent basis via telephone lines.
- 2.7 Control software shall include:
- a. Pretest control algorithms, including:
 - 1. Two-position control
 - 2. Proportional control
 - 3. Proportional plus integral control
 - 4. Proportional, integral, plus derivative control
 - 5. Control loop tuning
 - b. Equipment cycling
 - c. Heavy equipment delays
 - d. Powerfail motor restart
 - e. Common alarm with acknowledge/silence feature

- 2.8 Energy management application software shall include the following routines:
- a. Time of day scheduling
 - b. Calendar based scheduling
 - c. Holiday scheduling
 - d. Temporary schedule overrides
 - e. Optimal start
 - f. Optimal stop
 - g. Night setback
 - h. Enthalpy switchover (economizer operation)
 - i. Peak demand limiting
 - j. Temperature compensated load rolling
 - k. Fan speed/CFM control
 - l. Heating/cooling interlock
 - m. Cold deck reset
 - n. Hot deck reset
 - o. Hot water reset
 - p. Chilled water reset
 - q. Chiller sequencing
 - r. Dynamic pressure reset
 - s. Demand controlled ventilation
- 2.9 Panels shall be able to execute custom, job specific processes, defined by the operator to automatically perform calculations and special control routines.
- 2.10 Alarm management shall be provided to monitor, buffer and direct alarm reports to operator devices and memory files.
- 2.11 Totalization capability shall be provided for runtime, analog/pulse and event totalization.
- 2.12 Operator interface software shall provide the following features:
- a. English language prompting
 - b. Graphical and text-based display of all system point and application data.
 - c. Multiple, concurrent displays
 - d. Live BAS data exchange
 - e. Password protection
 - f. Operator commands
 - g. Logs and summaries
 - h. Third party interface capability for database and spreadsheet applications.
 - i. Remote paging
 - j. Multi-color printing
 - k. Color graphic display

I. System configuration and definition

- 2.13 Operator interface software shall operate in the latest Microsoft Windows operating system.
- 2.14 BACnet Compatibility – Building automation systems specified for installation shall be ASHRAE BACnet compatible to allow interoperability between different manufacturers of systems. System level controllers shall be specified to be BACnet compatible or fully BACnet compliant utilizing BACnet protocol software. Workstations shall be specified with operator-interface software containing BACnet driver software to allow communication with other BACnet compatible systems
- 2.15 Sequences of Operations
- a. Design documentation shall include project specific sequences of operation, including all setpoints. All setpoints shall be configured as adjustable variables.
 - b. Specify mock-up of controls and functionality to take place at Vendor's factory prior to installation.
- 2.16 All controllers shall be located within metal enclosures.
- 2.17 Coordinate power requirements (low voltage or line voltage) for all controllers and controlled devices.
- 2.18 Typical Laboratory Temperature Control (Not defined as Critical Environmental spaces)
Where laboratory variable volume systems are specified in new and substantially renovated science buildings they shall be furnished with a stand-alone DDC electronic controllers, pressure independent, variable air volume laboratory flow tracking system. The flow tracking system includes VAV boxes, reheat coils, damper and valve operators, with all control devices to monitor the following as minimum: room temperature, °F, room humidity, % RH, reheat coil valve position, reheat coil temperature °F, supply cfm, exhaust cfm. As program requires, emergency power should be provided for the entire DDC system. All DDC software must be web enabled for remote communications .
- 2.19 An environmental monitoring and security system shall be provided to monitor critical equipment such as freezers, designated environmental rooms, cabinets, and other types of equipment as indicated in the lab program. This system shall have "dial out" functionality to report alarm to lab administrator and have capability to be interfaced with the BAS system to provide emergency alarm/reporting only.
- 2.20 Equipment Requirements
- a. Sensors, Transmitters
 - 1) General: Designers are encouraged to submit alternate cost-saving equipment to be reviewed by Columbia University.

- (a) Accuracy from sensed parameter to digital readout at direct digital control panel shall include inaccuracies introduced by sensor, transmitter, wiring, I/O module and analog-to-digital convertor.
 - (1) Temperature and Pressure: Plus or minus 1½ percent of span (or as noted).
 - (2) Humidity: Plus or minus 2 percent of span (or as noted).
 - (b) Maximum transmitter spans (normal operating point at mid-scale):
 - (1) Room Temperature: 50°F.
 - (2) Chilled Water: 50°F.
 - (3) Condenser Water: 100°F.
 - (4) Duct Air Temperature:
 - (a) Heating: 100°F. or as required by maximum duct temperature.
 - (b) Cooling: 50°F.
 - (5) Dewpoint Temperature: 100°F.
 - (6) Room Air and Return Air Humidity: 0-100 percent RH
 - (7) Outside Air Temperature: 150°F. (-30°F. to 120°F.)
 - (8) (Note the use of thermistors invalidates the parameters (°F).)
 - (c) Transmitters shall have built-in circuit protection against reverse polarity and supply voltage transients.
- b. Automatic Control Valves
- 1) All automatic control valves shall be fully proportioning with modulating plug of v-port inner guides, unless otherwise specified. Characterized ball valves are permitted.
 - 2) The valves shall be quiet in operation and fail safe in either normally open or normally closed position in the event of the power failure. Valves capable of operating at varying rates of speed to correspond to the exact dictates of the controllers and variable load requirements and shall be capable of operating in sequence when required by the sequence of operation.
 - 3) Valve operators (industrial type) shall be of the motorized type sized to insure tight seating against maximum design differential pressure plus 25%.
 - 4) Characteristics (hydraulic and steam)
 - (a) Pressure independent, equal percentage flow characteristics, single seated or ball type.
 - (b) Hot Water Service: Equal percentage, single seated or ball type. For water temperature 250°F. or greater, provide stainless steel plug.
 - (c) Steam Service: Equal percentage flow characteristics, single seated. For steam at 50 psi or greater, provide stainless steel plug.
 - (d) Bypass Service: Linear flow characteristics. Double seated.
 - 5) Valve Action

- (a) Cooling valves normally closed.
 - (b) Preheat valves normally open.
- 6) Provide mechanical direct reading movement indicators on all valves located in mechanical rooms and any valves 2½ in. or larger.
- 7) Valve actuators shall be electric type, a 4-20 mA signal is preferred, 0-10 VDC is acceptable were the former is not available.
 - (a) Actuators shall be spring return to normal.
 - (b) Actuators shall operate over the full range unless otherwise noted.
- c. Automatic Dampers
 - 1) Construction
 - (a) Blades
 - (1) Extruded aluminum air foil type.
 - (2) Width:
 - (a) Minimum: 4 in.
 - (b) Maximum: 8 in.
 - (3) Length: Maximum 48 in.
 - (4) Gauge: 16 minimum.
 - (5) Modulating Dampers: Opposed-blade type.
 - (6) At Points of Contact: Interlocking edges of compressible seals, selected for temperature of (minus -50 to 180°F.) at specified leakage rate.
 - (7) Leakage When Closed: Guaranteed less than 10 CFM per square foot at 4 in. W.G. static pressure, less than 5 CFM per square foot at 1 in. W.G. static pressure.
 - (b) Frames:
 - (1) Shall match material of ductwork.
 - (2) Gauge: 13 minimum.
 - (3) Corner bracing for dampers above 4 square feet.
 - (4) Full size of duct or opening in which installed.
 - (c) Smoke Control Dampers: Same as control dampers except classified under UL Standard 555-S for use in smoke control systems.
 - (d) Coordinate with mechanical drawings for all damper locations and quantities.
- d. Materials, Pneumatic Tubing
 - 1) Copper tubing shall be round seamless per ASTM B-75, CA Alloy 122, hard drawn and soft annealed, eddy current tested, free from contamination per ASTM B-68. For sizes ½" or less: .022 wall thickness minimum; for sizes greater than ½ inch: Class M minimum. Use hard drawn type. Support shall be by means of and hangers fastened to the building structure.
 - 2) All tubing shall be supported at regular intervals to prevent sagging and use non-ferrous clamps.

- 3) Plastic tubing shall be permitted within control panels only. Plastic tubing shall be black single, twin or jacketed bundled multi-tube, virgin low density polyethylene ASTM D-1248, Type 1, Category 4, Class C, self-extinguishing (FR) plastic, UL 94-V2 flammability classification, UL listed.
- 4) Tags (Nameplates)
 - (a) Provide nameplates for the following list of all equipment provided. The tags shall be lamicoid plates with sticky back to identify all supplied equipment. The tags shall be a minimum of 1" by 2".
 - (1) Filter pressure sensors.
 - (2) Temperature sensors.
 - (3) Flow transmitters.
 - (4) Temperature low limits.
 - (5) Pressure differential switches.
 - (6) Duct static pressure sensors.
 - (7) Accessory panels.
 - (8) DDC panels.
 - (9) Pneumatic devices.
 - (10) Air flow stations and sensors.
 - (11) Reheat control valves.
 - (12) Finned tube radiator valves.
- e. Controllers
 - 1) Controllers shall be electronic modular controllers with ROM, EEPROM and SRAM memory utilized for specific applications shall be capable of receiving from 4 to 64 analog and digital inputs from such devices as thermistors, humidistats and pressure sensors and capable of sending from 4 to 64 analog and digital output signals to such devices as control valves, dampers and relays. Both input and output signals shall be received and sent from input/output modules directly connected to the unitary controller on DIN-rail mount. Controllers shall be provided with battery back-up to allow for orderly shutdown in the event of a power supply failure.
 - 2) Workstation computers shall function as operator workstations. They shall store and archive information in a database and provide operator interface. Computers shall be provided with the fastest microprocessor chip available at time of Contract award. Each computer shall be provided with minimum 100 gigabytes hard drive, 512 megabytes system RAM or minimum required by all software (whichever is greater), modem, 17-inch flat-screen color monitor, video card, network card, latest edition Microsoft Windows operating system, latest edition McAfee Virus scan software, and latest edition BAS system software. Uninterruptible power supply, laser printer and latest edition Microsoft Office software shall be provided where requested by the University.

- 3) Provide power filter on control panels to condition incoming power.
- 2.21 Label all wiring, cabling and tubing just prior to their termination in panel and at control/monitoring devices with nomenclature consistent with point address and drawings.
- 2.22 Commissioning and Testing
 - a. Specify that the building automation system contractor shall fully commission and test the installed system before acceptance by the University. For commissioning, the contractor shall prepare and submit for approval checklists of commissioning and testing procedures including a full point-to-point wiring checkout, software check and documented 72 hour of system operation in "automatic". Refer to section 230800 - Commissioning - for more information. The Contractor shall provide all required testing and corrective equipment to demonstrate compliance.

CONSTRUCTION REQUIREMENTS

- 3.1 Provide field I/O devices as indicated on Contract Drawings and Specifications.
- 3.2 Where performance specifications exceed capabilities of hardware specified, performance governs.
- 3.3 All analog input signals shall be 4-20 mA, 0-10 VDC or 1-5 VDC. Exception is thermistor sensor where conversion is not necessary, and the DDC shall be able to translate the signal directly into a temperature reading.
- 3.4 Minimum Contact Rating: 5 amp, 24 volts resistive.
- 3.5 Switching differential shall be adjustable as required to provide proper system control.
- 3.6 Transmitter power supplies in direct digital control panel.
- 3.7 Devices UL listed for electrical safety where applicable.
- 3.8 All components of sensors exposed to process shall be rated to withstand 150 percent of maximum process temperature and pressure.
- 3.9 Turnover Documents
 - a. Upon completion of the project, require the Contractor to submit operating and maintenance manuals for all equipment, components and software provided.
 - b. Upon completion of the project, require the Contractor to submit duplicate copies (2) of a CD-ROM of non-compiled (editable) and compiled application software setpoint and alarm values for all points installed.

- c. Upon completion of the project, submit operation and maintenance manuals consisting of the following:
 - 1.) Index sheet
 - 2.) Manufacturer's equipment parts list, Auto-CAD disk of system schematics including wiring diagrams.
 - 3.) Descriptions of Sequence of Operation
 - 4.) As-Built interconnection wiring diagram.
 - 5.) Operators Manual
 - 6.) Trunk cable schematic showing remote electronic panel locations and all trunk data.
 - 7.) List of connected data points, including panels to which they are connected and input device (ionization detector, sensor, etc.)
 - 8.) Conduit routing diagrams
 - 9.) Sensor location on floor plans

END OF SECTION