

Part 1 General

1.1 SECTION INCLUDES

- .1 All DDC building controllers.

1.2 RELATED SECTIONS

- .1 Section 25 05 01 - EMCS: General Requirements.
- .2 Section 25 30 02 - EMCS: Field Control Devices.

1.3 REFERENCES

- .1 <http://www.bacnetinternational.net/btl/>

1.4 SYSTEM DESCRIPTION

- .1 General. Provide an adequate number of Building Controllers to achieve the performance specified in the Part 1 Article on "System Performance." Each of these panels shall meet the following requirements.
 - .1 The Energy Management and Control System shall be comprised of one or more independent, standalone, microprocessor-based Building Controllers to manage the global strategies described in the System Software section.
 - .2 The Building Controller shall have sufficient memory to support its operating system, database, and programming requirements.
 - .3 Data shall be shared between networked Building Controllers.
 - .4 The operating system of the Building Controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information, and allow central monitoring and alarms.
 - .5 Controllers that perform scheduling shall have a real-time clock.
 - .6 Execute its logic and control using primary inputs and outputs connected directly to its onboard input/output field terminations or slave devices, and without need to interact with other controller. Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).

1.5 DESIGN REQUIREMENTS

- .1 To include:
 - .1 Scanning of Analog Input and Binary Output connected inputs for detection of change of value and processing detection of alarm conditions.
 - .2 Perform On-Off digital control of connected points, including resulting required states generated through programmable logic output.
 - .3 Perform Analog control using programmable logic, (including PID) with adjustable dead bands and deviation alarms.
 - .4 Control of systems as described in sequence of operations.
 - .5 Execution of optimization routines as listed in this section.
- .2 Total spare capacity: at least 25 % of each point type distributed throughout the controllers.

- .3 Field Termination and Interface Devices:
 - .1 To: CSA C22.2 No.205-12 – Signal Equipment.
 - .2 Electronically interface sensors and control devices to processor unit.
 - .3 Include, but not be limited to, following:
 - .1 Programmed firmware or logic circuits to meet functional and technical requirements.
 - .2 Power supplies for operation of logics devices and associated field equipment.
 - .3 Lockable wall cabinet.
 - .4 Required communications equipment and wiring (if remote units).
 - .5 Leave controlled system in "fail-safe" mode in event of loss of communication with, or failure of, processor unit.
 - .6 Input Output interface to accept as minimum Analog Input, Analog Output, Digital Input, Digital Output functions as specified.
 - .7 Wiring terminations: use conveniently located screw type or spade lug terminals.
 - .4 Analog Input interface equipment to:
 - .1 Convert analog signals to digital format with 10 bit analog-to-digital resolution.
 - .2 Provide for following input signal types and ranges:
 - .1 4 - 20 mA;
 - .2 0 – 10 V DC;
 - .3 100/1000 ohm RTD input;
 - .3 Meet IEEE C37.90.1 surge withstand capability.
 - .4 Have common mode signal rejection greater than 60 dB to 60 Hz.
 - .5 Where required, dropping resistors to be certified precision devices which complement accuracy of sensor and transmitter range specified.
 - .5 Analog Outputs interface equipment:
 - .1 Convert digital data from controller processor to acceptable analog output signals using 8 bit digital-to-analog resolution.
 - .2 Provide for following output signal types and ranges:
 - .1 4 - 20 mA.
 - .2 0 – 10 VDC.
 - .3 Meet IEEE C37.90.1 surge withstand capability.
 - .6 Binary Input interface equipment:
 - .1 Able to reliably detect contact change of sensed field contact and transmit condition to controller.
 - .2 Meet IEEE C37.90.1 surge withstand capability.
 - .3 Accept pulsed inputs up to 2 kHz.
 - .7 Binary Output interface equipment:
 - .1 Respond to controller processor output, switch respective outputs. Each DO hardware to be capable of switching up to 0.5 amps at 24V AC.

- .2 Switch up to 5 amps at 220V AC using optional interface relay.
- .4 Controllers and associated hardware and software: operate in conditions of 0°C to 44 °C and 20 % to 90 % non-condensing RH.
- .5 Controllers (MCU, LCU): mount in wall mounted cabinet with hinged, keyed-alike locked door.
 - .1 Provide for conduit entrance from top, bottom or sides of panel.
 - .2 ECUs and TCUs to be mounted in equipment enclosures or separate enclosures.
 - .3 Mounting details as approved by Engineer for ceiling mounting.
- .6 Cabinets to provide protection from water dripping from above, while allowing sufficient airflow to prevent internal overheating.
- .7 Provide surge and low voltage protection for interconnecting wiring connections.

1.6 SUBMITTALS

- .1 Make submittals in accordance with:
 - .1 Division 01 – General Requirements.
 - .2 Section 21 05 01 – Common Work Results for Mechanical.

1.7 MAINTENANCE PROCEDURES

- .1 Provide manufacturers recommended maintenance procedures in Operations and Maintenance Manual.

Part 2 Products

2.1 BUILDING CONTROLLER

- .1 General Requirements:
 - .1 BACnet Conformance:
 - .1 Building Controller shall be approved by the BTL as meeting the BACnet Building Controller requirements.
 - .2 Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
 - .2 Communication:
 - .1 Each Building Controller shall support direct Ethernet or a communications card. The Building Controller shall be connected to the BACnet network using the ISO 8802-3 (Ethernet) Data Link/ Physical layer protocol.
 - .2 Each Building Controller with a communications card shall perform BACnet routing if connected to a network of Custom Application and Application Specific Controllers.

- .3 The controller shall provide a service communication port using BACnet Data Link/ Physical layer protocol P-T-P for connection to a hand-held workstation/ and/or modem.
- .4 The Building Controller secondary communication network shall support BACnet MS/TP.
- .3 Environment: Controller hardware shall be suitable for the anticipated ambient conditions.
 - .1 Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures, and shall be rated for operation at 32°F to 100°F and 10 to 90% RH.
 - .2 Controllers used in conditioned space shall be mounted in dust-proof enclosures, and shall be rated for operation at 32°F to 120°F.
- .4 Building Controllers shall be fully peer to peer.
- .5 Serviceability: Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field- removable, modular terminal strips — or to a termination card connected by a ribbon cable.
- .6 Memory: The Building Controller shall have as a minimum standard SRAM of 256 KB, standard DRAM of 1MB and standard non-volatile 1 MB of flash memory in lieu of EPROM. Memory shall be user extendible through RAM chip sockets and SIMMs for future memory expansion.
- .7 Immunity to power and noise: Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. The Building Controller shall maintain all database information including BIOS and programming information in the event of a power loss for at least 72 hours. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m.
- .8 Inputs/Outputs:
 - .1 Inputs: Controller input/output board shall support dry contact, 0-5 VDC and 0-10 VDC- voltage, 4-20 mA- current and thermistor-resistive signal types on an individual basis for connecting any status or sensing device. Analog resolution shall be 10-bit A to D.
 - .2 Outputs: Controller input/output board shall support plug-and-play I/O modules or built in HOA modules configured with manual-auto-off override switch, potentiometer and input channel for feedback status or and unrelated analog or digital input. Output supported shall be 0-10 VDC. All HOA's shall be supervised.
 - .3 Diagnostics: Controller input/output board shall have red LEDs providing input status indication.
 - .4 External Power: Controller input/output board shall have one on-board 24 VDC terminal for directly connected active transducers.

2.2

ADVANCED APPLICATION CONTROLLERS

- .1 General: Provide an adequate number of Advanced Application Controllers to achieve the performance specified in the Part 1 Article on "System Performance." Each of these panels shall meet the following requirements.

- .1 The Advanced Application Controller shall have sufficient memory to support its operating system, database, and programming requirements.
- .2 Advanced Application Controllers shall be fully peer to peer.
- .3 The operating system of the Controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information, and allow central monitoring and alarms.
- .4 All equipment that requires scheduling shall be scheduled in that equipment's controller.
- .5 Both firmware and controller database shall be loadable over the network.
- .2 Communication:
 - .1 Each Advanced Application Controller shall reside on a BACnet network using the MS/TP or Ethernet Data Link/ Physical layer protocol.
 - .2 The controller shall provide a service communication port using BACnet Data Link/ Physical layer protocol for connection to portable operator's workstation and allow access to the entire network.
- .3 Environment. Controller hardware shall be suitable for the anticipated ambient conditions.
 - .1 Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures, and shall be rated for operation at 0°C to 40°C.
 - .2 Controllers used in conditioned space shall be mounted in dust-proof enclosures, and shall be rated for operation at 0°C to 50°C.
- .4 Serviceability: Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips — or to a termination card connected by a ribbon cable.
- .5 Memory: The Advanced Application Controller shall be non-volatile FLASH memory.
- .6 Immunity to power and noise: Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m.

2.3 APPLICATION SPECIFIC CONTROLLERS

- .1 General: Provide an adequate number of Advanced Application Controllers to achieve the performance specified in the Part 1 Article on "System Performance." Each of these panels shall meet the following requirements.
 - .1 The Application Specific Controller shall have sufficient memory to support its operating system, database, and programming requirements.
 - .2 Application Specific Controllers shall be fully peer to peer.
 - .3 The operating system of the Controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information, and allow central monitoring and alarms.
 - .4 Both firmware and controller database shall be loadable over the network.
 - .5 Advanced Application Controllers shall be BTL listed as a B-ASC device.

- .2 Communication:
 - .1 Each Application Specific Controller shall reside on a BACnet network using the MS/TP or Ethernet Data Link/ Physical layer protocol.
 - .2 The controller shall provide a service communication port using BACnet Data Link/ Physical layer protocol for connection to portable operator's workstation and allow access to the entire network.
- .3 Environment: Controller hardware shall be suitable for the anticipated ambient conditions.
 - .1 Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures, and shall be rated for operation at 0°C to 40°C.
 - .2 Controllers used in conditioned space shall be mounted in dust-proof enclosures, and shall be rated for operation at 0°C to 50°C.
- .4 Serviceability: Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips — or to a termination card connected by a ribbon cable.
- .5 Memory: The Application Specific Controller shall be non-volatile FLASH memory.
- .6 Immunity to power and noise: Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m.

2.4 INPUT/OUTPUT INTERFERENCE

- .1 Hardwired inputs and output points/objects may be wired into the system through building, Custom Application.
- .2 All input and output points shall be protected such that shorting of the point to itself, to another point, or to ground, will cause no damage to the controller. All input and output points shall be protected from voltage up to 24 volts of any duration, such that contact with this voltage will cause no damage to the controller.
- .3 Digital inputs shall allow the monitoring of ON/OFF signals from remote devices. The digital inputs shall provide a current of at least 12 mA to be compatible with commonly available control devices, and shall be protected against the effects of contact bounce and noise. Digital inputs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.
- .4 Analog inputs shall allow the monitoring of 0-5 VDC, 0-10 VDC-voltage, 4-20 mA-current, or thermistors. Analog inputs shall be compatible, and be field configurable to commonly available sensing devices.
- .5 Digital outputs shall provide for ON/OFF operation. Digital outputs on Building and Advanced Application Controllers shall have three-position override switches, Hand-Off-Auto with status lights. Outputs shall be selectable for either normally open or normally closed operation.

- .6 Analog outputs shall provide a modulating signal for the control of end devices. Outputs shall provide a 0 to 10 VDC signal as required to provide proper control of the output device. Analog outputs on Building or Advanced Application Controllers shall have status lights and a two-position (AUTO/MANUAL) switch and manually adjustable potentiometer for manual override. Analog outputs shall not exhibit a drift of greater than 0.4% of range per year.
- .7 Tri-State Outputs: Provide tri-state outputs (two coordinated binary outputs) for control of three-point floating type electronic actuators without feedback. Use of three-point floating devices shall be limited to zone control and terminal unit control applications (VAV terminal units, duct mounted heating coils, zone dampers, radiation, etc.).
- .8 Input/Output points/objects shall be universal type, i.e., controller input or output may be designated (in software) as either a binary or analog type point/object with appropriate properties. Application Specific Controllers are exempted from this requirement.
- .9 System Object Capacity: The system size shall be expandable to at least twice the number of input/output objects required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The Operator Workstations installed for this project shall not require any hardware additions or software revisions in order to expand the system.

2.5

CONTROL PANELS

- .1 Local Control Panels: Unitized NEMA 1 cabinet with suitable brackets for wall or floor mounting, located adjacent to each system under automatic control. Provide common keying for all panels.
 - .1 Fabricate panels of 0.06-inch thick, furniture-quality steel, or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish.
 - .2 Interconnections between internal and face-mounted devices pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL Listed for 600 volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
 - .3 Door-Mounted Equipment: Flush-mount (on hinged door) manual switches, including damper-positioning switches, changeover switches, thermometers, and gages.
 - .4 Provide ON/OFF power switch with over-current protection for control power sources to each local panel.
 - .5 When a control panel is located in a mechanical room with a HTHW heat exchanger, the panel shall be located in a NEMA 4x cabinet. If there is any question or an acceptable type panel, clarify with Owner's Representative.
 - .6 Provide engraved plastic nameplates indicating panel identification and all instruments and controls inside the cabinet and on the cabinet face.

2.6 TREND LOGS

- .1 The operator shall be able to define a custom trend log for any data object in the system. This definition shall include change-of-value digital, change-of-value analog, time interval, start time, and stop time. Trend data shall be sampled and stored on the Building Controller panel, and be archiveable on the hard disk and be retrievable for use in spreadsheets and standard database programs. Contractor to set up all trend logging requested by Owner's Representative.

As a minimum, Contractor to set up trend logging as outlined below:

Data logging to be set up by Contractor, format to be pre-approved by the Owner's Representative. The following points must be logged hourly for typical systems. Logs must be continuously updated.

- .1 D/N Points:

- D/N point switch over
- Space setpoint used as a D/N reference point
- Space actual temperature used as a D/N reference point
- Building override status, if used

If there are multiple zones, with separate D/N control, provide a trend log for each, containing the above information.

- .2 Scheduled Water:

- OAT temperature
- Scheduled water actual temperature
- Valve position (EMCS output signal) or boiler control input from EMCS
- Schedules water setpoint
- Scheduled water actual temperature

- .3 Pump Control:

- OAT temperature
- Lowest space value
- Pump control output value from EMCS (pump status value preferred if available)
- Pump status value if available

2.7 POWER SUPPLIES AND LINE FILTERING

- .1 Control transformers shall be UL listed. Furnish Class 2 current-limiting type, or furnish over-current protection in both primary and secondary circuits for Class 2 service per NEC requirements. Limit connected loads to 80% of rated capacity.
 - .1 DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100 microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection, and shall be able to withstand a 150% current overload for at least 3 seconds without trip-out or failure.
 - .1 Unit shall operate between 0°C and 50°C. EM/RF shall meet FCC Class B and VDE 0871 for Class B, and MIL-STD 810C for shock and vibration.

- .2 Line voltage units shall be UL recognized and CSA approved.
- .2 Power line filtering:
 - .1 Provide transient voltage and surge suppression for all workstations and controllers either internally or as an external component. Surge protection shall have the following at a minimum:
 - .1 Dielectric strength of 1,000 volts minimum.
 - .2 Response time of 10 nanoseconds or less.
 - .3 Transverse mode noise attenuation of 65 dB or greater.
 - .4 Common mode noise attenuation of 150 dB or better at 40 Hz to 100 Hz.
 - .3 Each panel shall have its own power supply/transformer.

Part 3 Execution

3.1 LOCATION

- .1 Location of Controllers to be approved by Owner's Representative.

3.2 INSTALLATION

- .1 Install Controllers in secure locking enclosures. Provide 120 V duplex receptacles on outside of each main control cabinet.
- .2 Provide necessary power from local 120 E.P.S. V branch circuit panel for equipment.
- .3 Install tamper locks on breakers of circuit breaker panel.
- .4 Use uninterruptible Power Supply (UPS) and emergency power when equipment must operate in emergency and co-ordinating mode. The UPS shall be rated for 850 VA/450W minimum and provide 90 minutes of backup power at 40W.

END OF SECTION