SECTION 23 09 00 - HVAC INSTRUMENTATION AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The section "Special Requirements" forms a part of this section by this reference thereto and shall have the same force and effect as if printed herewith in full. The Contract Drawings and the Standard Form of Agreement apply to this Section.

1.2 SUMMARY

A. This specification section is included for reference and documentation only. The University has previously entered into a competitively bid, open-book guaranteed pricing agreement with O.Z. Enterprises, Inc. and will issue a work order directly to O.Z. Enterprises, Inc. for the work described in this section. The mechanical contractor shall not include the cost for the work described in this section in his bid.

B. This Section includes automatic temperature control requirements for HVAC systems.

C. This project includes the following:

1. Control interface to the new rooftop air handling systems, modifications to the existing controls for the existing 2 pipe system conversion to a 4 pipe system, fan coil unit controls, air curtain controls, radiant panel and finned tube radiation controls, exhaust fan controls and relocation of zone sensors for the existing AHU-1 controls.

2. The rooftop air handling system will be provided with controls provided by the manufacturer to control the functions of the unit. These controls shall be integrated to the Johnson Control System. The Mechanical Contractor, equipment supplier and O.Z. Enterprise shall coordinate the controls provided by the unit, communication interfaces and that the points available through the unit controls and points O.Z. Enterprises will need to provide. A brief description of this line of demarcation of controls is provided in the sequence of operation; however, the actual unit provided may have some variations. These variations shall be identified in the submittal.

1.3 RELATED SECTIONS

A. Division 23 Section "Sequence of Operation" for requirements that relate to this Section.

1.4 DEFINITIONS

A. DDC: Direct-digital controls.

B. LAN: Local area network.

1.5 SYSTEM DESCRIPTION

A. Functionality Description

1. The Facility Management and Control System (FMCS) as provided in this Division shall be based on an open architecture framework. An open architecture framework means an open automation infrastructure that integrates diverse systems and devices (regardless of manufacturer, communication standard or software) into a unified platform that can be

easily managed in real time over the Internet using a standard Web browser. Proprietary systems not developed on an open architecture framework are unacceptable.

2. Extension of the existing Johnson Controls FX40 based Niagara Framework web accessible system installed by O.Z. Enterprises is the basis of design. Currently, the university enjoys full access to the DDC controls currently installed in the new student housing complex as well as several other buildings on campus through the Niagara Framework interface accessible by any computer using a standard web browser via the internet or the university's intranet. It is the intent of this specification to expand the university DDC system currently installed at Slippery Rock University without affecting or losing any current functionality or accessibility in any existing building. To ensure maintaining current functionality / accessibility, any system installed under this project must utilize the Niagara Framework – no exceptions. Proprietary systems available through a single vendor/company only are not acceptable. The Niagara Framework must be used to ensure future open compatibility with other manufacturer's systems as the Niagara Framework is available through multiple vendors / companies. Under the expanded system, all existing controls in all buildings, as well as the new controls for this project, must be integrated into one system under the Niagara Framework to ensure no loss of current system functionality or accessibility (i.e. all points in all buildings are accessible through one interface as well as all alarming, trending/data logging and database management is handled through a single database system). Simple web page links to the existing university's DDC systems from a non-Niagara Framework based new system are unacceptable.

3. The final completed DDC System shall be comprised of at least one Network Area Controller (NAC) – NO EXCEPTONS. The NAC's shall connect to the owner's wide area network to create one system with multiple NAC's enjoying full read/write capabilities with each other. Furthermore, to ensure future interoperability with open systems by multiple manufacturers / suppliers, each network control panel shall communicate to both LonMark/LonTalk (IDC) and BACnet (IBC) controllers and other open and legacy protocol systems/devices. Network Controllers (NAC) that do not communicate to both LonMark/LonTalk and BACnet controllers shall not be accecptable.

4. All data (database, alarms, trend / data logging, etc.) from each NAC shall be archived as described later in this section to a centrally located Web Supervisor Data Server in one database. Access to the system, either locally in each building, or remotely from a central site or sites, shall be accomplished through standard Web browsers, via the Internet and/or local area network. The final system shall incorporate access to all points in all buildings via one interface / menu structure. Systems which require access to the buildings via two separate access points / addresses are unacceptable.

5. Each NAC shall extend its capabilities through the use of application specific controllers (ASC) located in each school. The university utilizes application specific controllers as manufactured by Johnson Controls. In order to maintain consistency across the university from a re-stocking spare parts standpoint as well as a programming standpoint, All ASC's, including new ASC's for this project as well as existing ASC's throughout the university, shall be products of a single manufacturer – no exceptions. The ASC's shall also be fully compatible with the Niagara Framework NAC without the need for gateways or routers.

6. Furnish and install a complete DDC/electronic system of automatic temperature control as specified and as shown on the contract drawings.

7. The entire control installation, including control piping and electrical control wiring, shall be performed by skilled mechanics Supervised by the temperature control contractor's engineering representative. The temperature control contractor shall furnish and install control and interlock wiring between motor starter holding coils, auxiliary contacts, and

control devices, such as start/stop switches, pilot lights, electric relays, low limit thermostats, high limit thermostats, differential pressure switches, and associated safety and limit devices.

8. The control system shall be an extension to the existing Niagara Framework system as described above – NO EXCEPTIONS OR SUBSTITUTIONS.

B. General Product and Contractor Requirements

1. Materials and equipment shall be the catalog products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.

2. Install system using competent workmen who are fully trained in the installation of temperature control equipment.

3. Single source responsibility of supplier shall be the complete installation and proper operation of the ATC and control system and shall include debugging and proper calibration of each component in the entire system.

4. Supplier shall have an in-place support facility within 100 miles of the site with technical staff, spare parts inventory and all necessary test and diagnostic equipment.

5. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Section 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

6. ATC shall comply with UL 916 PAZX and 864 UDTZ and be so listed at the time of bid.

7. Design and build all system components to be fault-tolerant.

   a. Satisfactory operation without damage at 110% and 85% of rated voltage and at plus 3 Hertz variation in line frequency.

   b. Static, transient and short-circuit protection on all inputs and outputs.

   c. Protect communication lines against incorrect wiring, static transients and induced magnetic interference.

   d. Network-connected devices to be A.C. coupled or equivalent so that any single device failure will not disrupt or halt network communication.

   e. All real time clocks and data file RAM to be battery-backed for a minimum 72 hours and include local and system low battery indication.

   f. It must be possible to receive and print out alarms at a central location even when the workstation at that location is non-operational or taken out of service for periodic maintenance.

8. The temperature control contractor shall satisfactorily complete the entire control system so that it is functional and operating to the satisfaction of the Engineer. Systems and their controls and their sequencing must be demonstrated and operated to the satisfaction of the Engineer. It is the intent of this specification that this entire system, with its complement of equipment and controls, operate properly in accordance with the design concept and functional intent.

C. Automatic Temperature Control System Coordination:

1. Control Wiring: Branch circuit, feeder and power wiring to HVAC equipment, ATC system panels and electric motor operated dampers shall be provided by this contractor and in accordance with the NEC and Division 26 requirements. Unless otherwise specified on the drawings, 120 volt control and interlock wiring for HVAC systems and equipment indicated on the drawings will also be provided by the ATC Contractor. Low voltage control wiring (less than 120 volt) for HVAC systems and equipment shall be provided under Division 23 by the ATC Contractor. The ATC Contractor shall be responsible for furnishing and installing the thermostats, aquastats, etc. and the associated power wiring.

   a. Electric control wiring shall be in accordance with the National Electrical Code and Division 26 of these specifications and shall not be in conflict with state and local codes. All control wiring, outside of control panels, in exposed areas, shall be run in rigid steel conduit or EMT conduit. All low voltage control wiring (less than 30 Volts a/c) if located in concealed but accessible areas, may employ plenum rated cables installed in raceways. Wiring for controls, except the low voltage conductors, shall be single conductor solid or stranded copper not less than No. 12 AWG, 90 degrees C., with 600 volt Type THHN/THWN insulation. Wiring in panel construction may be No. 16 or No. 18 AWG copper provided same is properly protected and/or is in accordance with the NEC. No temperature control wiring installed under this contract shall be installed in common conduits with the building lighting and power circuit system.

   b. Low voltage two conductor and three conductor wire shall be twisted (six turns per foot) 16 AWG or 18 AWG wire, 90 degrees C., 600 volt THHN/THWN insulation. Cable shall be as manufactured by Alpha Wire Company, Belden Wire Company, Standard Wire and Cable or approved equal.

   c. All conduit, fittings, hangers and accessories for control wiring installed under Division 23 shall conform to the levels of quality specified under Division 26.

2. Smoke Detectors: Duct type smoke detectors for HVAC equipment will be furnished and installed by the Mechanical Contractor. The interlock or fan shutdown wiring shall be hard wired by the ATC Ccontractor to conform with the requirements of NFPA 90A. Wiring from contacts on the smoke detectors to the starters or control panels of HVAC equipment shall be provided by the ATC Contractor to shut down the equipment in accordance with the requirements of NFPA 90A. Power wiring and interface wiring from the duct type smoke detectors to the building fire alarm panel will be provided under Division 26.

3. Sensor Wells: Stainless steel separable wells for pipe mounted sensors required for ATC operation will be furnished by the ATC Contractor and installed in pipelines by the HVAC system installer at locations required by the ATC Contractor.

4. Control Valves: Automatic temperature control valves for HVAC equipment shall be furnished by the ATC Contractor and installed by the HVAC system installer.

5. Motor Operated Dampers: Motor operated dampers shall be furnished and installed in ductwork and at intake and discharge air louvers and ventilators under Division 23 by the HVAC systems installer. Air handling units will be factory furnished with dampers. Damper operators shall be furnished and installed by the ATC Contractor.

D. Description of Work

1. Provide control systems consisting of the following components, other apparatus and accessories required to operate mechanical systems and to perform functions specified.

a. Thermostats
b. Temperature Sensors
c. Carbon dioxide sensors
d. Static pressure sensors
e. Differential pressure switches
f. Air flow measuring stations
g. Control valves
h. Damper operators
i. Indicating devices
j. Interface equipment
k. Multi-purpose positioning relays
l. Transmitters
m. Miscellaneous accessories
n. Control panel
o. Alarm system
p. Control equipment.
q. Software.
r. All actuators and sensors required to provide the points on the points list.
s. Any apparatus that is required to meet the sequence of operation.

2. Provide the Facility Building Management and Control System (BMCS). This BMCS shall utilize the Niagara Framework. The BMCS shall consist of an information sharing network of stand-alone NAC's and Direct Digital Control Panels (DDCP's) to monitor and control equipment per the control sequence.

3. "Information sharing" shall be defined as the function of each DDCP to exchange data on the network trunk with other DDCP's without the need for additional devices such as network managers, gateways or central computers.

4. "Stand-alone" shall be defined as the function of each DDCP to independently monitor and control connected equipment through its own micro-computer.

1.6 SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. Each control device labeled with setting or adjustable range of control.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Schematic flow diagrams showing fans, coils, dampers, valves, air flow stations and control devices.
2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
3. Details of control panel faces, including controls, instruments, and labeling.
4. Written description of sequence of operation.
5. Schedule of valves including leakage and flow characteristics.
6. Trunk cable schematic showing programmable control unit locations and trunk data conductors.
7. Listing of connected data points, including connected control unit and input device.
8. System graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.
9. System configuration showing peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.

C. Software and Firmware Operational Documentation: Include the following:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On a compact disc or DVD disc, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.
   5. Software license required by and installed for DDC workstations and control systems.

D. Software Upgrade Kit: For Owner to use in modifying software to suit future system revisions or monitoring and control revisions.

E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

F. Maintenance Data: For systems to include in maintenance manuals specified in Division 1. Include the following:
   1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
   2. Interconnection wiring diagrams with identified and numbered system components and devices.
   3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
   4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
   5. Calibration records and list of set points.

G. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

H. Project Record Documents: Record actual locations of control components, including control units, thermostats, sensors and set points after the control loops have been tuned. Revise Shop Drawings to reflect actual installation and operating sequences.

1.7 QUALITY ASSURANCE

A. ATC Contractor Qualifications: An experienced contractor whose personnel have successfully completed the Niagara Framework manufacturer’s technical certification program and who can demonstrate the successful installation and completion of a minimum of ten (10) similar projects of similar size and scope to this project utilizing the Niagara Framework. Documentation verifying successful completion of the Niagara Framework manufacturer’s technical certification program as well as accompanying successfully completed project documentation shall be furnished to the owner, architect or engineer upon request.

B. Manufacturer Qualifications: A firm experienced in manufacturing automatic temperature-control systems similar to those indicated for this Project and with a record of successful in-service performance.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."

E. Ensure system is completed and commissioned.

1.8 COORDINATION

A. Coordinate location of thermostats, temperature sensors and other exposed control sensors with plans and room details before installation.

B. Coordinate supply of conditioned electrical circuits for control units and operator workstation.

C. Coordinate equipment with existing panelboards to achieve compatibility with starter coils and annunciation devices.

D. Coordinate work to ensure installation of components is complementary to installation of similar components in other systems.

E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

F. Coordinate actual operating set points and fan coil air flow rates with the balancing Subcontractor.

1.9 PROJECT RECORD DOCUMENTS

A. Accurately record actual location of control components, including panels, thermostats, temperature sensors, control valves, actuators and other sensors and apparatus.

B. Revise shop drawings to reflect actual installation, operating sequences and final set points after control loops have been tuned.

1.10 OPERATION AND MAINTENANCE DATA

A. Include systems descriptions, set points, and controls' settings and adjustments.

B. Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.

C. Include interconnection wiring diagrams complete field installed system with identified and numbered, system components and devices.

D. Include keyboard illustrations and step-by-step procedures indexed for each operator function.

1.11 GUARANTEE

A. The Building Management Control System, including all hardware and software components, shall be guaranteed for a period of one year as defined in General and Supplementary Conditions and Division 1. Any manufacturing and/or installation defects arising during this period shall be corrected without cost to the Owner.

1.12 MAINTENANCE SERVICE

A. Furnish service and maintenance of automatic controls system for one (1) year from Date of final acceptance by the Owner.

B. Provide complete service of controls systems, including call backs. Make minimum of two (2) complete normal inspections, one for heating system startup and one for cooling system; in addition to normal service calls to inspect, calibrate, and adjust controls, and submit written reports.

1.13 EXTRA MATERIALS

A. Provide a list of suggested extra materials and costs to owner prior to system final acceptance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Johnson Control by OZ Enterprises provided by a direct contract with the Slippery Rock University per the terms of the pre-negotiated open ended agreement.

2. Niagara Framework products

3. Tridium products

4. Substitutions are not permitted.

2.2 CONTROL AIR PIPING

A. Control air piping shall be copper tubing with soldered fittings and valves or

B. Piping hangers shall be clamp type.

C. All exposed copper tubing shall be hard drawn copper. All concealed copper tubing may be soft annealed kneeled copper.

D. All main and branch pneumatic control piping shall be copper. All pneumatic piping that is utilized for control of major equipment, such as air handling units, chillers, boilers, pumps, valves, dampers, etc. shall be either hard or soft copper.

2.3 CONTROL VALVES

A. Up to 2": Bronze body, bronze trim, rising stem, renewable composition disc, screwed ends, with backseating capacity repackable under pressure.

B. Valves for Hydronic Systems:

1. Rate for service pressure of 125 PSIG at 250 degrees Fahrenheit.

2. Replaceable plugs and seats of brass.

3. Size for 5 PSIG maximum pressure drop at design flow rate.

4. Two-way valves shall have equal percentage characteristics, three-way valves linear characteristics. Size two-way valve operators to close valves against pump shut off head.

2.4 DAMPER OPERATORS

A. General: Provide smooth proportional control with sufficient power for air velocities 50 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for fail safe operation.

B. Provide geared type electric motor damper operators. When operated at rated voltage, the operator shall be capable of delivering the torque required for continuous uniform movement of the damper, and shall withstand without damage continuous stalling. Operator shall function properly within range of 85 to 110% of line voltage.

C. The actuator shall have a -5 to 90 degree range which allocates 5 degrees for automatic compression and sealing of dampers.

D. Actuators shall be configurable for fail-closed and fail-open applications.

E. Proportioning operators shall be capable of stopping at all points in the cycle and starting in either direction from all points. Proportioning operators shall have spring returns to the fail safe position.

F. Actuators may include integral end switches versus separate remote mounted end switches. The ATC Contractor shall verify all actuators are securely mounted to the dampers shafts without slippage if the integral end switches are utilized.

G. Actuators shall be Belimo or equivalent as approved by the engineer.

2.5 ELECTRIC VALVE OPERATORS

A. Provide geared type electric motor valve operators. When operated at rated voltage, the operator shall be capable of delivering the torque required for continuous uniform movement of the valve, and shall withstand without damage continuous stalling. Operator shall function properly within range of 85 to 110% of line voltage.

B. Actuators shall be configurable for fail-closed and fail-open applications.

C. Proportioning operators shall be capable of stopping at all points in the cycle and starting in either direction from all points. Proportioning operators shall have spring returns to the fail safe position.

2.6 STATIC DIFFERENTIAL PRESSURE GAUGES

A. Provide static differential pressure gauges across all duct filters indicated on the drawings for monitoring static pressure differential.

B. Gauges shall be Dwyer Magnahelic or equal.

2.7 INDOOR AIR TEMPERATURE/HUMIDITY ROOM SENSORS (DIGITAL)

A. Sensor shall be a proportional temperature instrument.

B. The temperature sensing element shall be a thermistor, RTD or semi-conductor type.

C. Provide wall mounted polymer enclosure rated for -32 to 122oF and 0-95% non-condensing operation. The sensor shall have etched Teflon lead wires.

D. Sensor shall have a 0-10 VDC or 4-20 ma output corresponding to the temperature or humidity span of the instrument (0-120°F) or (0-100% RH).

E. Sensor temperature accuracy shall be +/-1oF through entire range. Sensor humidity accuracy shall be +/-3% through entire range.

F. Sensor shall be mounted no higher than 48” to the operating control in compliance with the ADA requirements.

2.8 DUCT TEMPERATURE/HUMIDITY SENSORS (DIGITAL)

A. Sensor shall be a proportional temperature instrument.

B. Provide gasketed galvanized steel junction box type for sensors located indoors.

C. The temperature sensing element shall be a thermistor, RTD or semi-conductor type.

D. Sensors shall be rated for -40 to 212^{o}F and 0-100% non-condensing operation. The probe shall be constructed of 304 stainless steel. The sensor shall have etched Teflon lead wires and be double encapsulated. The unit shall have a closed cell gasket to seal against duct leakage.

E. Sensor shall have a 0-10 VDC or 4-20 ma output corresponding to the temperature or humidity span of the instrument (0-120°F) or (0-100% RH).

F. Sensor temperature accuracy shall be +/-1^{o}F through entire range. The temperature sensing element shall be a thermistor, RTD or semi-conductor type.

G. Use duct averaging sensors in air handling units and in ducts where the smallest dimension is greater than 36".

2.9 SPACE STATIC PRESSURE SENSORS

A. The space static pressure sensor shall be comprised of a junction box mounted space static pressure pickup and pressure transmitter with a piezoresistive pressure sensor.

B. The transmitter shall of 2-wire design capable of transmitting a linear 0-10 VDC or 4-20 ma DC output single proportional to the pressure being measured.

C. The sensor shall have a pressure range of -0.25" to +0.25", a span adjustment of 20 to 100%, an accuracy of +_0.5% of span and a range suitable for the application.

D. The sensor shall be capable of operating accurately in an environment between 32^{o}F and 140^{o}F.

E. Provide surge dampener to dampen rapid fluctuations.

F. Provide stainless steel flat plate gasketed sensor pick-up to be mounted on a junction box appropriate for pressure sensor application.

G. The contractor shall be responsible for interconnecting the pressure transmitter to the static pressure probe assembly.

H. Provide weatherproof outdoor air pick-up for sensing outdoor air pressure.

2.10 DUCT STATIC PRESSURE SENSORS

A. The duct static pressure sensor shall be comprised of a duct mounted space static pressure pickup and pressure transmitter with a piezoresistive pressure sensor.

B. The transmitter shall of 2-wire design capable of transmitting a linear 0-10 VDC or 4-20 ma DC output single proportional to the pressure being measured. The transmitter shall have a local LCD readout.

C. The sensor shall have a pressure range of -5.0" to +5.0", a span adjustment of 20 to 100%, an accuracy of +_0.5% of span and a range suitable for the application.

D. The sensor shall be capable of operating accurately in an environment between 32^{o}F and 140^{o}F.

E. Provide surge dampener to dampen rapid fluctuations.

F. Single point static pressure sensor shall be constructed of 304 stainless steel or extruded aluminum and mounted on a carbon steel plate.

G. The contractor shall be responsible for interconnecting the pressure transmitter to the static pressure probe assembly.

H. Provide static pressure probe assembly according to duct size and manufacturer's recommendations.

2.11 IMMERSION WELL TEMPERATURE SENSORS (DIGITAL)

A. Sensor shall be a proportional temperature instrument.

B. Provide weatherproof cast aluminum enclosure for sensors located outdoors.

C. The temperature sensing element shall be a thermistor, RTD or semi-conductor type.

D. Sensors shall be rated for -40 to 212^{o}F and 0-100% non-condensing operation. The probe shall be constructed of 304 stainless steel. The sensor shall have etched Teflon lead wires and be double encapsulated.

E. Sensor shall have a 0-10 VDC or 4-20 ma output corresponding to the temperature or humidity span of the instrument (0-120°F) or (0-100% RH).

F. Sensor temperature accuracy shall be +/-1^{o}F through entire range. The temperature sensing element shall be a thermistor, RTD or semi-conductor type.

G. Select appropriate probe length in accordance with manufacturer's recommendations per pipe size.

2.12 FREEZESTATS

A. Freezestats shall have an extended 20 foot element to sense the temperature of the air entering the cooling coil. The freezestat shall respond to the coldest one foot segment.

B. If the temperature falls below the designated setpoint (usually 35°F) the freezestats output contacts shall transfer and stop the fan system. Freezestats shall be furnished with manual reset.

C. Provide the freezestats with identifying tags designed to prevent accidental removal.

D. Provide one freezestat for each 20 square feet of coil face area installed in a serpentine manner.

2.13 TRANSMITTERS

A. Sensors/Input Devices to BDCS

1. Room: Space temperature sensing shall be accomplished with a 10,000 Ohm NTC thermistor or 1,000 Ohm platinum RTD. Sensing temperatures shall range from 32 Deg. F. to 95 Deg. F.

2. Rigid Element Duct: Single point duct temperature sensors shall be the 1,000 ohm RTD type. The range shall be -40 to 240 degrees F with a factory calibration point of 32

degrees F. Accuracy shall be +/- 0.2 percent at calibration point. These sensors shall be used in the unit's discharge and return air ducts.

3. Averaging Element Duct: Averaging element sensors shall be the ohm RTD type. The range shall be -40 to 240 degrees F with a factory calibration point of 32 degrees F. Accuracy shall be +/-0.29 percent at calibration point. Minimum sensor length shall be 1.5 feet for a rigid averaging element sensor and 25 feet for a flexible averaging element sensor. These sensors shall be used in the unit mixed air or preheat coil discharge sections.

4. Outdoor air Temperature Sensor: Outdoor air temperature sensor shall be the 1,000 ohm RTD type. The range shall be -40 to 240 degrees F with a factory calibration point of 32 degrees F. Accuracy shall be +/- 0.2 percent at calibration point.

5. Liquid Immersion: Liquid Immersion temperature sensor shall be the ohm RTD type. The range shall be -40 to 240 degrees F with a factory calibration point of 32 degrees F. Accuracy shall be +/- % at calibration point.

6. Differential Pressure Switch: Differential Starter pressure air flow switch shall be SPDT snap action type. Range shall be .05 to WC.
   a. Carbon Dioxide Sensors
   b. Materials: Molded plastic enclosure
   c. Rating: 0 to 5000 ppm
   d. Mounting: Duct or Wall
   e. Range: 0 to 2000 ppm / 0-5000 User selectable
   f. Accuracy: +/- 50 ppm
   g. Output: 0-10 vDC, 4-20 mA
   h. Provide weather-cones for outdoor air CO2 sensors.

2.14 OPERATOR INTERFACE - WEB BROWSER CLIENTS

A. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer™ or Netscape Navigator™. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable.

B. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the FMCS, shall not be acceptable.

C. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.

D. The Web browser client shall support at a minimum, the following functions:

1. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.

2. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.

3. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.

4. Storage of the graphical screens shall be in the Network Area Controller (NAC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.

5. Real-time values displayed on a Web page shall update automatically without requiring a manual “refresh” of the Web page.

6. The system shall provide the capability to specify a user’s (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.

7. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:

   a. Modify common application objects, such as schedules, calendars, and set points in a graphical manner.

      1) Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.

      2) Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.

   b. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.

   c. View logs and charts

   d. View and acknowledge alarms

   e. Setup and execute SQL queries on log and archive information

E. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

2.15 COMMUNICATIONS PROCESSING

A. The design of the FMCS shall network operator workstations and stand-alone DDC Controllers. The network architecture shall consist of two levels, a high performance peer-to-peer network and NAC Controller specific local area networks.

B. Access to system data shall not be restricted by the hardware configuration of the building automation system. The hardware configuration of the BAS network shall be totally transparent to the user when accessing data or developing control programs.

C. Peer-to-Peer Network Level:

1. Operator workstations, Web Supervisor Data Servers and Network Area Controllers shall directly reside on a network such that communications may be executed directly between

NAC's, directly between workstations and between NAC's and workstations on a peer-to-peer basis.

2. Systems that operate via polled response or other types of protocols that rely on a central processor, file server, or similar device to manage panel-to-panel communications may be considered only if a similar device is provided as a standby. Upon a failure or malfunction of the primary central processor, the standby shall automatically, without any operator intervention, assume all BAS network management activities.

3. 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 peer-to-peer network. Access to data shall be based upon logical identification of building equipment. No hardware or software limits shall be imposed on the number of devices with global access to the network data.

4. Network design shall include the following provisions:

   a. Provide high-speed data transfer rates for alarm reporting, quick report generation from multiple controllers and upload/download efficiency between network devices. System performance shall insure that an alarm occurring at any DDC Controller is displayed at workstations and/or alarm printers within 5 seconds.

   b. Support of any combination of DDC Controllers and operator workstations directly connected to the peer-to-peer network. Minimum of 100 devices shall be supported on a single network.

   c. Message and alarm buffering to prevent information from being lost.

   d. Error detection, correction and retransmission to guarantee data integrity.

   e. Synchronization of real-time clocks, to include automatic daylight savings time updating between all DDC Controllers shall be provided.

D. DDC Controller Local Area Network (LAN):

1. This level communication shall support a family of application specific controllers and shall communicate bi-directionally with the peer-to-peer network through Network Area Controllers for transmission of global data.

2. Application specific controllers shall be arranged on the LANs in a functional relationship manner with NAC Controllers. For example, a VAV terminal unit controller shall be on a LAN from the NAC Controller that is controlling its corresponding AHU.

3. A maximum of 100 application specific controllers may be configured in an individual NAC's LAN to insure adequate global data and alarm response times.

   a. The FMCS shall operate as a true token-pass peer-to-peer communication network. Resident processors in each NAC shall provide for full exchange of system data between other NAC's on the network trunk. Systems that limit data exchange to a defined number of system points are not acceptable.

   b. Systems that operate via polled response or other types of protocols that rely on a central processor or similar device to manage NAC to NAC communications may be considered only if a similar device is provided as a standby. Upon a failure or malfunction of the primary device, the stand-by shall automatically, without any operator intervention, assume all BMCS network management activities.

c. The failure of any NAC on the network shall not affect the operation of other NAC's. A NAC failure shall be annunciated at the specified alarm printers or terminals.

2.16 DDCP HARDWARE - NETWORK AREA CONTROLLER (NAC)

A. The Automatic Temperature Controls Contractor shall supply at least one Network Area Controller as part of this contract – NO EXCEPTIONS. Additional NAC's may be required depending on the type and quantity of devices supplied to control the HVAC equipment.

B. The Network Area Controller (NAC) shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NAC. It shall be capable of executing application control programs to provide:
1. Calendar functions
2. Scheduling
3. Trending
4. Alarm monitoring and routing
5. Time synchronization
6. Integration of LonWorks controller data and BACnet controller data
7. Network Management functions for any LonWorks based devices

C. The Network Area Controller must provide the following hardware features as a minimum:
1. One Ethernet Port – 10/100 Mbps
2. One RS-232 port
3. One LonWorks Interface Port – 78KB FTT-10A
4. One RS-485 port
5. Battery Backup
6. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity)
7. The NAC must be capable of operation over a temperature range of 32 to 122°F
8. The NAC must be capable of withstanding storage temperatures of between 0 and 158°F
9. The NAC must be capable of operation over a humidity range of 5 to 95% RH, non-condensing

D. The NAC shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the NAC shall be an ODBC-compliant database or must provide an ODBC data access mechanism to read and write data stored within it.

E. The NAC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 32 simultaneous users.

F. Event Alarm Notification and Actions:

1. The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.

2. The NAC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up telephone connection, or wide-area network.

3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:
a. To alarm
b. Return to normal
c. To fault

4. Provide for the creation of a minimum of eight of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.

5. Provide timed (schedule) routing of alarms by class, object, group, or node.

6. Provide alarm generation from binary object “runtime” and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.

G. Control equipment and network failures shall be treated as alarms and annunciated.

H. Alarms shall be annunciated in any of the following manners as defined by the user:

1. Screen message text

2. Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:
   a. Day of week
   b. Time of day
   c. Recipient
   d. Level of Alarm

3. Text message.

4. Automated voice message to a phone.

5. Pagers via paging services that initiate a page on receipt of email message

6. Graphic with flashing alarm object(s)

7. Printed message, routed directly to a dedicated alarm printer

I. The following shall be recorded by the NAC for each alarm (at a minimum):

1. Time and date

2. Location (building, floor, zone, room number, etc.)

3. Equipment (air handler #, unit ventilator #, etc.)

4. Acknowledge time, date, and user who issued acknowledgement.

5. Number of occurrences since last acknowledgement.

J. Alarm actions may be initiated by user defined programmable objects created for that purpose.

K. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.

L. A log of all alarms shall be maintained by the NAC and the Web Supervisor Server (defined later in this section) and shall be available for review by the user.

M. Provide a “query” feature to allow review of specific alarms by user defined parameters.

N. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.

O. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

2.17 DATA COLLECTION AND STORAGE

A. The NAC shall have the ability to collect data for any property of any object and store this data for future use.

B. The data collection shall be performed by log objects, resident in the NAC that shall have, at a minimum, the following configurable properties:
1. Designating the log as interval or deviation.
2. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
3. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
4. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
5. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.

C. All log data shall be stored in a relational database in the NAC and the data shall be accessed from the Web Supervisor Server or a standard Web browser.

D. All log data, when accessed from the Web Supervisor Server, shall be capable of being manipulated using standard SQL statements.

E. D. All log data shall be available to the user in the following data formats:
1. HTML
2. XML
3. Electronic Spreadsheet
4. Plain Text
5. Comma or tab separated values

F. The NAC shall have the ability to archive its log data either locally (to itself), or remotely to the Web Supervisor Server on the network. Provide the ability to configure the following archiving properties, at a minimum:
1. Archive on time of day
2. Archive on user-defined number of data stores in the log (buffer size)
3. Archive when log has reached it’s user-defined capacity of data stores
4. Provide ability to clear logs once archived

G. Provide and maintain an Audit Log that tracks all activities performed on the NAC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the NAC), to another NAC on the network, or to a server. For each log entry, provide the following data:
1. Time and date
2. User ID
3. Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.

2.18 DATABASE BACKUP AND STORAGE

A. The NAC shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.

B. Copies of the current database and, at the most recently saved database shall be stored in the NAC. The age of the most recently saved database is dependent on the user-defined database save interval.

C. The NAC database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

2.19 GRAPHICAL USER INTERFACE (GUI) SOFTWARE

A. The GUI shall run on Microsoft Windows XP Professional operating system.

B. The GUI shall employ browser-like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu-pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.

C. Real-Time Displays. The GUI, shall at a minimum, support the following graphical features and functions:

1. Graphic screens shall be developed using any drawing package capable of generating a GIF, BMP, or JPG file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of a graphic background, the GUI shall support the use of scanned pictures.

2. Graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URL's, and links to other graphic screens.

3. Graphics shall support layering and each graphic object shall be configurable for assignment to a layer. A minimum of six layers shall be supported.

4. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.

   a. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.

   b. Holidays shall be set by using a graphical calendar without requiring any keyboard entry from the operator.

5. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.

6. Adjustments to analog objects, such as set points, shall be done by right-clicking the selected object and using a graphical slider to adjust the value. The user shall have the option of using the slider or entering text.

D. System Configuration. At a minimum, the GUI shall permit the operator to perform the following tasks, with proper password access:

1. Create, delete or modify control strategies.

2. Add/delete objects to the system.

3. Tune control loops through the adjustment of control loop parameters.

4. Enable or disable control strategies.

5. Generate hard copy records or control strategies on a printer.

6. Select points to be alarmable and define the alarm state.

7. Select points to be trended over a period of time and initiate the recording of values automatically.

E. On-Line Help. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext. All system documentation and help files shall be in HTML format.

F. Security. Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system administrator shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.

G. System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.

H. Alarm Console

1. The system will be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm. The use of the Alarm Console can be enabled or disabled by the system administrator.

2. When the Alarm Console is enabled, a separate alarm notification window will supercede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and un-acknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.

2.20 WEB SUPERVISOR SERVER FUNCTIONS AND HARDWARE

A. The central server shall support all Network Area Controllers (NAC) connected to the customer's network.

B. Local connections shall be via an Ethernet LAN. Remote connections can be via ISDN, ADSL, T1 or dial-up connection. Dial-up shall only be used as a secondary connection unless there are no other communications available at the facility.

C. It shall be possible to provide access to all Network Area Controllers via a single connection to the server. In this configuration, each Network Area Controller can be accessed from a remote

Graphical User Interface (GUI) or from a standard Web browser (WBI) by connecting to the server.

D. The server shall provide the following functions, at a minimum:

1. Global Data Access: The server shall provide complete access to distributed data defined anywhere in the system.

2. Distributed Control: The server shall provide the ability to execute global control strategies based on control and data objects in any NAC in the network, local or remote.

E. The server shall include a master clock service for its subsystems and provide time synchronization for all Network Area Controllers (NAC).

F. The server shall accept time synchronization messages from trusted precision Atomic Clock Internet sites and update its master clock based on this data.

G. The server shall provide scheduling for all Network Area Controllers and their underlying field control devices.

H. The server shall provide demand limiting that operates across all Network Area Controllers. The server must be capable of multiple demand programs for sites with multiple meters and or multiple sources of energy. Each demand program shall be capable of supporting separate demand shed lists for effective demand control.

I. The server shall implement the BACnet Command Prioritization scheme (16 levels) for safe and effective contention resolution of all commands issued to Network Area Controllers. Systems not employing this prioritization shall not be accepted.

J. Each Network Area Controller supported by the server shall have the ability to archive its log data, alarm data and database to the server, automatically. Archiving options shall be user-defined including archive time and archive frequency.

K. The server shall provide central alarm management for all Network Area Controllers supported by the server. Alarm management shall include:

1. Routing of alarms to display, printer, email, phone numbers and pagers

2. View and acknowledge alarms

3. Query alarm logs based on user-defined parameters

L. The server shall provide central management of log data for all Network Area Controllers supported by the server. Log data shall include process logs, runtime and event counter logs, audit logs and error logs. Log data management shall include:

1. Viewing and printing log data

2. Exporting log data to other software applications

3. Query log data based on user-defined parameters

M. Server Hardware Requirements: The server hardware platform shall have the following requirements:

1. The computer shall utilize a dual Intel Xeon processor (each having a minimum processing speed of 2.4 GHz with 8 GB RAM and a 4-teraabyte minimum hard drive). It shall include a DVD-RW/CD-RW Combination Drive, 2-parallel ports, 2-asynchronous serial ports and 2-USB ports. A minimum 21" flat panel color monitor, 3840 x 2160 optimal preset resolution, 25 ms response time shall also be included.

2. The server operating system shall be Microsoft Windows 7.0 or later. Include Microsoft Internet Explorer 10.0 or later.

3. Connection to the DDC network shall be via an Ethernet network interface card, 100 Mbps.

2.21 SYSTEM PROGRAMMING

A. The Graphical User Interface software (GUI) shall provide the ability to perform system programming and graphic display engineering as part of a complete software package. Access to the programming functions and features of the GUI shall be through password access as assigned by the system administrator.

B. A library of control, application, and graphic objects shall be provided to enable the creation of all applications and user interface screens. Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface displays shall not be acceptable.

C. Programming Methods

1. Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user's application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link; i.e., internal, external, hardware, etc.

2. Configuration of each object will be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.

3. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.

4. All programming shall be done in real-time. Systems requiring the uploading, editing, and downloading of database objects shall not be allowed.

5. The system shall support object duplication within a customer's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

2.22 OBJECT LIBRARIES

A. A standard library of objects shall be included for development and setup of application logic, user interface displays, system services, and communication networks.

B. The objects in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.

C. In addition to the standard libraries specified here, the supplier of the system shall maintain an on-line accessible (over the Internet) library, available to all registered users to provide new or updated objects and applications as they are developed.

D. All control objects shall conform to the control objects specified in the BACnet specification.

E. The library shall include applications or objects for the following functions, at a minimum:

1. Scheduling Object. The schedule must conform to the schedule object as defined in the BACnet specification, providing 7-day plus holiday & temporary scheduling features and a minimum of 10 on/off events per day. Data entry to be by graphical sliders to speed creation and selection of on-off events.

2. Calendar Object. . The calendar must conform to the calendar object as defined in the BACnet specification, providing 12-month calendar features to allow for holiday or special event data entry. Data entry to be by graphical "point-and-click" selection. This object must be "linkable" to any or all scheduling objects for effective event control.

3. Duty Cycling Object. Provide a universal duty cycle object to allow repetitive on/off time control of equipment as an energy conserving measure. Any number of these objects may be created to control equipment at varying intervals

4. Temperature Override Object. Provide a temperature override object that is capable of overriding equipment turned off by other energy saving programs (scheduling, duty cycling etc.) to maintain occupant comfort or for equipment freeze protection.

5. Start-Stop Time Optimization Object. Provide a start-stop time optimization object to provide the capability of starting equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled un-occupancy time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start / stop time object properties based on the previous day's performance.

6. Demand Limiting Object. Provide a comprehensive demand-limiting object that is capable of controlling demand for any selected energy utility (electric, oil, and gas). The object shall provide the capability of monitoring a demand value and predicting (by use of a sliding window prediction algorithm) the demand at the end of the user defined interval period (1-60 minutes). This object shall also accommodate a utility meter time sync pulse for fixed interval demand control. Upon a prediction that will exceed the user defined demand limit (supply a minimum of 6 per day), the demand limiting object shall issue shed commands to either turn off user specified loads or modify equipment set points to effect the desired energy reduction. If the list of sheddable equipment is not enough to

reduce the demand to below the set point, a message shall be displayed on the users screen (as an alarm) instructing the user to take manual actions to maintain the desired demand. The shed lists are specified by the user and shall be selectable to be shed in either a fixed or rotating order to control which equipment is shed the most often. Upon suitable reductions in demand, the demand-limiting object shall restore the equipment that was shed in the reverse order in which it was shed. Each sheddable object shall have a minimum and maximum shed time property to effect both equipment protection and occupant comfort.

F. The library shall include control objects for the following functions. All control objects shall conform to the objects as specified in the BACnet specification.

1. Analog Input Object - Minimum requirement is to comply with the BACnet standard for data sharing. Allow high, low and failure limits to be assigned for alarming. Also, provide a time delay filter property to prevent nuisance alarms caused by temporary excursions above or below the user defined alarm limits.

2. Analog Output Object - Minimum requirement is to comply with the BACnet standard for data sharing.

3. Binary Input Object - Minimum requirement is to comply with the BACnet standard for data sharing. The user must be able to specify either input condition for alarming. This object must also include the capability to record equipment run-time by counting the amount of time the hardware input is in an “on” condition. The user must be able to specify either input condition as the “on” condition.

4. Binary Output Object - Minimum requirement is to comply with the BACnet standard for data sharing. Properties to enable minimum on and off times for equipment protection as well as interstart delay must be provided. The BACnet Command Prioritization priority scheme shall be incorporated to allow multiple control applications to execute commands on this object with the highest priority command being invoked. Provide sixteen levels of priority as a minimum. Systems not employing the BACnet method of contention resolution shall not be acceptable.

5. PID Control Loop Object - Minimum requirement is to comply with the BACnet standard for data sharing. Each individual property must be adjustable as well as to be disabled to allow proportional control only, or proportional with integral control, as well as proportional, integral and derivative control.

6. Comparison Object - Allow a minimum of two analog objects to be compared to select either the highest, lowest, or equality between the two linked inputs. Also, allow limits to be applied to the output value for alarm generation.

7. Math Object - Allow a minimum of four analog objects to be tested for the minimum or maximum, or the sum, difference, or average of linked objects. Also, allow limits to be applied to the output value for alarm generation.

8. Custom Programming Objects - Provide a blank object template for the creation of new custom objects to meet specific user application requirements. This object must provide a simple BASIC-like programming language that is used to define object behavior. Provide a library of functions including math and logic functions, string manipulation, and e-mail as a minimum. Also, provide a comprehensive on-line debug tool to allow complete testing of the new object. Allow new objects to be stored in the library for re-use.

9. Interlock Object - Provide an interlock object that provides a means of coordination of objects within a piece of equipment such as an Air Handler or other similar types of

equipment. An example is to link the return fan to the supply fan such that when the supply fan is started, the return fan object is also started automatically without the user having to issue separate commands or to link each object to a schedule object. In addition, the control loops, damper objects, and alarm monitoring (such as return air, supply air, and mixed air temperature objects) will be inhibited from alarming during a user-defined period after startup to allow for stabilization. When the air handler is stopped, the interlocked return fan is also stopped, the outside air damper is closed, and other related objects within the air handler unit are inhibited from alarming thereby eliminating nuisance alarms during the off period.

10. Temperature Override Object - Provide an object whose purpose is to provide the capability of overriding a binary output to an “On” state in the event a user specified high or low limit value is exceeded. This object is to be linked to the desired binary output object as well as to an analog object for temperature monitoring, to cause the override to be enabled. This object will execute a Start command at the Temperature Override level of start/stop command priority unless changed by the user.

11. Composite Object - Provide a container object that allows a collection of objects representing an application to be encapsulated to protect the application from tampering, or to more easily represent large applications. This object must have the ability to allow the user to select the appropriate parameters of the “contained” application that are represented on the graphical shell of this container.

G. The object library shall include objects to support the integration of devices connected to the Network Area Controller (NAC). At a minimum, provide the following as part of the standard library included with the programming software:

1. LonMark/LonWorks devices. These devices shall include, but not be limited to, devices for control of HVAC, lighting, access, and metering. Provide LonMark manufacturer-specific objects to facilitate simple integration of these devices. All network variables defined in the LonMark profile shall be supported. Information (type and function) regarding network variables not defined in the LonMark profile shall be provided by the device manufacturer.

2. For devices not conforming to the LonMark standard, provide a dynamic object that can be assigned to the device based on network variable information provided by the device manufacturer. Device manufacturer shall provide an XIF file, resource file and documentation for the device to facilitate device integration.

H. For BACnet devices, provide the following objects at a minimum:
1. Analog In
2. Analog Out
3. Analog Value
4. Binary
5. Binary In
6. Binary Out
7. Binary Value
8. Multi-State In
9. Multi-State Out
10. Multi-State Value
11. Schedule Export
12. Calendar Export
13. Trend Export
14. Device

I. For each BACnet object, provide the ability to assign the object a BACnet device and object instance number. For BACnet devices, provide the following support at a minimum.

1. Segmentation
2. Segmented Request
3. Segmented Response
4. Application Services
5. Read Property
6. Read Property Multiple
7. Write Property
8. Write Property Multiple
9. Confirmed Event Notification
10. Unconfirmed Event Notification
11. Acknowledge Alarm
12. Get Alarm Summary
13. Who-has
14. I-have
15. Who-is
16. I-am
17. Subscribe COV
18. Confirmed COV notification
19. Unconfirmed COV notification
20. Media Types
21. Ethernet
22. BACnet IP Annex J
23. MSTP
24. BACnet Broadcast Management Device (BBMD) function
25. Routing

2.23 APPLICATION SPECIFIC CONTROLLERS - HVAC APPLICATIONS

A. Each Standalone Network Area Controller shall be able to extend its performance and capacity through the use of remote ApplicationSpecific Controllers (ASCs).

B. Each ASC shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor.

C. Each ASC shall have sufficient memory to support its own operating system and data bases including:
   1. Control Processes
   2. Energy Management Applications
   3. Operator I/O (Portable Service Terminal)

D. Application Specific Controllers shall directly support the temporary use of a portable service terminal. The capabilities of the portable service terminal shall include but not be limited to the following:
   1. Display temperature
   2. Display status
   3. Display setpoints
   4. Display control parameters
   5. Override binary output control
   6. Override analog setpoints
   7. Modification of gain and offset constants

E. Powerfail Protection: All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the controller. After a power failure, the controller shall be capable of automatic reset and resuming control after annunciating an alarm. If the controls

restart without error, a lower level alarm shall be annunciated. If the controls do not restart, a higher level alarm shall be annunciated.

F. Central Plant (DX-9100) programmable controllers:

1. Programmable controllers shall support, but not be limited to the following configurations of systems to address current requirements described in the "Sequence of Operation" portion of this specification, and for future expansion.

   a. Air Handling Units

   b. Generic system interlocking through hardware.

2. Programmable controllers shall support all the necessary point inputs and outputs to perform the specified control sequences in a totally standalone fashion.

3. Programmable controllers shall have a built-in status and adjust panel interface to allow for the local adjustment of all setpoints, temporary override of any input or output points and status of any points in alarm.

4. Alarm Management: Each Programmable controller shall perform its own limit and status monitoring and analysis to maximize network performance by reducing unnecessary communications.

G. Air Handling Unit (AHU) Controllers:

1. AHU Controllers shall support the specified sequence of operation and requirements as described in the "Sequence of Operation" section of the specifications, and for future expansion.

2. AHU Controllers shall support all the necessary point inputs and outputs to perform the specified control sequences in a totally standalone fashion.

3. AHU Controllers shall have a library of control routines and custom program logic to perform the sequence of operation as described in the "Sequence of Operation" section of the specifications.

4. AHU Controllers shall support the following types of point inputs and outputs in addition to air handling unit functions:

   a. Proportional Heating and Cooling Outputs for air handling unit and fan coil unit control.

   b. Fan Control Output (On/Off Logic, or Proportional Series Fan Logic)

   c. Damper and Control Valve actuation

   d. Analog and Binary Sensor Inputs

5. AHU Controllers shall support the following library of control strategies to address the requirements of the sequences described in the "Execution" portion of this specification, and for future expansion:
   a. Daily Schedules
   b. Comfort/Occupancy Mode
   c. Economy Mode
   d. Standby Mode

e. Unoccupied
f. Shutdown
g. Temporary Override Mode

6. Occupancy-based Comfort Mode Control: Each AHU controller shall have a provision for occupancy sensing overrides. Based upon the contact status of either a manual wall switch or an occupancy sensing device, the AHU Controller shall automatically select either an Unoccupied or Occupied mode set points.

7. Continuous Zone Temperature Histories: Each AHU Controller shall automatically and continuously maintain a history of the associated space temperature to allow users to quickly analyze space comfort and equipment performance for the past 24 hours. A minimum of two samples per hour shall be stored.

8. Alarm Management: Each AHU Controller shall perform its own limit and status monitoring and analysis to maximize network performance by reducing unnecessary communications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that conditioned power supply is available to control units.

B. Verify that duct-, pipe-, and equipment-mounted devices and wiring are installed before proceeding with installation.

3.2 INSTALLATION

A. Install equipment level and plumb.

B. Install software in control units and operator workstation. Implement all features of programs to specified requirements and as appropriate to sequence of operation.

C. Connect and configure equipment and software to achieve sequence of operation specified.

D. Verify location of thermostats and other exposed control sensors with plans and room details before installation. Locate all 48 inches above the floor meeting ADA requirements, unless noted otherwise on the drawings. Co-ordinate and verify all proposed locations prior to proceeding.

1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

E. Install guards on thermostats in the following locations:

1. Entrances.
2. Public areas.
3. Where indicated.

F. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

G. Transmitter and/or transducer shall be mounted in an accessible location.

H. Verify calibration of temperature sensors once installed.

I. Furnish control valves to Mechanical Contractor to install in piping systems.

J. Provide wiring of freezestats and firestats into the control circuit of the fans.

K. Wire smoke detectors to associated fan shutdown circuits.

L. Coordinate locations of temperature wells and other piping appurtenances required for the control system with the Mechanical Contractor.

3.3 ACTUATOR INSTALLATION

A. Actuators for BAS/DDC control systems shall be as follows:

1. Provide electric valve actuators for all water control valves 2” and under.
2. Provide electric damper actuators for all damper banks 48” or less in any dimension.

3.4 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. General: Provide a complete system of electric wiring for temperature control apparatus. In addition, provide 120 VAC power to terminal equipment controllers and various DDC panels, subpanels, damper actuators and valves.

B. The ATC contractor shall be responsible for all electrical installation which is necessary to achieve a fully functional ATC system (and which may or may not be shown on the Electrical Drawings, or required by the Division 26 Electrical Specifications). All wiring shall also be in accordance with applicable local and national codes.

C. Install control wire, raceways, boxes, and cabinets according to applicable sections of Division 26 Electrical.

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.

2. Install exposed cable in raceway.

3. All control wiring shall be routed in rigid steel conduit or EMT. Low voltage control wiring may be routed in plenum rated cable, without conduits, above accessible ceilings only.

4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.

5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.

6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.

D. Connect manual-reset limit controls independent of manual-control switch positions.

E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.5 CONNECTIONS

A. Coordinate piping installations and specialty arrangements with schematics on Drawings and with requirements specified in piping systems. If Drawings are explicit enough, these requirements may be reduced or omitted.

B. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Install piping adjacent to machine to allow service and maintenance.

C. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.6 DEMONSTRATION

A. Engage a factory-trained service representative to train Owner's maintenance personnel to adjust, operate, and maintain control systems and components.
1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
2. Provide operator training on data display, alarm and status descriptors, requesting data, executing commands, calibrating and adjusting devices, resetting default values, and requesting logs. Include a minimum of 16 hours' dedicated instructor time on-site.
3. Review data in maintenance manuals.
4. Schedule training with Owner with at least ten business days' advance notice.

3.7 ON-SITE ASSISTANCE

A. Occupancy Adjustments: Within one year of date of Substantial Completion, provide Project site visits, when requested by Owner, to adjust and calibrate components and to assist Owner's personnel in making program changes and in adjusting sensors and controls to suit actual conditions.

END OF SECTION 23 09 00

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