23 09 00 CONTROLS AND INSRUMENTATION

This specification section is a living document due to the nature of the rapid changes in technology. Please consult UNC as to any new changes. This is not intended to be the final version of the specification section to be inserted into a project manual. The Engineer is responsible for the review and adaptation that is required for each individual project application. It is requested that the Engineer red-line this document for UNC to review for each individual project.

BUILDING AUTOMATION INSTRUMENTATION AND CONTROLS SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. This Section covers the requirements for the Building Automation System hardware, software, instrumentation and control equipment for HVAC systems and components, lighting, energy and utility monitoring, and security including but not limited to:

1. Furnish and install a complete, fully functional BAS control system per this specification and construction documents including all computer software and hardware, licensing, construction supervision, startup and commissioning, demonstration and training, and warranty service.

2. Actuators, thermostats, sensors, transmitters, transducers, relays, local control panels, thermowells, instrument air compressors, filter/dryers, gauges.

3. Control valves, dampers, linkages, and mounting hardware as applicable.

4. Control components for terminal heating and cooling units not supplied with factory-wired controls.

B. Related Sections include the following:

1. Division 15 Section "Meters and Gages" for measuring equipment that relates to this Section.

2. Division 15 Section "Sequence of Operation" for requirements that relate to this Section.

3. Division 16 Section “Panelboards” for measuring requirements that relate to this Section.

4. Division 16 Section “Interior Lighting” for requirements related to

this Section.

5. Division 16 Section “Exterior Lighting” for requirements related to this Section.

6. Division 16 Section “Fire Detection and Alarm” for requirements related to this Section.

7. Division 16 Section “Basic Electrical Requirements” and “Basic Electrical Materials and Methods” for requirements related to this Section.

C. Products Supplied, But Not Installed Under This Section:

1. The Controls Contractor shall provide all automatic temperature control dampers for installation by the Mechanical Contractor under the Control Contractor’s supervision.

1.02 DEFINITIONS

A. It is the intent of these specifications and drawings to call for finished work, tested, and ready for operation. Whenever the word “provide” is used, it shall mean “furnish and install complete and ready for use”.

B. DDC/BAS: Direct Digital Control/Building Automation System.

C. I/O: Input/output.

D. IP: Internet Protocol

F. MS/TP: Master slave/token passing.

G. PC: Personal computer.

H. PID: Proportional plus integral plus derivative.

I. RTD: Resistance temperature detector.

1.03 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:

1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.

2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.

3. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:

a. Water Temperature: Plus or minus 1 deg F.

b. Water Flow: Plus or minus 5 percent of full scale.

c. Water Pressure: Plus or minus 2 percent of full scale.

d. Space Temperature: Plus or minus 1 deg F.

e. Ducted Air Temperature: Plus or minus 1 deg F.

f. Outside Air Temperature: Plus or minus 2 deg F.

g. Dew Point Temperature: Plus or minus 3 deg F.

h. Temperature Differential: Plus or minus 0.25 deg F.

i. Relative Humidity: Plus or minus 5 percent.

j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.

k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.

l. Airflow (Terminal): Plus or minus 10 percent of full scale.

m. Air Pressure (Space): Plus or minus 0.01-inch wg.

n. Air Pressure (Ducts): Plus or minus 0.1-inch wg.

o. Carbon Dioxide: Plus or minus 50 ppm.

p. Electrical: Plus or minus 5 percent of reading.

1.04 SUBMITTALS

Submittals must meet the requirements under specification section 01300.

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. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.

2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications. Include all necessary licensing documentation.

3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

B. Shop Drawings: Drawings shall be prepared using AutoCAD 2005 or latest version. Final or record drawings shall be submitted in electronic PDF format, and three 11x 17 printed and bound sets, and one 11x 17 laminated set. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Bill of materials of equipment indicating quantity, manufacturer, and model number.

2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.

3. Wiring Diagrams: Power, signal, and control wiring.

4. Details of control panel faces, including controls, instruments, and labeling.

5. Written description of sequence of operation.

6. Schedule of dampers including size, leakage, fail position, and flow characteristics.

7. Schedule of valves including flow characteristics.

8. DDC System Hardware:

a. Wiring diagrams for control units with termination numbers.

b. Schematic diagrams and floor plans for field sensors and control hardware.

c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.

9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.

10. Controlled Systems:

a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.

b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.

c. Scaled floor and roof plan drawings showing the location of control panels, sensors, etc…

d. Written description of sequence of operation including schematic diagram.

e. Points list.

C. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.

D. Qualification Data: For Installer and manufacturer.

E. Field quality-control test reports.

F. Project Record Documents. Submit three copies of record (as-built) documents upon completion of installation for approval prior to final completion. Submittal shall consist of:

1. Project Record Drawings. As-built versions of submittal shop drawings provided as AutoCAD 2004 (or newer) compatible files (file format: .DWG, .DXF, .VSD, or comparable) and 6 prints of each drawing on 11" x 17" paper and a PDF electronic version of the final as-built control drawings.

2. Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements of Section 15900 Article 3.16 (Control System Demonstration and Acceptance).

3. Operation and Maintenance (O&M) Manual. Printed and electronic PDF documentation of the following:

    a. As-built versions of submittal product data.

    b. Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.

    c. Operator's manual with procedures for operating control systems: logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.

    d. Programming manual or set of manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.

    e. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.

    f. Documentation of programs created using custom programming language including setpoints, tuning parameters, and object database. Electronic copies of programs shall meet this requirement if control logic, setpoints, tuning parameters, and objects can be viewed using furnished programming tools.

    g. Graphic files, programs, and database on magnetic or optical media.

    h. List of recommended spare parts with part numbers and suppliers.

    i. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.

    j. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation or web server software, and graphics software.

k. Licenses, guarantees, and warranty documents for equipment and systems.

l. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.

4. Ownership Of Proprietary Material

a. Project-specific software and documentation shall become Owner's property. This includes, but is not limited to:

1. Graphics

2. Record drawings

3. Database

4. Application programming code

5. Documentation

1.05 QUALITY ASSURANCE

A. Installer Qualifications: An independent contractor who is an automatic control system manufacturer's authorized representative and is trained and approved for installation of system components required for this Project.

B. 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.

C. Comply with ASHRAE 135 for DDC system components.

D. Comply with BACnet, and Niagara communication protocols for each DDC system component.

E. Wiring shall be a Class A installation per the requirements of NEC and Division 16.

F. Generic End Devices – input devices and controlled devices. Includes temperature, humidity, pressure, flow sensors for input, valve and damper actuators, etc. for output. For a retrofit project, all existing end devices and wiring thereto can be re-used by the contractor provided they are compatible with installed BAS product. Confirm that existing sensors meet the criteria in other parts of this document. Notify the engineer of any end

devices that are not in working condition.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

1.07 COORDINATION

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

F. Coordinate equipment with Division 16 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system.

G. Coordinate equipment with Division 16 Section "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces.

H. Coordinate equipment with Division 16 Section "Motor Control Centers" to achieve compatibility with motor starters and annunciation devices.

1.08 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. One of each type of controller, actuator and sensor.

2. Allow spare configurable controller space of 10% for ach different type of point on each controller.

1.09 Codes and Standards

A. Work, materials, and equipment shall comply with the most restrictive of local, state, and federal authorities' codes and ordinances or these plans and specifications. As a minimum, the installation shall comply

with current editions in effect 30 days prior to receipt of bids of the following codes:

1. National Electric Code (NEC)
2. International Building Code (IBC)
    a. Section 719 Ducts and Air Transfer Openings
    b. Section 907 Fire Alarm and Detection Systems
    c. Section 909 Smoke Control Systems
    d. Chapter 28 Mechanical
3. For BACnet systems, ASHRAE/ANSI 135-2001: Data Communication Protocol for Building Automation and Control Systems (BACNET)

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 CONTROL SYSTEM

A. Acceptable DDC System Manufacturers:

1. Schneider Niagara by Dynamic Controls
2. Honeywell installed by Honeywell.
3. Niagara or Lynxpring by Dynamic Controls

B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

C. AHU controllers and terminal unit controllers will be same brand as BAS. Chiller controllers will come with the chillers and have a BACnet I/P or BACnet MS/TP interface. Boilers controls can be done either way (by boiler manufacturer of BAS supplier). Chiller and Boiler management will be performed by the BAS. VFD's will have a BACnet interface to directly communicate with the BAS as any other controller

D. All equipment interfacing directly to JACE's are [referred to be BACnet IP or MS/TP.

2.03 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES

A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system that is compliant with the ASNI/ASHRAE Standard 135-1995 BACnet communication protocols, into one open interoperable system.

B. The University currently has in place a server and Tridium front end and is based on the N4 format. The Controls Contractor shall provide the new equipment, hardware, software, and licensing to be fully integrated and compatible with the current system. BACnet IP or Niagara Protocol for all JACE's on N4

C. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry standards including ANSI / ASHRAE™ Standard 135-1995, BACnet to assure interoperability between all system components is required. For each BACnet device, the device supplier must provide a PICS document showing the installed device's compliance level. Minimum compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet. MS/TP is also acceptable.

D. All components and controllers supplied under this contract shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data shall not be acceptable.

E. The supplied system must incorporate the ability to access all data using Java or HTML5enabled browsers without requiring proprietary operator interface and configuration programs. An Open DataBase Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a supplier-installed server for all database access. Systems requiring proprietary database and user interface programs shall not be acceptable.

F. A hierarchical topology is required to assure reasonable system

response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a "flat" single tiered architecture shall not be acceptable.

1. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.

2. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or Internet connected user interfaces.

G. The Local Area Network (LAN) shall be either a 10 or 100 Megabits/sec Ethernet network supporting BACnet, Java, XML, SOAP, HTTP, and CORBA IIOP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Area Controllers (NACs), user workstations and, if specified, a local host computer system.

H. Local area network minimum physical and media access requirements:

a. Ethernet; IEEE standard 802.3

b. Cable; 10 Base-T, UTP-8 wire, category 6

c. Minimum throughput; 10 Mbps, with ability to increase to 1 Gbps

I. Network Access

1. Remote Access.

a. For Local Area Network installations, provide access to the LAN from a remote location, via the Internet. The owner shall provide a connection to the Internet to enable this access via the Owner's Intranet to a corporate server providing access to an Internet Service Provider (ISP).

J. Licensing

1. All licensing needed for BAS system to be provided by contractor.

2. No protocol convertors or gateways that communicate using different protocols will be allowed unless approved by UNC.

2.04 NETWORK AREA CONTROLLER (NAC)

A. 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 BACnet controller data

7. Network Management functions for all devices

B. The Network Area Controller must provide the following hardware features as a minimum:

1. One Ethernet Port -10 / 100 Mbps

2. 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)

3. The NAC must be capable of operation over a temperature range of 0 to 55°C

4. The NAC must be capable of withstanding storage temperatures of between 0 and 70°C

5. The NAC must be capable of operation over a humidity range of 5 to 95% RH, non-condensing

C. The NAC shall be fully enclosed in a NEMA 1 constructed cabinet for indoor installations and NEMA 12 for outdoor installations. It shall have a hinged door, key lock, baked enamel finish, and be wall-mounted. All panels shall be keyed alike.

D. All panels shall house the NAC, network connections (one for the controller), power supply, a 120v duplex outlet, and EDCO HSP121BT-1RU surge suppression/protection device. For exterior panels include fan and heat strip to regulate the temperature in the panel within the NAC's operation range. Fan and heat strip shall be controlled via a temperature sensor in the panel. The cabinet installation and layout shall match the

University's standard.

E. 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.

F. The NAC shall support standard Web browser access via the Intranet/Internet. It shall support unlimited simultaneous users.

G. 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, 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 an unlimited number 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.

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

I. Alarms shall be routed by the BACnet IP network to the EBI alarm server in any of the following manners:

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

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

1. Time and date

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

3. Equipment (air handler #, accessway, etc.)

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

5. Number of occurrences since last acknowledgement.

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

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

M. A log of all alarms shall be maintained by the NAC and/or a server (if configured in the system) and shall be available for review by the user.

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

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

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

2.05 AUXILIARY DEVICES

A. Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable plus or minus 200% (minimum) from setpoint shown on plans. Contact rating, configuration, and coil voltage suitable for application. Provide NEMA 1 enclosure

when not installed in panel. Seimens series CK or Engineer-approved equal.

B. Control transformers shall be UL listed, Class 2 current-limiting type, or shall be furnished with overcurrent protection with a resetable circuit breaker.

C. Manual control switches shall be UL listed for use in NEMA 1 enclosures with contact arrangement and rating suitable for application. Bat handle or knob actuator with nameplate clearly indentifying function of each switch position.

D. Power Supplies:

1. Unit output shall match the required output current and voltage requirements. Current output shall allow for a 50% safety factor. Output ripple shall be 3.0 MV maximum P-P. Regulation shall be 0.10% line and load combined, with 50-microsecond response time for 50% load changes. Unit shall have built-in over voltage protection.

2. Unit shall operate between 0 degrees C and 50 degrees C. EM/RF shall meet FCC Class B and VDE 0871 for Class B, and MIL Standard 810C for shock and vibration.

3. Unit shall be UL recognized.

4. Functional Devices, MAMAC Systems, Inc. or Engineer-approved equal.

E. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.

1. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.

2. Selector Switch: Integral, manual on-off-auto.

F. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.

1. Bulb Length: Minimum 20 feet.

2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

G. Equipment safeties (freeze, smoke detectors, etc.) will be hardwired into the start circuits for equipment shutdown. All safety devices will be 2-pole devices – one to shut down equipment and one to alarm the BAS.

2.06 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Thermistor Temperature Sensors and Transmitters:

1. Manufacturers:

a. MAMAC Systems, Inc.

b. Schneider Electric

c. Siemens

d. Honeywell

2. Accuracy: Plus or minus 0.5 deg F at calibration point.

3. Wire: Twisted, shielded-pair cable.

4. Insertion Elements in Ducts: Single point, 18 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.

5. Averaging Elements in Ducts: 36 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft.

6. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.

7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

8. Room Security Sensors for high traffic areas as required by Owner: Stainless-steel cover plate with insulated back and security screws.

C. RTDs and Transmitters:

1. Manufacturers:

a. MAMAC Systems, Inc.

b. Schneider Electric

c. Siemens

d. Honeywell

2. Accuracy: Plus or minus 0.2 percent at calibration point.

3. Wire: Twisted, shielded-pair cable.

4. Insertion Elements in Ducts: Single point, 18 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.

5. Averaging Elements in Ducts: 48 inches long, rigid; use where prone to temperature stratification or where ducts are larger than 9 sq. ft.; length as required.

6. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.

7. Outside-Air Sensors: Watertight inlet fitting, provide sun shields.

8. Room Security Sensors for high traffic areas as required by Owner: Stainless-steel cover plate with insulated back and security screws.

D. Pressure Transmitters/Transducers:

1. Manufacturers:

a. Schneider Electric

b. Honeywell

c. MAMAC Systems, Inc.

2. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.

a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.

b. Output: 4 to 20 mA.

c. Building Static-Pressure Range: 0- to 0.25-inch wg.

d. Duct Static-Pressure Range: 0- to 5-inch wg.

3. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.

4. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.

5. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.

6. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

7. Electropneumatic Transducers: 100% solid-state piezorestive silicon pressure sensor, high air flow capacity (output of 25psig), field selectable 4 to 20 mA, o to 5 VDC or o0 to 10 VDC input. For service with HTHW control valves.

8. Electropneumatic Transducers: 100% solid-state piezorestive silicon pressure sensor, low air flow capacity (output of 15psig), field selectable 4 to 20 mA, o to 5 VDC or o0 to 10 VDC input.

E. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180-degree field of view with vertical sensing adjustment; for flush mounting.

F. Room sensor accessories include the following where required by Owner:

1. Insulating Bases: For sensors located on exterior walls.

2. Guards: Locking; heavy-duty, transparent plastic; mounted on separate base.

3. Adjusting Key: As required for calibration and cover screws.

G. Flood detector: 24VAC, latching relay, LED indicators, isolated contactors with reset button. Manufactured by Wagner Manufacturing.

2.07 STATUS SENSORS

A. Status Inputs for Fans: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig, piped across pump, provide ball valves and union for isolation of differential-pressure switch.

C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.

E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

H. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure, provide isolation valves.

1. Manufacturers:

a. MAMAC Systems, Inc.

b. I.T.M. Instruments Inc.

c. Schneider Electric

d. Honeywell

I. Control relays shall be UL listed plug-in type with dust cover and LED “energized” indicator. Contact rating, configurable, and coil voltage suitable for application. Manufactured by IDEC.

J. Control relays shall be UL listed with HOA and LED “energized” indicator. Contact rating, configurable, and coil voltage suitable for application. Manufactured by Functional Devices.

2.08 GAS DETECTION EQUIPMENT

A. Manufacturers:

1. AirSense by Honeywell International Inc.

3. Schneider Electric

4. Honeywell International Inc.

5. Vulcain Inc.

6. Macurco

B. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA output;, for wall mounting.

2.09 PROGRAMABLE EQUIPMENT CONTROLLERS (PEC)

A. Manufacturers:

1. Schneider Electric (Only Niagara Products)

2. Lynxpring

3. Honeywell

B. Programmable Equipment Controllers (PEC's) shall be stand-alone, multi-tasking, real-time digital control processors.

C. Programming of the PEC shall be accomplished by using graphical software that incorporates drag and drop capabilities. The PEC software database must be able to execute all of the specified mechanical system controls functions. The programming software shall be able to bundle software logic to simplify control sequencing. All values, which make up the PID output value, shall be readable and modifiable at a workstation or portable service tool. Each input, output, or calculation result shall be capable of being shared/bound with any controller or interface device on the network.

D. PEC's shall allow for free-form programming and be able to execute custom, job-specific processes defined by the user, and to automatically perform calculations and special control routines.

1. A single process shall be able to incorporate measured or calculated data from any and all other PEC's on the network. In addition, a single process shall be able to issue commands to points in any and all other PEC's on the network.

2. Processes shall be able to generate operator messages and advisories to operator I/O devices.

E. Each PEC shall support firmware upgrades without the need to replace hardware.

F. Each PEC shall continuously perform self-diagnostics, which include communication diagnosis and diagnosis of all components.

G. In the event of the loss of normal power, there shall be an orderly shutdown of all PEC's to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory of minimum of 72 hours.

1. Upon restoration of normal power, the PEC shall automatically resume full operation without manual intervention.

2. All PEC's control programming and databases must be stored in Flash memory, therefore eliminating data loss, downtime, and re-load time.

I. Spare points will be provided at each controller (except unitary controllers) for each type of point (AI, BI, AO & BO) in a quantity equal to or greater than 10%.

2.10 CONFIGURABLE CONTROLLERS(CC)

Controllers (field and terminal) should allow for free-form programming in lieu of "application specific controllers".

A. Manufactures:

1. Viconics

2. Schneider Electric (Only Niagara Products)

3. Lynxpring

4. Honeywell

B. Each Configurable controller (CC) shall operate as a stand – alone controller capable of performing its specified control responsibilities independent of other controllers in the network. Each CC shall be a minimum of 16-Bit microprocessor based, multi-tasking, multi-user, real time digital control processor.

C. Flash memory reload or updating of an existing control algorithm shall be completed over the network.

D. Network access shall be accomplished at the electrical room NAC. All units are to be networked via communications cable.

E. Controllers shall include all inputs and outputs necessary to perform the specified control sequences. Analog and digital outputs shall be industry standard signals such as 0-10V and 3-point floating control allowing for interface to a variety of industry standard modulating actuators. The CC inputs shall consist of industry standards 10K thermistor, 0-10V, 4-20mA and DI. Inputs shall be electrically isolated from outputs, communications, and power. All inputs shall be provided with an auto-calibrate function to eliminate sensing errors.

F. All controller sequences and operation shall provide closed loop control of the intended application. Closing control loops over the network is not acceptable.

G. Thermostat Controllers shall be provided for Fan Coil Unit and/or single or multiple stage HVAC applications where applicable:

1. All FCU thermostats shall be microprocessor-based with PI (proportional and integral) control algorithm. Thermostats shall be suitable for control of single or multi-speed fan coil units. Thermostat shall be provided with three control outputs, and capable of supporting both two and four pipe, heating or cooling applications with or without local changeover. Thermostat shall be proved with three configurable inputs to, which can support all required local occupancy functions required within the zone being service. Thermostats shall support momentary contact input from motion detector or PIR. Thermostats shall support remote room and duct sensing. The thermostat must contain six levels of keypad accessibility, including the capacity to completely disable the keypad. All installer parameters are to be set using a dedicated key function accessible without removing the cover. Thermostat shall be provided with local configuration utility embedded with device as standard.

2. All installer parameter shall have the option to be set using a dedicated key accessible when the cover is removed or downloaded from the Network Area Controller. Each controller shall be able to be operated as stand-alone preprogrammed devices to facilitate local commissioning and start-up procedures.

I. The control program shall reside in the CC. The application program configuration information shall be stored in non-volatile memory with no battery back up.

J. After a power failure the CC must run the control application using the current set point and configuration. Reverting to default or factory set points are not acceptable.

K. The controller shall be an electrical class-II device constructed form UL tested flame and smoke retardant materials to allow mounting in the return air plenum. The controller shall be listed UL-916. All electrical connections shall be made to a combination base and terminal strip assembly. To ensure long-term reliability, all electrical connections shall be screw type.

L. Spare points will be provided at each controller (except unitary controllers) for each type of point (AI, BI, AO & BO) in a quantity equal to or greater than 10%.

2.11 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

1. Comply with requirements in Division 15 Section "Motors."

2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

3. Nonspring-Return Motors for Valves Larger than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.

4. Spring-Return Motors for Valves Larger than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.

5. Nonspring-Return Motors for Dampers Larger than 25 Sq. Ft.:

Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.

6. Spring-Return Motors for Dampers Larger than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque. Actuator size and rating shall be suitable for intended purpose. Actuators relying on batteries are unacceptable.

1. Manufacturers:

a. Belimo Aircontrols (USA), Inc.

b. Schneider Electric

c. Seimens

d. Seibe

e. Honeywell.

2. Valves: Size for torque required for valve close off at maximum pump differential pressure.

3. Dampers: Size for running torque calculated as follows:

a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.

b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.

c. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.

d. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.

4. Coupling: V-bolt and V-shaped, toothed cradle.

5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.

6. Fail-Safe Operation: Mechanical, spring-return mechanism.

Provide external, manual gear release on nonspring-return actuators.

7. Power Requirements (Two-Position Spring Return): 24-V ac.

8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.

9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.

10. Temperature Rating: Minus 22 to plus 122 deg F.

11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.

12. Run Time: 12 seconds open, 5 seconds closed.

2.12 CONTROL VALVES

A. Manufacturers:

1. Schneider Electric
2. Belimo
3. Fisher
4. Honeywell

B. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

C. Hydronic system globe valves shall have the following characteristics:

1. NPS 2 and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.

2. NPS 2-1/2 and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.

3. Internal Construction: Replaceable plugs and stainless-steel or brass seats.

a. Single-Seated Valves: Cage trim provides seating and

guiding surfaces for plug on top and bottom.

b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.

4. Sizing: 3-psig maximum pressure drop at design flow rate or the following:

a. Two Position: Line size.

b. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.

c. Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.

5. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

D. Butterfly Valves: 150-psig maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.

1. Body Style: Lug.

2. Sizing: 1-psig maximum pressure drop at design flow rate.

E. Terminal Unit Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.

1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.

2. Sizing: 3-psig maximum pressure drop at design flow rate, to close against pump shutoff head.

3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

2.13 DAMPERS

A. Manufacturers:

1. Greenheck

2. Ruskin

3. Honeywell

B. Dampers: AMCA-rated, opposed-blade design; 0.108-inch- minimum thick, galvanized-steel or 0.125-inch- minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- thick galvanized steel with maximum blade width of 8 inches and length of 48 inches.

1. Secure blades to 1/2-inch- diameter, zinc-plated axles using zinc-plated hardware, with oil-impregnated sintered bronze blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.

2. Operating Temperature Range: From minus 40 to plus 200 deg F.

3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.

4. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 in. x lbf; when tested according to AMCA 500D.

2.14 DATA COLLECTION AND STORAGE

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

1. The data collection shall be performed by log objects, resident in the NAC that shall have, at a minimum, the following configurable properties:

2. Designating the log as interval or deviation.

3. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.

4. 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.

5. 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.

6. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.

B. All log data shall be stored in a relational database in the NAC and the data shall be accessed from a server (if the system is so configured) or a standard Web Browser.

C. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.

D. All log data shall be available to the user in the following data formats:

1. HTML

2. XML

3. Plain Text

4. Comma or tab separated values

E. Systems that do not provide log data in HTML and XML formats at a minimum shall not be acceptable.

F. The NAC shall have the ability to archive its log data either locally (to itself), or remotely to a server or other NAC 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

2.15 AUDIT LOG

A. 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, programming changes, etc.

2.16 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.

2.17 GRAPHICAL USER INTERFACE SOFTWARE

A. Operating System:

1. The GUI shall run on Microsoft Windows NT Workstation 4.0, Service Pack 4 or later, Windows XP or Windows 2000.

B. The GUI shall employ internet browser 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, 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. No entry of text shall be required.

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 alarm able 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. Alarms are to be routed to EBI server via BACnet IP and N4 supervisor station via BACnet IP or Niagara network. The use of the Alarm Console can be enabled or disabled by the system administrator.

2.18 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 N4 supervisor/server 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. 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

7. 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.

8. 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.

2.19 SERVER FUNCTIONS AND HARDWARE

A. A central server shall be provided where required effective for NAC communication over the Ethernet. The server shall support all Network Area Controllers (NAC) connected to the customer's network whether local or remote.

B. Local connections shall be via an Ethernet LAN. Remote connections can be via ISDN, ADSL, T1 or dial-up connection.

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 the 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.

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

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

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

6. 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.

7. 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.

8. 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.

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

a. Routing of alarms to N4 alarm console email and EBI

b. View and acknowledge of alarms

c. Query alarm logs based on user-defined parameters

10. 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:

a. Viewing and printing log data

b. Exporting log data to other software applications

c. Query log data based on user-defined parameters

2.20 SYSTEM PROGRAMMING

A. Only Niagara software modules allowed for Niagara programming and graphics. No Aftermarket modules allowed.

B. 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.

C. 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 display shall not be acceptable.

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

D. 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.

E. 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.

F. 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. For BACnet devices, provide the following objects at a minimum:

a. BACnet AI

b. BACnet AO

c. BACnet BI

d. BACnet BO

e. BACnet Device

2. For each BACnet object, provide the ability to assign the object to a BACnet device and object's instance number.

2.23 DDE DEVICE INTEGRATION

A. The Network Area Controller shall support the integration of device data via Dynamic Data Exchange (DDE), over the Ethernet Network. The Network Area Controller shall act as a DDE client to another software application that functions as a DDE server.

B. Provide the required objects in the library, included with the Graphical User Interface programming software, to support the integration of these devices into the BAS. Objects provided shall include at a minimum:

1. DDE Generic AI Object

2. DDE Generic AO Object

3. DDE Generic BO Object

4. DDE Generic BI Object

PART 3 - EXECUTION

3.01 INSTALLATION

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

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

C. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above the floor.

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

zigzag pattern.

D. Install guards on thermostats or blank plate sensors in the following locations:

1. Entrances.

2. Public areas.

3. Gymnasiums

4. Locker rooms.

E. Install automatic dampers according to Division 15 Section "Duct Accessories."

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

G. Install labels and nameplates to identify control components according to Division 15 Section "Mechanical Identification."

H. Install hydronic instrument wells, valves, and other accessories according to Division 15 Section "Hydronic Piping."

I. Install refrigerant instrument wells, valves, and other accessories according to Division 15 Section "Refrigerant Piping."

J. Install duct volume-control dampers according to Division 15 Sections specifying air ducts.

K. Install electronic and fiber-optic cables according to Division 17 Section "Voice and Data Communication Cabling."

L. Exterior Lighting: Provide electronically held contact to BAS for control exterior lighting.

M. Fire Alarm: The fire alarm panel will be provided with three (3) voltage free normally open contacts that need to be monitored by the BAS: 1. Alarm, 2. Trouble, 3. Supervisory. Under normal conditions, all contacts will be open.

N. Intrusion Alarm: Provide (if required) two (2) normally open contacts to be monitored: 1. Intrusion, 2. Trouble.

O. Control drawings will be laminated and mounted in each control panel.

P. Emergency generators need to be connected to BAS utilizing BACnet

protocol using all points available.

3.02 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Division 16 Section "Raceways and Boxes."

B. Install building wire and cable according to Division 16 Section "Conductors and Cables."

C. Install signal and communication cable according to Division 17 Section "Voice and Data Communication Cabling."

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

2. Install exposed cable in raceway.

3. Install concealed cable in raceway.

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.

7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

8. If no IP device is located in mechanical room, we need one CAT-6 Data drop for connection to BAS for troubleshooting purposes.

D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

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

F. Wire labeling of signal points and location at both ends.

G. Interconnections between internal and face-mounted devices prewired with color-coded stranded conductors neatly installed in plastic troughs

and/or tie wrapped. Terminal blocks shall be provided for all field connections, and shall be UL listed for 600-volt service, individually identified per control drawings, with adequate clearance for field wiring.

1. Control terminations for field connection shall be individually identified per control drawings.

2. All internal wiring between panel mounted devices and field terminal blocks shall be marked on both ends with the appropriate identifying tag.

H. Internal panel components shall be securely mounted. Each component shall be individually labeled with function and device identification, as shown on the control drawings.

3.03 FIELD QUALITY CONTROL

A. Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.

2. Test and adjust controls and safeties.

3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.

4. Test each point through its full operating range to verify that safety and operating control set points are as required.

5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.

6. Test each system for compliance with sequence of operation.

7. Test software and hardware interlocks.

C. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.

2. Check instruments for proper location and accessibility.

3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.

4. Check instrument tubing for proper fittings, slope, material, and support.

5. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.

6. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.

7. Check temperature instruments and material and length of sensing elements.

8. Check control valves. Verify that they are in correct direction.

9. Check DDC system as follows:

a. Verify that DDC controller power supply is from emergency power supply, if applicable.

b. Verify that wires at control panels are tagged with their service designation and approved tagging system.

c. Verify that spare I/O capacity has been provided.

d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

E. After all required manufacturers checks, DDC verification, adjustments and equipment replacements have been completed and the BAS system is fully functional, coordinate with Owner's Representative for a Final system functional demonstration and verification to be performed in the presence of the Owner's Representative.

3.04 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.

2. Make three-point calibration test for both linearity and accuracy for each analog instrument.

3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.

4. Control System Inputs and Outputs:

a. Check analog inputs at 0, 50, and 100 percent of span.

b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.

c. Check digital inputs using jumper wire.

d. Check digital outputs using ohmmeter to test for contact making or breaking.

e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

5. Flow:

a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.

b. Manually operate flow switches to verify that they make or break contact.

6. Pressure:

a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.

b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

7. Temperature:

a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.

b. Calibrate temperature switches to make or break contacts.

8. Stroke and adjust control valves and dampers without

positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.

9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.

10. Provide diagnostic and test instruments for calibration and adjustment of system.

11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.05 Control System Demonstration and Acceptance

A. Demonstration. Prior to acceptance, perform the following performance tests to demonstrate system operation and compliance with specification after and in addition to tests specified in Article 3.17 (Control System Checkout and Testing). Provide Engineer with log documenting completion of startup tests.

1. Engineer will be present to observe and review system demonstration. Notify Engineer at least 10 days before system demonstration begins.

2. Demonstration shall follow process submitted and approved under Section 15900 Article 1.10 (Submittals). Complete approved checklists and forms for each system as part of system demonstration.

3. Demonstrate actual field operation of each sequence of operation as specified in Section 15900 Appendix A. Provide at least two persons equipped with two-way communication. Demonstrate calibration and response of any input and output points requested by Engineer. Provide and operate test equipment required to prove proper system operation.

4. Demonstrate compliance with Section 15900 Part 1 (System Performance).

5. Demonstrate compliance with sequences of operation through each operational mode.

6. Demonstrate complete operation of operator interface.

7. Demonstrate each of the following.

    a. DDC loop response. Supply graphical trend data output showing each DDC loop's response to a setpoint change representing an actuator position change of at least 25% of full range. Trend sampling rate shall be from 10 seconds to 3 minutes, depending on loop speed. Each sample's trend data shall show setpoint, actuator position, and controlled variable values. Engineer will require further tuning of each loop that displays unreasonably under- or over-damped control.

    b. Demand limiting. Supply trend data output showing demand-limiting algorithm action. Trend data shall document action sampled each minute over at least a 30-minute period and shall show building kW, demand-limiting setpoint, and status of setpoints and other affected equipment parameters.

    c. Building fire alarm system interface.

    d. Trend logs for each system. Trend data shall indicate setpoints, operating points, valve positions, and other data as specified in the points list provided with each sequence of operation in Section 15900 Appendix A. Each log shall cover three 48-hour periods and shall have a sample frequency not less than 10 minutes or as specified on its points list. Logs shall be accessible through system's operator interface and shall be retrievable for use in other software programs as specified in Section 15900 Article 2.3 Paragraph E.11 (Trend Configuration).

8. Tests that fail to demonstrate proper system operation shall be repeated after Contractor makes necessary repairs or revisions to hardware or software to successfully complete each test.

B. Acceptance.

1. After tests described in this specification are performed to the satisfaction of both Engineer and Owner, Engineer will accept control system as meeting completion requirements. Engineer may exempt tests from completion requirements that cannot be performed due to circumstances beyond Contractor's control.

Engineer will provide written statement of each exempted test. Exempted tests shall be performed as part of warranty.

2. System shall not be accepted until completed demonstration forms and checklists are submitted and approved as required in Section 15900 Article 1.10 (Submittals).

3.06 Training

A. Provide training for a designated staff of Owner's representatives. Training shall be provided via self-paced training, web-based or computer-based training, classroom training, or a combination of training methods.

B. Provide 3-ring binders (quantity?) with a hard copy of the specified documents prior to the start of training. These documents will be continuously up-dated (slip sheeting is permitted) during the training/warranty period.

C. Adequate training shall be provided to cover the complete operation and maintenance of the BAS

D. Training shall take place over a one-year period. Early sessions will be longer and closer together; later sessions can be shorter and spaced further apart. This is done so that the operators do not get data overload trying to learn everything in a one week training session.

E. Training shall be done with operation and maintenance manuals complete and up-to-date.

F. The training will include both generic system and site specific training.

G. At the start of the training period, project documents in electronic form will be provided to the owner on CD, including project as-built control drawings, system software, system graphics and product data.

H. As changes in sequences and points are put in place during the first year of operation, updated as-builts will be submitted to the owner.

I. At the end of the warranty and training period, the electronic files will be conveyed to the owner in a format specified by the owner so that the owner can alter the documents in the future.

J. Training shall enable students to accomplish the following objectives.

1. Proficiently operate system

2. Understand control system architecture and configuration
3. Understand DDC system components
4. Understand system operation, including DDC system control and optimizing routines (algorithms)
5. Operate workstation and peripherals
6. Log on and off system
7. Access graphics, point reports, and logs
8. Adjust and change system setpoints, time schedules, and holiday schedules
9. Recognize common HVAC system malfunctions by observing system graphics, trend graphs, and other system tools
10. Understand system drawings and Operation and Maintenance manual
11. Understand job layout and location of control components
12. Access data from DDC controllers
13. Operate portable operator's terminals
14. Create and change system graphics
15. Create, delete, and modify alarms, including configuring alarm reactions
16. Create, delete, and modify point trend logs (graphs) and multi-point trend graphs
17. Configure and run reports
18. Add, remove, and modify system's physical points
19. Create, modify, and delete application programming
20. Add operator interface stations
21. Add a new controller to system
22. Download firmware and advanced applications programming to a controller
23. Configure and calibrate I/O points
24. Maintain software and prepare backups

25. Interface with job-specific, third-party operator software

26. Add new users and understand password security procedures

K. Divide presentation of objectives into three sessions (1-13, 14-23, and 24-26). Participants will attend one or more of sessions, depending on knowledge level required.

1. Day-to-day Operators (objectives 1-13)

2. Advanced Operators (objectives 1-13 and 14-23)

3. System Managers and Administrators (objectives 1-13 and 24-26)

L. Provide course outline and materials according to Section 15900 Article 1.10 (Submittals). Provide one copy of training material per student.

M. Instructors shall be factory-trained and experienced in presenting this material.

N. Perform classroom training using a network of working controllers representative of installed hardware.

3.07 WARRANTY

A. Refer to general warranty requirements.

B. Special warranty:

1. The warranty period shall begin as authorized by the Owner's representative in writing. Completion shall not occur before the Contractor has performed all of the required tests and has demonstrated full functionality to the Owner.

2. The control system shall be warranted to be free from defects in material and workmanship and in software design and operation for a period of one year after completion of the contract. The Contractor shall provide the necessary skills, labor, and parts to ensure that all system component failures are promptly repaired. This warranty shall become effective starting on the date of completion.

3. The Contractor shall coordinate and provide for a site visit at every change of season during the warranty period to ensure that all systems are functional.

4. The Contractor shall receive calls during the warranty period for all problems or questions experienced in the operation of the installed equipment and shall take steps to correct any deficiencies that may exist. The response time to critical problems shall be two (2) hours maximum.

5. The Contractor shall maintain a backup of all software installed in the system. The backup shall be updated monthly or whenever a change to the software is made. A reload of the backup software into the system shall be performed by the Contractor immediately upon notification by the Owner at no extra charge to the Owner.

6. The Contractor shall optimize all control software to ensure acceptable operating and space conditions and peak energy efficiency. This shall include changes needed to optimize the operation of the systems even if not explicitly described.

7. The Contractor shall provide and install at no extra cost all hardware, firmware, and software updates released prior to and during the warranty period. These updates shall be installed and fully implemented on every device to which they apply, throughout the project. Written authorization by the Owner must be obtained prior to the installation of theses changes.

8. At the end of the warranty period, the Contractor shall supply updated copies of the latest versions of all project record documentation. This includes final updated drawings, programming, software documentation, and magnetic media backups that include all changes that have been made to the system during the warranty period.

9. The contractor will provide a written guarantee from the manufacturer that the technology being provided will be supported for a minimum of ten years following completion of the project.

3.08 Commissioning

A. The contractor is expected to completely commission the building automation system prior to the Commissioning Authority (third-party or owner’s rep) starting their work on the BAS. This commissioning process and documentation will be contained in a written log for submission to the owner.

B. The contractor will submit the commissioning procedure and blank log book for approval prior to starting commissioning work.

C. The contractor will start with a verification of the control inputs and outputs on a point-to-point basis.

D. Each analog input and output will be properly calibrated. This means utilizing an independently certified temperature, pressure, etc. measurement device and performing at least a three point calibration. One point shall be at the low end of the operational range, one at the normal operating value and the third point at the high end of the operational range.

E. The sequences of operation will be tested in all normal modes and verified back to the original final contract documents. Where possible, off-line program simulation should be used prior to actual program operation on equipment.

F. Loop tuning will be performed for all analog outputs under operating conditions. The P, I and D constants will be logged and noted which ones were utilized.

G. The alarms, safeties, failure and system re-start modes will then be tested.

H. Next, all the systems will be run for 72 hours in fully automatic mode with no intervention from the operators. All points (inputs, outputs and calculated points) will be trended during this period on a one minute sample basis (or change of value for binary points).

I. The final step in the commissioning process will be the integrated systems testing. This is defined as *testing the dynamic interaction between the electrical, mechanical and life safety systems.* This will involve all systems operating in fully automatic mode. During this step, various setpoints and/or pieces of equipment will be manually manipulated to test for electrical system failures, life safety events and mechanical equipment failures including major setpoint changes.

J. At the conclusion of the commissioning and project turn-over, spare parts will be delivered to the owner in the types and quantities for adequate on-site maintenance.

3.09 Control Software (Sequences of Operation) Requirements

A. The primary principle for Sequences of Operation is the “KISS” principle. Control programs should contain only the logic that is necessary for the purpose intended.

B. Program functionality to reside at the controller level for true stand alone operation. No control sequences will be allowed at the system front-end or in routers/gateways.

C. Any critical values common to the entire system (outdoor air temperature, humidity, life safety points) will obviously need to be shared on the network. But to ensure system integrity, we should strive to have these inputs duplicated on separate field controllers so that the failure of one control panel does not cause a failure of critical information. One of the sensors would be designated as primary and the other as secondary. A critical alarm will be generated when the field controllers containing either primary or secondary fail.

D. Each AHU and Central Plant system will have field controllers (some with expansion modules) to handle the larger point counts of chiller/boiler systems directly connected at the Ethernet level.

E. All manifolded equipment (pairs of fans, pumps, multiple boilers, multiple chillers, etc) that are to be controlled and sequenced together must be controlled from a single controller. They must not rely on the BAS IT network for communication. The BAS field controllers will have enough point capacity (this can be through DDC expanders) and software capacity to handle all control strategies, trends for all points and required alarms within the processor for that field panel. In lieu of all points being contained in one large controller, a mini high-speed sub-network would be allowed for just that set of manifolded equipment.

F. Optimization routines that will be included are major equipment operation based on the summation of loads at the terminal unit level, then to the air handling unit level and finally to the central palt equipment. This is sometimes referred to as “load based control”.

G. Scheduling unoccupied areas based on time-of-day should be done if the space use and temperature/pressure requirements permit. A zone status light and override push-button to bring system back to occupied mode will be utilized in areas not open to the public.

H. If any life safety functions (smoke control) are required to be performed within the BAS software, these points and functions should be protected by the highest level of system access. Where at all

possible, these life safety functions should reside in a separate program area and have the highest level of prioritization.

I. Special care should be provided when controlling electronic actuators so as not to abuse the actuator. An electronic actuator will not last long with “excessive” actuations.

J. The contractor should be prepared to make some adjustments in the sequence of operation at the time of commissioning at no extra cost to the owner. Systems seldom perform as intended and final configurations are seldom as designed initially.

SPECIFIC SEQUENCES OF OPERATION TO BE COMPLETED BY ENGINEER FOR EACH SPECIFIC APPLICATION

3.10 Points List

A. The following includes a typical points list required. This list is not all inclusive.

1. Condenser Water System:

a. Cooling tower fan VFD

b. Cooling tower fan start/stop

c. Cooling tower fan status

d. Cooling tower run time

e. Cooling tower basin temps

f. Condenser water supply temp

g. Condenser water return temp

h. Condenser water pump status

i. Condenser water pump start/stop

j. Condenser water pump speed reference

k. Condenser water pump differential pressure

2. Chilled Water System:

a. Chilled water supply temp
b. Chilled water return temp
c. Chilled water pumps status
d. Chilled water pumps start/stop
e. Chilled water pumps speed reference
f. Chilled water supply differential pressure
g. Chilled water flow switch
h. Chiller start/stop/status
i. Outdoor air temp

3. Heating System:
    a. Heating water supply temp (both heat exchangers)
    b. Heating water return temp (both heat exchangers)
    c. Heating water pumps status
    d. Heating water pumps start/stop
    e. Heating water pumps speed reference
    f. Heating water supply differential pressure
    g. Heating water flow switch (both heat exchangers)
    h. Heating water alarm at pressure drop
    i. HTHWS supply temp
    j. HTHWR return temp
    k. HTHWS @ domestic hot water heater
    l. HTHWR @ domestic hot water heater
    m. HTHWS control valve @ heat exchangers

n. HTHWR control valve @ domestic hot water heaters

o. HTHW system meters at building entry

p. Domestic hot water temp

q. Domestic hot water recirc. temp

r. Domestic hot water circ. pump status

s. Outdoor air tem

t. Domestic water booster pump

4. Air Handling Equipment:

a. Supply fan start/stop

b. Supply fan status

c. Supply fan VFD modulation

d. Supply fan differential static pressure

e. Return fan start/stop

f. Return fan status

g. Return fan VFD modulation

h. Return fan low limit

i. Pre filter DP

j. Supply air temp

k. Heating coil control temp

l. Outdoor air temp

m. Return air temp

n. Outdoor/return air damper

o. Exhaust air damper

p. Cooling coil control valve

q. Mixed air temp

r. Freeze stat alarm

s. Exhaust fans start/stop (all)

t. Exhaust fans status (all)

u. Smoke detector SA

v. Smoke detector RA

w. Supply fan high limit alarm

x. AHU space served – room space temp at several locations

2. Miscellaneous Systems **(COORDINATE WITH WORK OR OTHER SECTIONS)**

a. Fan coil units

b. Unit heaters

c. VAV boxes with hot water reheat coils

d. Pneumatic TC air compressor – low pressure

e. Water Flow switches

f. Energy Management; electrical meters, Btu meters, water service meters

g. Fire Alarm status (occasionally)

h. Intrusion Alarms

i. Exterior and interior general and security lighting

j. Generators

END OF SECTION 23 09 00