

NEW MEMORIAL ELEMENTARY SCHOOL
FOR EAST BRUNSWICK SCHOOL DISTRICT
ISSUE FOR BID 8/2/10

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1. The attention of the bidder is directed to the following changes, additions, substitutions and/or clarifications affecting the above referenced content.
2. This Addendum contains changes to the requirements of the Contract Drawings and Specifications. Such changes are deemed to be incorporated into the Contract Documents and shall apply to the work with the same meaning and force as if they had been included in the original Documents. Whenever this Addendum modifies a portion of a paragraph of the Specifications, or any portion of any drawing, the remainder of the paragraph or drawings affected shall remain in force.
3. The conditions and terms of the Specifications shall govern work described in this Addendum. Whenever the conditions of work and the quality or quantity of materials or workmanship are not fully described in this Addendum, the conditions of work, etc., included in the Specifications for similar terms of work shall apply to the work described in this Addendum.

I. THE FOLLOWING RELATE TO THE DRAWINGS

Drawing F0.1

- 1.) Drawing shall be revised as per the attached sketch F0.1.1 Addendum #2.

Drawing F2.1

- 1.) Drawing shall be revised as per the attached sketch F2.1.1 Addendum #2.

Drawing F2.2a

- 1.) Drawing shall be revised as per the attached sketch F2.2a.1 Addendum #2.
- 2.) Drawing shall be revised as per the attached sketch F2.2a.2 Addendum #2.

Drawing F2.2b

- 1.) Drawing shall be revised as per the attached sketch F2.2b.1 Addendum #2.

Drawing F2.2c

- 1.) Drawing shall be replaced by the attached full-size drawing F2.2c.1 Addendum #2.

Drawing F2.3b

- 1.) Drawing shall be replaced by the attached full-size drawing F2.3b.1 Addendum #2.

Drawing P0.1

- 1.) Drawing shall be revised as per the attached sketch P0.1.1 Addendum #2.

Drawing P2.1

- 1.) Drawing shall be replaced by the attached full-size drawing P2.1.1 Addendum #2.

Drawing P2.2b

- 1.) Drawing shall be revised as per the attached sketch P2.2b.1 Addendum #2.
- 2.) Drawing shall be revised as per the attached sketch P2.2b.2 Addendum #2.

Drawing P5.1

- 1.) Drawing shall be revised as per the attached sketch P5.1.1 Addendum #2.

Drawing P5.6

- 1.) Drawing shall be revised as per the attached sketch P5.6.1 Addendum #2.

Drawing P5.7

- 1.) Drawing shall be revised as per the attached sketch P5.7.1 Addendum #2.

Drawing M2.1c

- 1.) Drawing shall be revised as per the attached sketch M2.1c.1 Addendum #2.
- 2.) Drawing shall be revised as per the attached sketch M2.1c.2 Addendum #2.

Drawing M2.1d

- 1.) Drawing shall be revised as per the attached sketch M2.1d.1 Addendum #2.

Drawing M2.2a

- 1.) Drawing shall be replaced by the attached full-size drawing M2.2a.1 Addendum #2.

Drawing M2.2b

- 1.) Drawing shall be replaced by the attached full-size drawing M2.2b.1 Addendum #2.

Drawing M2.3

- 1.) Drawing shall be revised as per on the attached sketch M2.3.1 Addendum #2.

Drawing M5.3

- 1.) Drawing shall be revised per on the attached sketch M5.3.1 Addendum #2.

Drawing M5.4

- 1.) Drawing shall be replaced by the attached full-size drawing M5.4.1 Addendum #2.

Drawing M 6.3

- 1.) Drawing shall be revised as per the attached sketch M6.3.1 Addendum #2.

Drawing E0.1

- 1.) Drawing shall be revised to delete Note #8 and Note #9 from the General Notes.

Drawing E1.0

- 1.) Drawing shall be replaced by the attached full-size drawing E1.0.1 Addendum #2.

Drawing E2.1

- 1.) Drawing shall be revised as per the attached sketch E2.1.1 Addendum #2.

Drawing E2.2a

- 1.) Drawing shall be revised as per the attached sketch E2.2a.1 Addendum #2.

Drawing E2.2b

- 1.) Drawing shall be revised as per the attached sketch E2.2b.1 Addendum #2.

Drawing E2.2c

- 1.) Drawing shall be revised as per the attached sketch E2.2c.1 Addendum #2.

Drawing E2.2d

- 1.) Drawing shall be replaced by the attached full-size drawing E2.2d.1 Addendum #2.

Drawing E2.3a

- 1.) Drawing shall be replaced by the attached full-size drawing E2.3a.1 Addendum #2.

Drawing E2.3b

- 1.) Drawing shall be replaced by the attached full-size drawing E2.3b.1 Addendum #2.

Drawing E2.3c

- 1.) Drawing shall be revised as per the attached sketch E2.3c.1 Addendum #2.

Drawing E2.3d

- 1.) Drawing shall be revised as per the attached sketch E2.3d.1 Addendum #2.

Drawing E3.1

- 1.) Drawing shall be revised as per the attached sketch E3.1.1 Addendum #2.

Drawing E3.2a

- 1.) Drawing shall be revised as per the attached sketch E3.2.a.1 Addendum #2.

Drawing E3.2b

- 1.) Drawing shall be revised as per the attached sketch E3.2.b.1 Addendum #2.

Drawing E3.2c

- 1.) Drawing shall be replaced by the attached full-size drawing E3.2c.1 Addendum #2.

Drawing E3.2d

- 1.) Drawing shall be replaced by the attached full-size drawing E3.2d.1 Addendum #2.

Drawing E3.2e

- 1.) Drawing shall be replaced by the attached full-size drawing E3.2e.1 Addendum #2.

Drawing E3.3a

- 1.) Drawing shall be revised as per the attached sketch E3.3.a.1 Addendum #2.

Drawing E3.3d

- 1.) Drawing shall be revised as per the attached sketch E3.3.d.1 Addendum #2.

Drawing E3.4a

- 1.) Note #1 on drawing shall be revised to indicate “THE ELIMINATION OF THE ENTIRE PHOTOVOLTAIC SYSTEM SHALL BE PRICED SEPARATELY AS PART OF THE DEDUCT/ALTERNATE BID #4. THIS INCLUDES THE PHOTOVOLTAIC ARRAYS, INVERTERS, DISCONNECT SWITCHES, WIRING, CONDUIT, RACKING SYSTEM, ETC.”

Drawing E3.4b

- 1.) Note #1 on drawing shall be revised to indicate “THE ELIMINATION OF THE ENTIRE PHOTOVOLTAIC SYSTEM SHALL BE PRICED SEPARATELY AS PART OF THE DEDUCT/ALTERNATE BID #4. THIS INCLUDES THE PHOTOVOLTAIC ARRAYS,

INVERTERS, DISCONNECT SWITCHES, WIRING, CONDUIT, RACKING SYSTEM, ETC.”

Drawing E4.3a

- 1.) Tag for horn strobe in TR 219 shall be revised to indicate “INCLUDE IN DEDUCT/ALTERNATE BID #2 AN AUDIO/VISUAL NOTIFICATION DEVICE IN TR.”

Drawing E4.3b

- 1.) Tag for horn strobe in Corridor C22 shall be revised to indicate “INCLUDE IN DEDUCT/ALTERNATE BID #2 AN AUDIO/VISUAL NOTIFICATION DEVICE IN TR AND SMOKE DETECTOR IN STORAGE ROOM.”

Drawing E5.0a

- 1.) Tag for photovoltaic system shall be revised to indicate “DEDUCT/ALTERNATE BID #4”.

Drawing E5.1

- 1.) Drawing shall be revised to include a control module and relay for the roll-up doors on the first floor.

Drawing E5.2

- 1.) Drawing shall be replaced by the attached full-size drawing E5.2.1 Addendum #2.

Drawing E5.3

- 1.) Drawing shall be revised to delete Detail #4.

Drawing E6.1

- 1.) Drawing shall be replaced by the attached full-size drawing E6.1.1 Addendum #2.

Drawing E6.2

- 1.) Drawing shall be replaced by the attached full-size drawing E6.2.1 Addendum #2.

Drawing E6.3

- 1.) Drawing shall be revised as per the attached sketch E6.3.1 Addendum #2.

Drawing E6.4

- 1.) Drawing shall be revised as per the attached sketch E6.4.1 Addendum #2.

Drawing E6.5

- 1.) Drawing shall be replaced by the attached full-size drawing E6.5.1 Addendum #2.

Drawing E7.2

- 1.) Drawing shall be replaced by the attached full-size drawing E7.2.1 Addendum #2.

II. THE FOLLOWING RELATES TO THE PROPOSAL PAGES – NOT USED

III. THE FOLLOWING RELATE TO THE SPECIFICATIONS

Specification Section 22 13 19 – Sanitary Waste Piping Specialties

- 1.) Paragraph 2.2 shall be revised as follows:

2.2 FLOOR DRAINS

A. Finished Areas/Toilet Rooms:

1. Jay R. Smith model 2005Y-A or a comparable product by one of the following:
 - a. Josam Company; Josam Div.
 - b. Tyler Pipe; Wade Div.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Light Commercial Operation.
2. Assembly: ANSI A112.21.2. Body: Duco cast iron with flashing. Accessories: Flashing collar with adjustable strainer head with sediment bucket.
3. Anchor Flange and clamping device: Required.
4. Top or Strainer Material: Round Nickel bronze.
5. Top Loading Classification: Light Duty.
6. Provide vandal proof top.
7. All floor drains shall be provided with a deep seal "P" trap.

B. MER spaces & Kitchen areas where not otherwise indicated on the food service drawings:

1. Jay R. Smith model 2420 or a comparable product by one of the following:
 - a. Josam Company; Josam Div.
 - b. Tyler Pipe; Wade Div.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Light Commercial Operation.
2. ANSI A112.21.1; Duco cast iron body with hinged grate, locking device, sediment bucket and flashing collar.
3. Anchor Flange and clamping device: Required.
4. Trap Material: Cast iron.
5. All floor drains shall be provided with a deep seal "P" trap.

C. Funnel Floor Drains:

1. Jay R. Smith model 3720 or a comparable product by one of the following:
 - a. Josam Company; Josam Div.
 - b. Tyler Pipe; Wade Div.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Light Commercial Operation.
2. Assembly: ANSI A112.21.2. Body: Duco cast iron with flashing. Accessories: Flashing collar with adjustable strainer head with sediment bucket, and funnel.
3. Anchor Flange and clamping device: Required.
4. Top or Strainer Material: Round Nickel bronze.
5. Top Loading Classification: Light Duty.
6. Trap Material: Cast iron.
7. All floor drains shall be provided with a deep seal "P" trap.

Specification Section 22 13 19 – Sanitary Waste Piping Specialties

2.) paragraph 2.3 shall be added:

2.3 AREA DRAINS

A.

1. Jay R. Smith model 2225 or a comparable product by one of the following:
 - a. Josam Company; Josam Div.
 - b. Tyler Pipe; Wade Div.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Light Commercial Operation.
2. Assembly: ANSI A112.21.2.
3. "Safe-Set" bucket with flange, suitable for concrete deck installation. Cast iron body and flashing collar, with flush-mounted cast iron grate and sediment bucket. Side outlet, round top.
4. Provide vandal proof top.

Specification Division 23 – Mechanical Table of Contents

- 1.) The table of contents for Division 23 shall be revised as per the attached Mechanical Table of Contents.

Specification Section 23 07 13 – HVAC Duct Insulation

- 1.) "Note #2" in the table at the end of this section shall be revised as follows:
 - "2. Omit external insulation for internally lined ductwork except for outdoor installations or where specifically noted on plans. Refer to notes on drawing M2.1C. On outdoor installations insulation thickness shall be at a minimum as scheduled but not less than the height of standing seams or angle bracing."
- 2.) The table at the end of this section shall be revised to indicate that "Note #2" shall apply to the following category of ductwork:
"Interior H&V, AC systems SA & RA
Including flexible run outs & all concealed,
not internally insulated ductwork."

Specification Section 23 07 16 – HVAC Equipment Insulation

- 3.) Add the following sub-paragraph to Paragraph 3.02:
"N. Insulate all pumps with type C insulation. Fabricate custom aluminum sheet metal enclosure around pump body and fittings. Cut and fit insulation to tightly fit the size and shape of the pump body parts including the volute and inlet and outlet piping and fittings. The enclosure shall be removable without cutting or breaking the insulation. The enclosure shall be vapor tight to prevent condensation."
- 4.) The table at the end of this section shall be revised to indicate that "type C" insulation, 1.5" thick, shall be provided for "Centrifugal and all air separators".

Specification Section 23 09 01 – Direct Digital Control Equipment

- 1.) This section shall be replaced by the attached specification section 23 09 01.

Specification Section 23 09 93 – Sequence of Operations

- 1.) The attached specification section 23 09 93 shall be added to the specifications.

Specification Section 23 64 16 – Centrifugal Water Chillers

- 1.) Paragraph 2.1.A shall be revised as follows:

- “A. Manufacturer: As manufactured by Johnson Controls/York; model, size, and capacity as noted and scheduled on plans.
 - 1. Other acceptable manufacturers:
 - a. McQuay.
 - b. Carrier.
 - c. Trane.”

Specification Section 23 65 00 – Cooling Towers

- 1.) Paragraph 2.1.A shall be revised as follows:
 - “A. Products: Shall be Baltimore Air Coil, BAC series 3000 as schedule on plans.
 - 1. Other acceptable manufacturers:
 - a. Marley.
 - b. Evapco.”

Specification Section 23 82 19 – Fan Coil Units

- 1.) Paragraph 2.1.A shall be revised as follows:
 - “A. As manufactured by Johnson Controls and as scheduled on plan.
 - 1. Other acceptable manufactures:
 - a. McQuay.
 - b. Trane.
 - c. Carrier.”

Specification Section 26 09 23 – Lighting Control Devices

- 1.) The following shall be added as indicated:

“1.7 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. Outdoor Photoelectric Switches: 10 % for each type and rating installed. Furnish at least one of each type.
 - 2. Indoor Photoelectric Switches: 10 % for each type and rating installed. Furnish at least one of each type.
 - 3. Indoor Occupancy Sensors: 10 % for each type and rating installed. Furnish at least one of each type.
 - 4. Outdoor Motion Sensors: 10 % for each type and rating installed. Furnish at least one of each type.
 - 5. Emergency Shunt Relays: 10 % for each type and rating installed. Furnish at least one of each type.
 - 6. Integrated Classroom Lighting System: 10% for each component of the system included by not limited to expansion packs, occupancy sensors and control center light switches. Furnish at least one of each type.”

Specification Section 26 51 00 – Interior Lighting

- 1.) The following shall be added as indicated:

“3.3 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate and maintain lighting system.”

Specification Section 28 31 11 – Digital, Addressable Fire-Alarm System

- 1.) The following shall be added to Paragraph 2.2.B as follows:
“12. Activate roll up doors in corridors to close.”

IV. QUESTIONS AND ANSWERS – NOT USED

V. REMINDERS – NOT USED

End of Addendum

SECTION 23 09 01 - DIRECT DIGITAL CONTROL EQUIPMENT

Part 1 – General

1.01 SUMMARY

- A. Section Includes:
1. Definitions
 2. BMS System Description
 3. Quality Assurance
 4. References
 5. Work By Others
 6. Submittals
 7. Record Documentation
 8. Warranty

1.02 Related Documents

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. All work of this Division shall be coordinated and provided by the single Building Management System (BMS) Contractor.
- C. The work of this Division shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference the Division 23 Sections for details.
- D. The work of this Division shall be as required by the Specifications, Point Schedules and Drawings.
- E. If the BMS Contractor believes there are conflicts or missing information in the project documents, the Contractor shall promptly request clarification and instruction from the design team.

1.03 Definitions

- A. Analog: A continuously variable system or value not having discrete levels. Typically exists within a defined range of limiting values.
- B. Binary: A two-state system where an “ON” condition is represented by one discrete signal level and an “OFF” condition is represented by a second discrete signal level.
- C. Building Management System (BMS): The total integrated system of fully operational and functional elements, including equipment, software, programming, and associated materials, to be provided by this Division BMS Contractor and to be interfaced to the associated work of other related trades.
- D. BMS Contractor: The single Contractor to provide the work of this Division. This Contractor shall be the primary manufacturer, installer, commissioner and ongoing service provider for the BMS work.
- E. Control Sequence: An BMS pre-programmed arrangement of software algorithms, logical computation, target values and limits as required to attain the defined operational control objectives.

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- F. Direct Digital Control: The digital algorithms and pre-defined arrangements included in the BMS software to provide direct closed-loop control for the designated equipment and controlled variables.
- G. Inclusive of Proportional, Derivative and Integral control algorithms together with target values, limits, logical functions, arithmetic functions, constant values, timing considerations and the like.
- H. BMS Network: The total digital on-line real-time interconnected configuration of BMS digital processing units, workstations, panels, sub-panels, controllers, devices and associated elements individually known as network nodes. May exist as one or more fully interfaced and integrated sub-networks, LAN, WAN or the like.
- I. Node: A digitally programmable entity existing on the BMS network.
- J. BMS Integration: The complete functional and operational interconnection and interfacing of all BMS work elements and nodes in compliance with all applicable codes, standards and ordinances so as to provide a single coherent BMS as required by this Division.
- K. Provide: The term “Provide” and its derivatives when used in this Division shall mean to furnish, install in place, connect, calibrate, test, commission, warrant, document and supply the associated required services ready for operation.
- L. PC: IBM-compatible Personal Computer from a recognized major manufacturer
- M. Furnish: The term “Furnish” and its derivatives when used in this Division shall mean supply at the BMS Contractor’s cost to the designated third party trade contractor for installation. BMS Contractor shall connect furnished items to the BMS, calibrate, test, commission, warrant and document.
- N. Wiring: The term “Wiring” and its derivatives when used in this Division shall mean provide the BMS wiring and terminations.
- O. Install: The term “Install” and its derivatives when used in this Division shall mean receive at the jobsite and mount.
- P. Protocol: The term “protocol” and its derivatives when used in this Division shall mean a defined set of rules and standards governing the on-line exchange of data between BMS network nodes.
- Q. Software: The term “software” and its derivatives when used in this Division shall mean all of programmed digital processor software, preprogrammed firmware and project specific digital process programming and database entries and definitions as generally understood in the BMS industry for real-time, on-line, integrated BMS configurations.
- R. The use of words in the singular in these Division documents shall not be considered as limiting when other indications in these documents denote that more than one such item is being referenced.
- S. Headings, paragraph numbers, titles, shading, bolding, underscores, clouds and other symbolic interpretation aids included in the Division documents are for general information only and are to assist in the reading and interpretation of these Documents.
- T. The following abbreviations and acronyms may be used in describing the work of this Division:
- | | | |
|-------|---|--|
| ADC | - | Analog to Digital Converter |
| AI | - | Analog Input |
| AN | - | Application Node |
| ANSI | - | American National Standards Institute |
| AO | - | Analog Output |
| ASCII | - | American Standard Code for Information Interchange |

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| | | |
|--------|---|---|
| ASHRAE | | American Society of Heating, Refrigeration and Air Conditioning Engineers |
| AWG | - | American Wire Gauge |
| CPU | - | Central Processing Unit |
| CRT | - | Cathode Ray Tube |
| DAC | - | Digital to Analog Converter |
| DDC | - | Direct Digital Control |
| DI | - | Digital Input |
| DO | - | Digital Output |
| EEPROM | - | Electrically Erasable Programmable Read Only Memory |
| EMI | - | Electromagnetic Interference |
| FAS | - | Fire Alarm Detection and Annunciation System |
| GUI | - | Graphical User Interface |
| HOA | - | Hand-Off-Auto |
| ID | - | Identification |
| IEEE | - | Institute of Electrical and Electronics Engineers |
| I/O | - | Input/Output |
| LAN | - | Local Area Network |
| LCD | - | Liquid Crystal Display |
| LED | - | Light Emitting Diode |
| MCC | - | Motor Control Center |
| NC | - | Normally Closed |
| NIC | - | Not In Contract |
| NO | - | Normally Open |
| OWS | - | Operator Workstation |
| OAT | - | Outdoor Air Temperature |
| PC | - | Personal Computer |
| RAM | - | Random Access Memory |
| RF | - | Radio Frequency |
| RFI | - | Radio Frequency Interference |
| RH | - | Relative Humidity |
| ROM | - | Read Only Memory |
| RTD | - | Resistance Temperature Device |
| SPDT | - | Single Pole Double Throw |
| SPST | - | Single Pole Single Throw |
| XVGA | - | Extended Video Graphics Adapter |
| TBA | - | To Be Advised |
| TCP/IP | - | Transmission Control Protocol/Internet Protocol |
| TTD | - | Thermistor Temperature Device |
| UPS | - | Uninterruptible Power Supply |
| VAC | - | Volts, Alternating Current |
| VAV | - | Variable Air Volume |
| VDC | - | Volts, Direct Current |
| WAN | - | Wide Area Network |

1.04 BMS Description

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- A. The Building Management System (BMS) shall be a complete system designed for use with the enterprise IT systems. This functionality shall extend into the equipment rooms. Devices residing on the automation network located in equipment rooms and similar shall be fully IT compatible devices that mount and communicate directly on the IT infrastructure in the facility. Contractor shall be responsible for coordination with the owner's IT staff to ensure that the BMS will perform in the owner's environment without disruption to any of the other activities taking place on that LAN.
- B. All points of user interface shall be on standard PCs that do not require the purchase of any special software from the BMS manufacturer for use as a building operations terminal. The primary point of interface on these PCs will be a standard Web Browser.
- C. Where necessary and as dictated elsewhere in these Specifications, Servers shall be used for the purpose of providing a location for extensive archiving of system configuration data, and historical data such as trend data and operator transactions. All data stored will be through the use of a standard data base platform: Microsoft SQL Server Express or Microsoft SQL Server as dictated elsewhere in this specification. The work of the single BMS Contractor shall be as defined individually and collectively in all Sections of this Division specifications together with the associated Point Sheets and Drawings and the associated interfacing work as referenced in the related documents.
- D. The BMS work shall consist of the provision of all labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, cleaning, cutting and patching, warranties, services, and items, even though these may not be specifically mentioned in these Division documents which are required for the complete, fully functional and commissioned BMS.
1. All automation and control components shall be integrated into a distributed network system communicating over a nonproprietary network. This system shall consist of field Stand-alone Direct Digital Controllers (DDC), Smart Local DDC's and PC-based operator workstations. The control System shall support the Internet Protocol (IP) implementation of BAC NET defined in Annex J of the ASHRAE standard.
 1. The PC workstation and building management system provided under this contract shall communicate with the existing Johnson Metasys district wide DDC control system. This communication shall consist of monitoring systems and changing set points from the PC workstation. Any software changes (i.e.: changing of sequences of operation) shall have to be done at the local school.
- E. Provide a complete, neat and workmanlike installation. Use only manufacturer employees who are skilled, experienced, trained, and familiar with the specific equipment, software, standards and configurations to be provided for this Project.
- F. Manage and coordinate the BMS work in a timely manner in consideration of the Project schedules. Coordinate with the associated work of other trades so as to not impede or delay the work of associated trades.
- G. The BMS as provided shall incorporate, at minimum, the following integrated features, functions and services:
1. Operator information, alarm management and control functions.

2. Enterprise-level information and control access.
3. Information management including monitoring, transmission, archiving, retrieval, and reporting functions.
4. Diagnostic monitoring and reporting of BMS functions.
5. Offsite monitoring and management access.
6. Energy management
7. Standard applications for terminal HVAC systems.
8. indoor air quality monitoring (CO₂)

H. The Building Automation System (BAS) shall be designed in strict accordance with ASHRAE's BACnet standard, 135-2001, to provide interoperability between different building subsystems. The system shall also provide a graphical, web-based operator interface that allows for instant access to any system through a standard browser.

The system shall use BACnet network types and protocols exclusively. Non-BACnet-based systems are not acceptable. The contractor must provide PC-based programming workstations, operator workstations and microcomputer controllers of modular design providing distributed processing capability, and allowing future expansion of both input/output points and processing/control functions. Contractor must provide manufacturer's Protocol Implementation Conformance Statement (PICS) for workstation software and every controller model that are installed.

1. Administration and Programming Workstation

The BAS Contractor shall furnish 1 Administration and Programming Workstation Computer and (1) printer as described in Part 2 of the specification. These workstations must be running the standard workstation software developed and tested by the manufacturer of the network controllers and the standalone controllers. No third party front-end workstation software will be acceptable. Workstations must conform to the B-OWS BACnet device profile.

2. Operator Workstations

The BAS Contractor shall furnish licenses for (2) concurrent users to the BAS system. Users shall have access to all system points and graphics, shall be able to receive and acknowledge alarms, and shall be able to control setpoints and other parameters. A central web server shall be provided to manage the web-based users. The web-based interface must conform to the B-OWS BACnet device profile. The new work station shall be located in the Physical Plant office.

3. Ethernet-based Network Router and/or Controller(s).

The BAS Contractor shall furnish Ethernet-based network controllers as described in Part 2 of the specification. These controllers will connect directly to the Operator Workstation over Ethernet, using the BACnet/IP protocol at a minimum of 100mbps, and provide communication to the Standalone Digital Control Units and/or other Input/Output Modules. Network Controllers shall conform to BACnet device profile B-BC. Network controllers that utilize RS232 serial communications or ARCNET to communicate with the workstations will not be accepted. Network Controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as Building Controllers (B-BC).

4. Standalone Digital Control Units (SDCUs).

Provide the necessary quantity and types of SDCUs to meet the requirements of the project for mechanical equipment control including air handlers, central plant control, and terminal unit control. Each SDCU will operate completely standalone, containing all of the I/O and programs to control its associated equipment. Each SDCU shall conform to the BACnet device profile B-AAC.

SDCUs shall be tested and certified by the BACnet Testing Laboratory (BTL) as Advanced Application Controllers (B-AAC).

1.05 Quality Assurance

A. General

1. The Building Management System Contractor shall be the primary manufacturer-owned branch office that is regularly engaged in the engineering, programming, installation and service of total integrated Building Management Systems.
2. The BMS Contractor shall have a branch facility within a 100-mile radius of the job site supplying complete maintenance and support services on a 24 hour, 7-day-a-week basis.
3. As evidence and assurance of the contractor's ability to support the Owner's system with service and parts, the contractor must have been in the BMS business for at least the last ten (10) years and have successfully completed total projects of at least 10 times the value of this contract in each of the preceding five years.
4. The Building Management System architecture shall consist of the products of a manufacturer regularly engaged in the production of Building Management Systems, and shall be the manufacturer's latest standard of design at the time of bid and shall be Johnsons Metasys. Others systems by Johnsons controls or licensed venders or franchises systems including the FX system are not acceptable.
5. The following is a list of acceptable BMS Systems:
 1. Johnson Controls – Edison, NJ Branch Office
 2. Johnson Controls - ATC systems Inc – Middlesex NJ
 3. Siemens – Pinebrook, NJ Branch Office
 4. Honeywell – Morristown, NJ Branch Office

1.06 References

A All work shall conform to the following standards.

- a. National Fire Protection Association (NFPA) Standards
- b. National Electric Code (NEC) and applicable local Electric Code
- c. Underwriters Laboratories (UL) listing and labels
- d. NFPA 90A - Standard For The Installation Of Air Conditioning And Ventilating Systems.
- e. Air Movement and Control Association (AMCA)
- f. Occupational Safety and Health Administration (OSHA)
- g. ANSI/EIA 909.1-A-1999 (LonWorks)
- h. ANSI/ASHRAE Standard 195-2004 (BACnet)

B In the case of conflicts or discrepancies, the more stringent regulation shall apply.

C All work shall meet the approval of the Authorities Having Jurisdiction at the project site.

1.07 Work by Others

- A. The BMS Contractor shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of work by others.
- B. The BMS Contractor shall furnish all control valves, sensor wells, flow meters and other similar equipment for installation by the Mechanical Contractor.
- C. The BMS Contractor shall provide field supervision to the designated contractor for the installation of the following:
- D. Automatic control dampers
 - 1. Fire/smoke dampers
 - 2. Blank-off plates for dampers that are smaller than duct size.
 - 3. Sheet metal baffle plates to eliminate stratification.
- E. The Electrical Contractor shall provide:
 - 1. All power wiring to motors, heat trace, junction boxes for power to BAS panels.
 - 2. Furnish smoke detectors and wire to the building fire alarm system. HVAC Contractor to mount devices. BAS Contractor to hardwire to fan shut down.
- F. The BMS Contractor shall provide:
 - 1. All power wiring to all smoke damper actuators for smoke control sequence.
- G. Code Compliance
 - 1. Provide BAS components and ancillary equipment, which are UL-916 listed and labeled.
 - 2. All equipment or piping used in conditioned air streams, spaces or return air plenums shall comply with NFPA 90A Flame/Smoke/Fuel contribution rating of 25/50/0 and all applicable building codes or requirements.
 - 3. All wiring shall conform to the National Electrical Code.
 - 4. All smoke dampers shall be rated in accordance with UL 555S.
 - 5. Comply with FCC rules, Part 15 regarding Class A radiation for computing devices and low power communication equipment operating in commercial environments. Comply with FCC, Part 68 rules for telephone modems and data sets.

1.08 Submittals

- A. All shop drawings shall be prepared in Visio Professional or AutoCAD software. In addition to the drawings, the Contractor shall furnish a CD containing the identical information. Drawings shall be 11x17 size or larger.
- B. Shop drawings shall include a riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also included shall be individual schematics of each mechanical system showing all connected points with reference to their associated controller. Typical drawings will be allowed where appropriate.

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- C. Submittal data shall contain manufacturer's data on all hardware and software products required by the specification. Valve, damper and air flow station schedules shall indicate size, configuration, capacity and location of all equipment.
- D. Software submittals shall contain narrative descriptions of sequences of operation, program listings, point lists, and a complete description of the graphics, reports, alarms and configuration to be furnished with the workstation software. Submit print out of sample graphics for all major equipment, including the boiler plant, chiller plant(if applicable), air handlers, AC units, pumps, etc. sample Information shall be bound or in a three ring binder with an index and tabs.
- E. Submit five (5) copies of submittal data and shop drawings to the Engineer for review prior to ordering or fabrication of the equipment. The Contractor prior to submitting shall check all documents for accuracy.
- F. The Engineer will make corrections, if required, and return to the Contractor. The Contractor will then resubmit with the corrected or additional data. This procedure shall be repeated until all corrections are made to the satisfaction of the Engineer and the submittals are fully approved.
- G. Sequence of operations: The controls contractor shall review the sequences of operation given in division 23 of this specification. "Canned", preprogrammed, or typical sequences by the manufacture may not be acceptable and shall only be used if accepted by the engineer. Otherwise the controls contractor shall be capable of and responsible for providing custom programming, hardware, software, and labor as required to achieve the sequences specified
- H. Shop Drawings, Product Data, and Samples
 - 1. At a minimum, submit the following:
 - a. BMS network architecture diagrams including all nodes and interconnections.
 - b. Systems schematics, sequences and flow diagrams.
 - c. Points schedule for each point in the BMS, including: Point Type, Object Name, Expanded ID, Display Units, Controller type, and Address.
 - d. Samples of Graphic Display screen types and associated menus.
 - e. Detailed Bill of Material list for each system or application, identifying quantities, part numbers, descriptions, and optional features.
 - f. Control Damper Schedule including a separate line for each damper provided under this section and a column for each of the damper attributes, including: Code Number, Fail Position, Damper Type, Damper Operator, Duct Size, Damper Size, Mounting, and Actuator Type.
 - g. Control Valve Schedules including a separate line for each valve provided under this section and a column for each of the valve attributes: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close off Pressure, Capacity, Valve CV, Design Pressure, and Actuator Type.
 - h. Room Schedule including a separate line for each VAV box and/or terminal unit indicating location and address
 - i. Details of all BMS interfaces and connections to the work of other trades.
 - j. Product data sheets or marked catalog pages including part number, photo and description for all products including software.

1.09 Record Documentation

A. Operation and Maintenance Manuals

1. Three (3) copies of the Operation and Maintenance Manuals shall be provided to the Owner's Representative upon completion of the project. The entire Operation and Maintenance Manual shall be furnished on Compact Disc media, and include the following for the BMS provided:
 - Table of contents.
 - As-built system record drawings. Computer Aided Drawings (CAD) record drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.
 - Manufacturers product data sheets or catalog pages for all products including software.
 - System Operator's manuals.
 - Archive copy of all site-specific databases and sequences. BMS network diagrams.
 - Interfaces to all third-party products and work by other trades.
2. The Operation and Maintenance Manual CD shall be self-contained, and include all necessary software required to access the product data sheets. A logically organized table of contents shall provide dynamic links to view and print all product data sheets. Viewer software shall provide the ability to display, zoom, and search all documents.

1.10 Warranty

A. Standard Material and Labor Warranty:

1. Provide a one-year labor and material warranty on the BMS.
2. If within twelve (12) months from the date of acceptance of product, upon written notice from the owner, it is found to be defective in operation, workmanship or materials, it shall be replaced, repaired or adjusted at the option of the BMS Contractor at the cost of the BMS Contractor.
3. Maintain an adequate supply of materials within 100 miles of the Project site such that replacement of key parts and labor support, including programming. Warranty work shall be done during BMS Contractor's normal business hours.

1.11 Scope of work

- A The Contractor shall furnish and install a complete building automation system including all necessary hardware, sensors, controllers, and all operating and applications software necessary to perform the control sequences of operation as specified. This shall include, workstations, application controllers, unitary controllers, LANs, WANs etc. Communication shall be through the BACnet protocol, as defined by ASHRAE Standard 135-2001. No gateways shall be used for communication to controllers furnished under this section. This contractor shall perform all programming and software configurations required for all new software as required to completely represent all new equipment graphically and so that the BMS can perform all the functions necessary to achieve the sequence of operation as specified. This contractor shall provide a new building wide Ethernet to integrate new Level 1 controllers. Level 2 networks, LANs and or

WANs shall be completely installed by this contractor as required. At a minimum, provide controls for the following new and existing equipment:

1. All Air handling units
 2. All AC units split and packaged
 3. All supply, return and exhaust air fans
 4. Boiler room sump pumps and ejectors
 5. Chilled water system including pumps, chiller
 6. Hot water system including boilers and hot water pumps
 7. Hot water, condenser water and chilled water pumps
 8. Cooling tower controls and fans
 9. Refrigerant detection and exhaust system
 10. Smoke evacuation sequence of AHUs and return fans including smoke control dampers and fire command override panel. (not used)
 11. Radiant panel controls and hot water coils.
 12. Smoke dampers / combination fire smoke dampers
 13. Gas fired make up air unit
 14. Motorized damper, smoke dampers and combination fire/smoke dampers
 15. Variable volume and constant volume box control including interlocks with heating valves and controls
 16. Cabinet unit heater and convector controls, fan coil units
 17. Monitoring points for packaged equipment such as emergency generators, air compressors, and boilers
 18. Motor starters and combination starter/disconnects.
 19. Power wiring to DDC devices, smoke control dampers and BAS panels. Except as otherwise noted, the control system shall consist of all Ethernet Network Controllers, Standalone Digital Control Units, workstations, software, sensors, transducers, relays, valves, dampers, damper operators, control panels, and other accessory equipment, along with a complete system of electrical interlocking wiring to fill the intent of the specification and provide for a complete and operable system. Provide operators for equipment such as dampers and valves if the equipment manufacturer does not provide these. Coordinate requirements with the various Contractors.
- B. The BMS contractor shall review and study all HVAC drawings and the entire specification to familiarize himself with the equipment and system operation and to verify the quantities and types of dampers, operators, alarms, etc. to be provided.
- C. All interlocking, wiring and installation of control devices associated with the equipment listed below shall be provided under this Contract. All wiring that can be concealed in ceiling or walls shall be concealed in surface mounted metal raceways provided by this contractor. When the BMS system is fully installed and operational, the BMS Contractor and representatives of the Owner will review and check out the system. At that time, the BAS contractor shall demonstrate the operation of the system and prove that it complies with the intent of the drawings and specifications.
- D. Provide services and manpower necessary for commissioning of system in coordination with the HVAC Contractor, Balancing Contractor and Owner's representative.
- E. All work performed under this section of the specifications will comply with all codes, laws and governing bodies. If the drawings and/or specifications are in conflict with governing codes, the Contractor shall submit a proposal with appropriate modifications to the project to meet code restrictions. If this specification and associated drawings exceed governing code requirements,

the specification will govern. The Contractor shall obtain and pay for all necessary construction permits and licenses.

1.12 System Start up and Commissioning

- A. Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BAS will be tested against the appropriate sequence of operation specified herein. A written report will be submitted to the owner indicating that the installed system functions in accordance with the plans and specifications.
- B. The BAS contractor shall commission and set in operating condition all major equipment and systems, such as the chilled water, hot water and all air handling systems, in the presence of the equipment manufacturer's representatives, as applicable, and the Owner and Architect's representatives.
- C. The BAS Contractor shall provide all manpower and engineering services required to assist the HVAC Contractor and Balancing Contractor in testing, adjusting, and balancing all systems in the building. The BAS Contractor shall have a trained technician available on request during the balancing of the systems. The BAS Contractor shall coordinate all requirements to provide a complete air and water balance with the Balancing Contractor and shall include all labor and materials in his contract.
- D. At the completion of all mechanical work, including balancing, this contractor shall perform a full demonstration of the controls system to the engineer. This shall include running all equipment through the full sequence of operation. Each piece of equipment shall be monitored at the work station and responses shall be visually verified. Where required, (if weather conditions do not permit) the set-points shall be adjusted beyond the normal range to force sequences to operate. Sequences such as morning warm up shall be initiated by resetting start time outside the normal range.

1.13 Training

- A. The BAS Contractor shall provide both on-site and classroom training to the Owner's representative and maintenance personnel per the following description:
On-site training shall consist of a minimum of 3 (8) hour sessions of hands-on instruction for (4) operators, geared at the operation and maintenance of the systems. The curriculum shall include
 - ◆ System Overview
 - ◆ System Software and Operation
 - System access
 - Software features overview
 - Changing setpoints and other attributes
 - Scheduling
 - Editing programmed variables
 - Displaying color graphics
 - Running reports
 - Workstation maintenance
 - Application programming
 - ◆ Operational sequences including start-up, shutdown, adjusting and balancing.
 - ◆ Equipment maintenance.

- B. Classroom training will include a minimum of (2) training slots for two weeks of course material covering workstation operation and controller programming

Part 2 – Products

2.01 General Description

- A. The Building Management System (BMS) shall use an open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BMS shall support open communication protocol standards and integrate a wide variety of third-party devices and applications. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other owner provided networks. The system shall be furnished and installed Johnson Controls and shall be Johnson Metasys 5.0 or the latest version currently available.
- B. The Building Management System shall consist of the following:
 - 1. Standalone Network Automation Engine(s)
 - 2. Field Equipment Controller(s)
 - 3. Input/Output Module(s)
 - 4. Local Display Device(s)
 - 5. Portable Operator's Terminal(s)
 - 6. Distributed User Interface(s)
 - 7. Network processing, data storage and communications equipment
 - 8. Other components required for a complete and working BMS
- C. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.
- D. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.
 - 1. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
 - 2. The System shall maintain all settings and overrides through a system reboot.
- E. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.
- F. Acceptable Manufacturers
 - 1. Honeywell, Enterprise Building Integrator (EBI)
 - 2. Siemens Building Systems, APOGEE

2.02 BMS Architecture

- A. Automation Network
 - 1. The automation network shall be based on a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard “off the shelf” products available through normal PC vendor channels.

2. The BMS shall network multiple user interface clients, automation engines, system controllers and application-specific controllers. Provide application and data server(s) as required for systems operation.
3. All BMS devices on the automation network shall be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication.
4. Network Automation Engines (NAE) shall reside on the automation network.
5. The automation network will be compatible with other enterprise-wide networks. Where indicated, the automation network shall be connected to the enterprise network and share resources with it by way of standard networking devices and practices.

B. Control Network

1. Network Automation Engines (NAE) shall provide supervisory control over the control network and shall support all three (3) of the following communication protocols:
 - a. BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9
 - ◇ The NAE shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
 - ◇ The NAE shall be tested and certified as a BACnet Building Controller (B-BC).
 - b. LonWorks enabled devices using the Free Topology Transceiver (FTT-10a).
 - c. The Johnson Controls N2 Field Bus.
2. Control networks shall provide either “Peer-to-Peer,” Master-Slave, or Supervised Token Passing communications, and shall operate at a minimum communication speed of 9600 baud.
3. DDC Controllers shall reside on the control network.
4. Control network communication protocol shall be BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135.
5. A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.
6. The PICS shall be submitted 10 days prior to bidding.

C. Integration

1. Hardwired
 - a. Analog and digital signal values shall be passed from one system to another via hardwired connections.
 - b. There will be one separate physical point on each system for each point to be integrated between the systems.
2. Direct Protocol (Integrator Panel)
 - a. The BMS system shall include appropriate hardware equipment and software to allow bi-directional data communications between the BMS system and 3rd party manufacturers’ control panels. The BMS shall receive, react to, and return information from multiple building systems, including but not limited to the chillers, boilers, variable frequency drives, power monitoring system, and medical gas.
 - b. All data required by the application shall be mapped into the Automation Engine’s database, and shall be transparent to the operator.

- c. Point inputs and outputs from the third-party controllers shall have real-time interoperability with BMS software features such as: Control Software, Energy Management, Custom Process Programming, Alarm Management, Historical Data and Trend Analysis, Totalization, and Local Area Network Communications.
3. BACnet Protocol Integration - BACnet
 - a. The neutral protocol used between systems will be BACnet over Ethernet and comply with the ASHRAE BACnet standard 135-2003.
 - b. A complete Protocol Implementation Conformance Statement (PICS) shall be provided for all BACnet system devices.
 - c. The ability to command, share point object data, change of state (COS) data and schedules between the host and BACnet systems shall be provided.

2.03 User Interface

A. Dedicated Web Based User Interface

1. Where indicated on plans the BMS Contractor shall provide and install a personal computer for command entry, information management, network alarm management, and database management functions. All real-time control functions, including scheduling, history collection and alarming, shall be resident in the BMS Network Automation Engines to facilitate greater fault tolerance and reliability.
2. Dedicated User Interface Architecture – The architecture of the computer shall be implemented to conform to industry standards, so that it can accommodate applications provided by the BMS Contractor and by other third party applications suppliers, including but not limited to Microsoft Office Applications. Specifically it must be implemented to conform to the following interface standards.
 - a. Microsoft Internet Explorer for user interface functions
 - b. Microsoft Office Professional for creation, modification and maintenance of reports, sequences other necessary building management functions
 - c. Microsoft Outlook or other e-mail program for supplemental alarm functionality and communication of system events, and reports
 - d. Required network operating system for exchange of data and network functions such as printing of reports, trends and specific system summaries
3. PC Hardware – The personal computer(s) shall be configured as follows:
 - a. Memory – 1 GB (512 MB Minimum)
 - b. CPU– Intel Core 2 Duo processor. 2 GB memory
 - c. Hard Drive – 320 GB free hard drive space
 - d. Hard drive backup system – CD/RW, DVD/RW
 - e. CD ROM Drive – 64X performance
 - f. Ports – (2) Serial and (1) parallel, (2) USB ports
 - g. Keyboard – 101 Keyboard and 2 Button Mouse
 - h. CRT configuration – 1 CRTs as follows:
 - ◇ Each Display – 17” Flat Panel Monitor 1280 x 1024 resolution minimum
 - ◇ 16 bit or higher color resolution
 - ◇ Display card with multiple monitor support
 - i. LAN communications – Ethernet communications board; 3Comm or equal
4. Operating System Software

- a. Windows 7 Professional
 - b. Where user interface is not provided via browser, provide complete operator workstation software package, including any hardware or software keys. Include the original installation disks and licenses for all included software, device drivers, and peripherals.
 - c. Provide software registration cards to the Owner for all included software.
5. Peripheral Hardware
- a. Reports printer:
 - ◇ Printer Make – Hewlett Packard DeskJet
 - ◇ Print Speed – 600 DPI Black, 300 DPI Color
 - ◇ Buffer – 64 K Input Print Buffer
 - ◇ Color Printing – Include Color Kit
- B. Distributed Web Based User Interface
1. All features and functions of the dedicated user interface previously defined in this document shall be available on any computer connected directly or via a wide area or virtual private network (WAN/VPN) to the automation network and conforming to the following specifications.
 2. The software shall run on the Microsoft Internet Explorer (6.0 or higher) browser supporting the following functions:
 - ◇ Configuration
 - ◇ Commissioning
 - ◇ Data Archiving
 - ◇ Monitoring
 - ◇ Commanding
 - ◇ System Diagnostics
 3. Minimum hardware requirements:
 - ◇ 512 MB RAM
 - ◇ 2.0 GHz Clock Speed Pentium 4 Microprocessor
 - ◇ 100.0 GB Hard Drive.
 - ◇ 1 Keyboard with 83 keys (minimum).
 - ◇ SVGA 1024x768 resolution display with 64K colors and 16 bit color depth
 - ◇ Mouse or other pointing device
- C. User Interface Application Components
1. Operator Interface
 - a. An integrated browser based client application shall be used as the user operator interface program.
 - b. The System shall employ an event-driven rather than a device polling methodology to dynamically capture and present new data to the user.
 - c. All Inputs, Outputs, Setpoints, and all other parameters as defined within Part 3, shown on the design drawings, or required as part of the system software, shall be displayed for operator viewing and modification from the operator interface software.

- d. The user interface software shall provide help menus and instructions for each operation and/or application.
 - e. The system shall support customization of the UI configuration and a home page display for each operator.
 - f. The system shall support user preferences in the following screen presentations:
 - ◇ Alarm
 - ◇ Trend
 - ◇ Display
 - ◇ Applications
 - g. All controller software operating parameters shall be displayed for the operator to view/modify from the user interface. These include: setpoints, alarm limits, time delays, PID tuning constants, run-times, point statistics, schedules, and so forth.
 - h. The Operator Interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:
 - ◇ User access for selective information retrieval and control command execution
 - ◇ Monitoring and reporting
 - ◇ Alarm, non-normal, and return to normal condition annunciation
 - ◇ Selective operator override and other control actions
 - ◇ Information archiving, manipulation, formatting, display and reporting
 - ◇ BMS internal performance supervision and diagnostics
 - ◇ On-line access to user HELP menus
 - ◇ On-line access to current BMS as-built records and documentation
 - ◇ Means for the controlled re-programming, re-configuration of BMS operation and for the manipulation of BMS database information in compliance with the prevailing codes, approvals and regulations for individual BMS applications
 - i. The system shall support a list of application programs configured by the users that are called up by the following means:
 - ◇ The Tools Menu
 - ◇ Hyperlinks within the graphics displays
 - ◇ Key sequences
 - j. The operation of the control system shall be independent of the user interface, which shall be used for operator communications only. Systems that rely on an operator workstation to provide supervisory control over controller execution of the sequences of operations or system communications shall not be acceptable.
2. Navigation Trees
- a. The system will have the capability to display multiple navigation trees that will aid the operator in navigating throughout all systems and points connected. At minimum provide a tree that identifies all systems on the networks.
 - b. Provide the ability for the operator to add custom trees. The operator will be able to define any logical grouping of systems or points and arrange them

- on the tree in any order. It shall be possible to nest groups within other groups. Provide at minimum 5 levels of nesting.
- c. The navigation trees shall be “dockable” to other displays in the user interface such as graphics. This means that the trees will appear as part of the display, but can be detached and then minimized to the Windows task bar or closed altogether. A simple keystroke will reattach the navigation to the primary display of the user interface.
3. Alarms
- a. Alarms shall be routed directly from Network Automation Engines to PCs and servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the user interface shall, at the minimum, provide the following functions:
- ◇ Log date and time of alarm occurrence.
 - ◇ Generate a “Pop-Up” window, with audible alarm, informing a user that an alarm has been received.
 - ◇ Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.
 - ◇ Provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the user, the alarm, the action taken on the alarm, and a time/date stamp.
 - ◇ Provide the ability to direct alarms to an e-mail address or alphanumeric pager. This must be provided in addition to the pop up window described above. Systems that use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.
 - ◇ Any attribute of any object in the system may be designated to report an alarm.
- b. The BMS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions.
- c. The BMS shall allow a minimum of 4 categories of alarm sounds customizable through user defined wav.files.
- d. The BMS shall annunciate application alarms at minimum, as required by Part 3.
4. Reports and Summaries
- a. Reports and Summaries shall be generated and directed to the user interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall provide the following reports:
- ◇ All points in the BMS
 - ◇ All points in each BMS application
 - ◇ All points in a specific controller
 - ◇ All points in a user-defined group of points
 - ◇ All points currently in alarm
 - ◇ All points locked out
 - ◇ All BMS schedules
 - ◇ All user defined and adjustable variables, schedules, interlocks and the like.

- b. Summaries and Reports shall be accessible via standard UI functions and not dependent upon custom programming or user defined HTML pages.
- c. Selection of a single menu item, tool bar item, or tool bar button shall print any displayed report or summary on the system printer for use as a building management and diagnostics tool.
- d. The system shall allow for the creation of custom reports and queries via a standard web services XML interface and commercial off-the-shelf software such as Microsoft Access, Microsoft Excel, or Crystal Reports.
- e. Provide the capability to view, command and modify large quantities of similar data in tailored summaries created online without the use of a secondary application like a spreadsheet. Summary definition shall allow up to seven user defined columns describing attributes to be displayed including custom column labels. Up to 100 rows per summary shall be supported. Summary viewing shall be available over the network using a standard Web browser.
- f. Provide a focused set of reports that includes essential information required for effective management of energy resources within the facility. Energy reports shall be configurable from predefined, preconfigured templates. Required includes but shall not be limited to:
 - a. Energy Overview
 - b. Load Profile
 - c. Simple Energy Cost
 - d. Consumption
 - e. Equipment Runtime
 - f. Electrical Energy
 - g. Energy ProductionReports shall be selectable by date, time, area and device. Each report shall include a color visual summary of essential energy information.

5. Schedules

- a. A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:
 - ◇ Weekly schedules
 - ◇ Exception Schedules
 - ◇ Monthly calendars
- b. Weekly schedules shall be provided for each group of equipment with a specific time use schedule.
- c. It shall be possible to define one or more exception schedules for each schedule including references to calendars
- d. Monthly calendars shall be provided that allow for simplified scheduling of holidays and special days for a minimum of five years in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the exception schedules.
- e. Changes to schedules made from the User Interface shall directly modify the Network Automation Engine schedule database.

- f. Schedules and Calendars shall comply with ASHRAE SP135/2003 BACnet Standard.
 - g. Selection of a single menu item or tool bar button shall print any displayed schedule on the system printer for use as a building management and diagnostics tool.
 - h. Software shall be provided to configure and implement optimal start and stop programming based on existing indoor and outdoor environmental conditions as well as equipment operating history
6. Password
- a. Multiple-level password access protection shall be provided to allow the user/manager to user interface control, display, and database manipulation capabilities deemed appropriate for each user, based on an assigned password.
 - b. Each user shall have the following: a user name (accept 24 characters minimum), a password (accept 12 characters minimum), and access levels.
 - c. The system shall allow each user to change his or her password at will.
 - d. When entering or editing passwords, the system shall not echo the actual characters for display on the monitor.
 - e. A minimum of five levels of access shall be supported individually or in any combination as follows:
 - ◇ Level 1 = View Data
 - ◇ Level 2 = Command
 - ◇ Level 3 = Operator Overrides
 - ◇ Level 4 = Database Modification
 - ◇ Level 5 = Database Configuration
 - ◇ Level 6 = All privileges, including Password Add/Modify
 - f. A minimum of 100 unique passwords shall be supported.
 - g. Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on.
 - h. The system shall automatically generate a report of log-on/log-off and system activity for each user. Any action that results in a change in the operation or configuration of the control system shall be recorded, including: modification of point values, schedules or history collection parameters, and all changes to the alarm management system, including the acknowledgment and deletion of alarms.
7. Screen Manager
- a. The User Interface shall be provided with screen management capabilities that allow the user to activate, close, and simultaneously manipulate a minimum of 4 active display windows plus a network or user defined navigation tree.
8. Dynamic Color Graphics
- a. The graphics application program shall be supplied as an integral part of the User Interface. Browser or Workstation applications that rely only upon HTML pages shall not be acceptable.

- b. The graphics applications shall include a create/edit function and a runtime function. The system architecture shall support an unlimited number of graphics documents (graphic definition files) to be generated and executed. The graphics shall be able to display and provide animation based on real-time data that is acquired, derived, or entered.
 - c. Graphics runtime functions – A maximum of 16 graphic applications shall be able to execute at any one time on a user interface or workstation with 4 visible to the user. Each graphic application shall be capable of the following functions:
 - ◇ All graphics shall be fully scalable
 - ◇ The graphics shall support a maintained aspect ratio.
 - ◇ Multiple fonts shall be supported.
 - ◇ Unique background shall be assignable on a per graphic basis.
 - ◇ The color of all animations and values on displays shall indicate if the status of the object attribute.
 - d. Operation from graphics – It shall be possible to change values (setpoints) and states in system controlled equipment by using drop-down windows accessible via the pointing device
 - e. Graphic editing tool – A graphic editing tool shall be provided that allows for the creation and editing of graphic files. The graphic editor shall be capable of performing/defining all animations, and defining all runtime binding.
 - ◇ The graphic editing tool shall in general provide for the creation and positioning of point objects by dragging from tool bars or drop-downs and positioning where required.
 - ◇ In addition, the graphic editing tool shall be able to add additional content to any graphic by importing backgrounds in the SVG, BMP or JPG file formats.
 - f. Aliasing – Many graphic displays representing part of a building and various building components are exact duplicates, with the exception that the various variables are bound to different field values. Consequently, it shall be possible to bind the value of a graphic display to aliases, as opposed to the physical field tags.
9. Historical trending and data collection
- a. Each Automation Engine shall store trend and point history data for all analog and digital inputs and outputs, as follows:
 - ◇ Any point, physical or calculated, may be designated for trending. Three methods of collection shall be allowed:
 - Defined time interval
 - Upon a change of value
 - ◇ Each Automation Engine shall have the capability to store multiple samples for each physical point and software variable based upon available memory, including an individual sample time/date stamp. Points may be assigned to multiple history trends with different collection parameters.
 - b. Trend and change of value data shall be stored within the engine and uploaded to a dedicated trend database or exported in a selectable data

- format via a provided data export utility. Uploads to a dedicated database shall occur based upon one of the following: user-defined interval, manual command, or when the trend buffers are full. Exports shall be as requested by the user or on a time scheduled basis.
- c. The system shall provide a configurable data storage subsystem for the collection of historical data. Data can be stored in either Microsoft Access or SQL database format.
10. Trend data viewing and analysis
- a. Provide a trend viewing utility that shall have access to all database points.
 - b. It shall be possible to retrieve any historical database point for use in displays and reports by specifying the point name and associated trend name.
 - c. The trend viewing utility shall have the capability to define trend study displays to include multiple trends
 - d. Displays shall be able to be single or stacked graphs with on-line selectable display characteristics, such as ranging, color, and plot style.
 - e. Display magnitude and units shall both be selectable by the operator at any time without reconfiguring the processing or collection of data. This is a zoom capability.
 - f. Display magnitude shall automatically be scaled to show full graphic resolution of the data being displayed.
 - g. Trend studies shall be capable of calculating and displaying calculated variables including highest value, lowest value and time based accumulation.
 - h. The Display shall support the user's ability to change colors, sample sizes, and types of markers.
11. Database Management
- a. Where a separate SQL database is utilized for information storage the System shall provide a Database Manager that separates the database monitoring and managing functions by supporting two separate windows.
 - b. Database secure access shall be accomplished using standard SQL authentication including the ability to access data for use outside of the Building Automation application.
 - c. The database managing function shall include summarized information on trend, alarm, event, and audit for the following database management actions:
 - ◇ Backup
 - ◇ Purge
 - ◇ Restore
 - d. The Database Manager shall support four tabs:
 - ◇ Statistics – shall display Database Server information and Trend, Alarm (Event), and Audit information on the Metasys Databases.
 - ◇ Maintenance – shall provide an easy method of purging records from the Metasys Server trend, alarm (event), and audit databases by supporting separate screens for creating a backup prior to purging, selecting the database, and allowing for the retention of a selected number of day's data.

- ◇ Backup – Shall provide the means to create a database backup file and select a storage location.
- ◇ Restore – shall provide a restricted means of restoring a database by requiring the user to log into an Expert Mode in order to view the Restore screen.
- e. The Status Bar shall appear at the bottom of all Metasys Database Manager Tabs and shall provide information on the current database activity. The following icons shall be provided:
 - ◇ Ready
 - ◇ Purging Record from a database
 - ◇ Action Failed
 - ◇ Refreshing Statistics
 - ◇ Restoring database
 - ◇ Shrinking a database
 - ◇ Backing up a database
 - ◇ Resetting internet information Services
 - ◇ Starting the Metasys Device Manager
 - ◇ Shutting down the Metasys Device Manager
 - ◇ Action successful
- f. The Database Manager monitoring functions shall be accessed through the Monitoring Settings window and shall continuously read database information once the user has logged in.
- g. The System shall provide user notification via taskbar icons and e-mail messages when a database value has exceeded a warning or alarm limit.
- h. The Monitoring Settings window shall have the following sections:
 - ◇ General – Shall allow the user to set and review scan intervals and start times.
 - ◇ Email – Shall allow the user to create and review e-mail and phone text messages to be delivered when a Warning or Alarm is generated.
 - ◇ Warning – shall allow the user to define the Warning limit parameters, set the Reminder Frequency, and link the e-mail message.
 - ◇ Alarm – shall allow the user to define the Alarm limit parameters, set the Reminder Frequency, and link the e-mail message.
 - ◇ Database login – Shall protect the system from unauthorized database manipulation by creating a Read Access and a Write Access for each of the Trend, Alarm (Event) and Audit databases as well as an Expert Mode required to restore a database.
- i. The Monitoring Settings Taskbar shall provide the following informational icons:
 - ◇ Normal – Indicates by color and size that all databases are within their limits.
 - ◇ Warning - Indicates by color and size that one or more databases have exceeded their Warning limit.
 - ◇ Alarm - Indicates by color and size that one or more databases have exceeded their Alarm limit.
- j. The System shall provide user notification via Taskbar icons and e-mail messages when a database value has exceeded a warning or alarm limit.

12. Demand Limiting and Load Rolling
 - a. The System shall provide a Demand Limiting and Load Rolling program for the purpose of limiting peak energy usage and reducing overall energy consumption.
 - b. The System shall support both Sliding Window and Fixed Window methods of predicting demand.
 - c. The System shall support three levels of sensitivity in the Sliding Window demand calculations for fine tuning the system.
 - ◇ Low Setting – Sheds loads later and over the shortest amount of time. Maximizes the time the equipment is on.
 - ◇ Medium Setting – Sheds loads earlier over a longer amount of time than the Low Setting. Increases the time the equipment is on and decreases the probability of exceeding the Tariff Target over the Low Setting.
 - ◇ High Setting – Sheds loads earlier over a longer amount of time than the Medium Setting. Minimizes the probability of exceeding the Tariff Target.
 - d. The System shall have both a Shed Mode and a Monitor Only Mode of operation.
 - ◇ When the Shed Mode is engaged, the System shall actively control the Demand.
 - ◇ When the Monitor Mode is engaged, the System will simulate the shedding action but will not take any action.
 - e. The Demand Limiting program shall monitor the energy consumption rate and compare it to a user defined Tariff Target. The system shall maintain consumption below the target by selectively shedding loads based upon a user defined strategy.
 - f. The Demand Limiting program shall be capable of supporting a minimum of 10 separate Load Priorities. Each load shall be user assigned to a Load Priority.
 - g. The Demand Limiting program shall be capable of supporting a minimum of 12 separate Tariff Targets defining the maximum allowed average power during the current interval.
 - h. The System shall support a Maximum Shed Time for each load as determined by the user. The system shall restore the load before the Maximum Shed time has expired.
 - i. The System shall support a Minimum Shed Time for each load as determined by the user. The system shall not restore the load sooner than the Minimum Shed Time has expired.
 - j. The System shall support a Minimum Release Time for each load as determined by the user. The System shall not shed the load until it has been off for the Minimum Release time.
 - k. The System shall support three user defined options if the meter goes unreliable.
 - ◇ Shedding – The currently shed loads will be released as their Maximum shed Times expire.

- ◇ Maintain the Current Shed Rate – The System will use the Demand Limiting shed rate that was present when the meter went unreliable.
 - ◇ Use Unreliable Meter Shed Rate – the system will control to a user defined Unreliable Shed Rate target.
 - l. The Load Rolling program shall sum the loads currently shed and compare it to a user defined Load Rolling Target. The system shall maintain consumption below the target by selectively shedding loads based upon a user defined Load Priority.
 - m. The Load Rolling program shall be capable of supporting a minimum of 10 separate Load Priorities. Each load shall be user assigned to a Load Priority.
 - n. The Load Rolling program shall be capable of supporting a minimum of 12 separate Tariff Targets defining the amount of power by which the demand must be reduced.
 - o. The System shall provide the user with a Load Tab that displays all of the Demand Limiting and Load Rolling parameters for any selected load.
 - p. The System shall provide the user with a Load Summary that displays all of the loads associated with the Demand Limiting and Load Rolling programs. Status Icons for each load shall indicate:
 - ◇ Load is Offline
 - ◇ Load is Disabled
 - ◇ Load is Shed
 - ◇ Load is Locked
 - ◇ Load is in Comfort Override
 - q. The Load Summary shall include a Load Summary Runtime view listing the following load conditions:
 - ◇ Load Priority
 - ◇ Shed Strategy
 - ◇ Load Rating
 - ◇ Present Value
 - ◇ Ineligibility Status
 - ◇ Active Timer
 - ◇ Time Remaining
 - ◇ Last Shed Time
- D. Portable Operator Terminal
- 1. For systems that do not provide full access to systems configuration and definition via the Browser Based user interface the BMS Contractor shall provide a portable operator terminal for programming purposes. The terminal shall be configured as follows:
 - a. Personal Laptop Computer Manufacturer – Dell, Compaq or HP
 - b. 1 GB RAM (256 MB minimum) – XP Professional
 - c. 1.8 GHz Clock Speed Pentium 4 Microprocessor (800 MHz minimum)
 - d. 40 GB Hard Drive (40 GB minimum)
 - e. (1) CD-ROM Drive, 32x speed
 - f. (1) Serial (1) Parallel (2) USB ports
 - g. 1 Keyboard with 83 keys (minimum).

- h. Integral 2 button Track Point or Track Ball.
 - i. 10" SVGA 1024x768 resolution color display
 - j. Two PCMCIA Type II or one Type III card slot
 - k. Complete operator workstation software package, including any hardware or software.
 - l. Original printed manuals for all software and peripherals.
 - m. Original installation disks or CD for all software, device drivers, and peripherals
 - n. Software registration cards for all included software shall be provided to the Owner.
 - o. Carrying case
 - p. Spare battery.
 - q. External power supply/battery charger
2. Proprietary Portable Terminal
- a. Manufacturers providing proprietary portable terminals shall submit technical data sheets for the terminal and all associated software and hardware.
 - b. The proprietary terminal shall meet the same operator interface software requirements as specified above.
3. Software
- a. Portable operator terminals shall support all controllers within the system on a direct-connect communications basis.
 - b. When used to access First or Second Tier controllers, the portable operator terminal shall utilize the standard operator workstation software, as previously defined.
 - c. When used to access Application Specific Controllers, the portable operator terminal shall utilize either the standard operator workstation software, as previously defined, or controller-specific utility software.
- E. Ready Access Portal User Interface
- 1. BMS Contractor shall provide and install all computer hardware and software required for the purpose of configuration and consolidation of information and programs required for the delivery of a Task Focused, Web Based Portal to the BMS. This Ready Access Portal shall provide a natural, complementary extension to the Metasys site management user interface previously described.
 - 2. Ready Access Portal Architecture – The architecture of the system shall be implemented to conform to industry standards, so that it can accommodate the required applications provided by the BMS Contractor as well as communicate information too and from the Metasys system Site Director.
 - 3. PC Hardware – The personal computer(s) shall be configured as follows:
 - a. Memory – 2 GB (1 GB Minimum)
 - b. CPU– Pentium 4 processor. 2.8 Hz Clock Speed (2.0 GHz minimum)
 - c. Hard Drive – 200 GB free hard drive space (80 GB minimum)
 - d. Hard drive backup system – CD/RW, DVD/RW or network backup software provided by IT department
 - e. DVD ROM Drive – 16X performance

- f. Ports – (1) Serial, (2) USB ports
 - g. Keyboard – 101 Keyboard and 2 Button Mouse
 - h. CRT configuration
 - ◇ 17” Flat Panel Monitor 1280 x 1024 resolution minimum
 - ◇ 16 bit or higher color resolution
 - i. LAN communications – Ethernet communications board; 100Mbps Min.
4. Operating System Software
- a. Windows XP Professional, IIS Version 5.1, .Net Version 2.0, SQL server 2005 Express software with SP2 or <Alternately> Microsoft Windows Server 2003 OS with SP2, IIS Version 6.0, .Net version 2.0 and SQL Server 2005 with SP@
 - b. Provide required software and hardware required for integration of computing hardware on enterprise IT network.
 - c. Provide software registration cards to the Owner for all included software.
5. User Interface Application Components
- a. The ready access portal shall provide an intuitive user interface to key Metasys functions and tasks via web browser.
 - b. Plug-ins or special software shall not be required for access to alarm, summary, schedule and trend data.
 - c. The portal shall include the ability to view full graphical representations of systems and equipment on PC platforms
 - d. The control system shall provide Secure Sockets Level (SSL) and Active Directory service support. If the Active Directory service and Single Sign-On features are enabled and the user is logged in to the Windows desktop, the login screen does not appear and access to the system is automatic.
 - e. Provide a common tool for graphics creation, schedule creation, custom programming, user access and hardware definition
 - f. Information shall be accessible on both personal computer and handheld device platforms as follows:
 - ◇ Personal computers – Internet Explorer Version 7.0 recommended
 - ◇ Handheld devices – Internet Explorer for Window Mobile Version 5.0 or 6.0 recommended. UI is optimized for devices with a 240 x 320 pixel screen size (QVGA). Other devices may display the UI but full functionality is not guaranteed.
6. Operator Interface
- a. Password access shall be as described previously for management portal UI
 - b. Once logged in, the System shall display a pre-selected screen tailored to the task requirements of the individual user.
 - c. The User Interface shall utilize an intuitive navigation and display method designed for operators who access the system for casual information and control or on an infrequent basis. It shall feature three basic components.
 - ◇ Radio buttons for selection of the type of information to be displayed including Alerts, Summary, Schedules and Diagnostics
 - ◇ Navigation tree for selection of the specific data to be displayed on screen for the selected type. The navigation tree may be hidden and expanded by the operator to optimize the display of information

- ◇ A display window that provides the selected information by type in a pre-configured tabular format
- d. The user interface software shall provide help menus and instructions for each operation and/or application.
- e. The system shall provide support for up to 100 concurrent users from an unlimited universe individuals with defined password access to the system
- f. The system shall utilize Secure Sockets Level (SSL) support as required to allow the ready access portal to communicate across a network in a way designed to prevent eavesdropping, tampering, and message forgery. It provides endpoint authentication and communications privacy over the network using cryptography
- g. The system shall have the capability to display multiple navigation trees that correspond to the user views configured in the management portal UI.
- h. The alert summary of the remote access portal shall, at the minimum, provide the following information
 - ◇ Alert (Alarm) type
 - ◇ Date and time of alert occurrence
 - ◇ Priority (color coded to level)
 - ◇ Item name.
 - ◇ Item value (if applicable)
 - ◇ Message
 - ◇ Any attribute of any object in the system may be designated to report an alarm
- i. A standard summary on the remote access portal shall, at the minimum, provide the following information
 - ◇ Point type graphic icon
 - ◇ Item name
 - ◇ Item value
 - ◇ Item status
 - ◇ Access to the Change Value window (if applicable) for the purpose of setting, holding or releasing an item value
- j. The schedule detail summary of the remote access portal shall, at the minimum, provide the following information
 - ◇ Scheduled occurrences including time and value
 - ◇ Scheduled overrides including start time, end time and value
 - ◇ A list of all scheduled items including name and attribute, value, status and priority
 - ◇ Access to the Add Temporary Override window for the purpose of adding a temporary override to the schedule
- k. The diagnostic (trend) summary of the remote access portal as viewed on a personal computing device shall provide the following information.
 - ◇ Item name
 - ◇ Item status
 - ◇ Trend name
 - ◇ Trend status
 - ◇ Full path name

- ◇ Access to trend detail summary including trended value, time and date arranged in a user selectable format of 1 hour, 12 hours, 24 hours, 48 hours or 72 hours

2.04 Network Automation Engines (NAE)

A. Network Automation Engine (NAE 35XX)

1. The Network Automation Engine (NAE) shall be a fully user-programmable, supervisory controller. The NAE shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.
2. Automation network – The NAE shall reside on the automation network and shall support a subnet of system controllers.
3. User Interface – Each NAE shall have the ability to deliver a web based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.
 - a. The web based UI software shall be imbedded in the NAE. Systems that require a local copy of the system database on the user's personal computer are not acceptable.
 - b. The NAE shall support a minimum of two (2) concurrent users.
 - c. The web based user shall have the capability to access all system data through one NAE.
 - d. Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one NAE.
 - e. Systems that require the user to address more than one NAE to access all system information are not acceptable.
 - f. The NAE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NAE.
 - g. Systems that support UI Graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.
 - h. The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer:
 - ◇ Configuration
 - ◇ Commissioning
 - ◇ Data Archiving
 - ◇ Monitoring
 - ◇ Commanding
 - ◇ System Diagnostics
 - i. Systems that require workstation software or modified web browsers are not acceptable.
 - j. The NAE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.
4. Processor – The NAE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NAE size and capability shall be sufficient to fully meet the requirements of this Specification.

5. Memory – Each NAE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.
6. Hardware Real Time Clock – The NAE shall include an integrated, hardware-Based, real-time clock.
7. The NAE shall include troubleshooting LED indicators to identify the following conditions:
 - a. Power - On/Off
 - b. Ethernet Traffic – Ethernet Traffic/No Ethernet Traffic
 - c. Ethernet Connection Speed – 10 Mbps/100 Mbps
 - d. FC Bus – Normal Communications/No Field Communications
 - e. Peer Communication – Data Traffic between NAE Devices
 - f. Run – NAE Running/NAE in Startup/NAE Shutting Down/Software Not Running
 - g. Bat Fault – Battery Defective, Data Protection Battery Not Installed
 - h. Fault – General Fault
 - i. Modem RX – NAE Modem Receiving Data
 - j. Modem TX – NAE Modem Transmitting Data
8. Communications Ports – The NAE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator’s terminals.
 - a. USB port
 - b. URS-232 serial data communication port
 - c. RS-485 port
 - d. Ethernet port
9. Diagnostics – The NAE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Automation Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.
10. Power Failure – In the event of the loss of normal power, The NAE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.
 - a. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.
 - b. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.
11. Certification – The NAE shall be listed by Underwriters Laboratories (UL).
12. Controller network – The NAE shall support the following communication protocols on the controller network:
 - a. The NAE shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.

- ◇ The NAE shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
- ◇ The NAE shall be tested and certified as a BACnet Building Controller (B-BC).
- ◇ A BACnet Protocol Implementation Conformance Statement shall be provided for the NAE.
- ◇ The Conformance Statements shall be submitted 10 days prior to bidding.
- ◇ The NAE shall support a minimum of 50 control devices.
- b. The NAE shall support LonWorks enabled devices using the Free Topology Transceiver FTT10.
 - ◇ All LonWorks controls devices shall be LonMark certified.
 - ◇ The NAE shall support a minimum of 64 LonWorks enabled control devices.
- c. The NAE shall support the Johnson Controls N2 Field Bus.
 - ◇ The NAE shall support a minimum of 50 N2 control devices.
 - ◇ The Bus shall conform to Electronic Industry Alliance (EIA) Standard RS-485.
 - ◇ The Bus shall employ a master/slave protocol where the NAE is the master.
 - ◇ The Bus shall employ a four (4) level priority system for polling frequency.
 - ◇ The Bus shall be optically isolated from the NAE.
 - ◇ The Bus shall support the Metasys Integrator System.

B. Network Automation Engine (NAE 45XX)

1. The Network Automation Engine (NAE) shall be a fully user-programmable, supervisory controller. The NAE shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.
2. Automation network – The NAE shall reside on the automation network and shall support a subnet of system controllers.
3. User Interface – Each NAE shall have the ability to deliver a web based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.
 - a. The web based UI software shall be imbedded in the NAE. Systems that require a local copy of the system database on the user's personal computer are not acceptable.
 - b. The NAE shall support a minimum of two (2) concurrent users.
 - c. The web based user shall have the capability to access all system data through one NAE.
 - d. Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one NAE.

- e. Systems that require the user to address more than one NAE to access all system information are not acceptable.
 - f. The NAE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NAE.
 - g. Systems that support UI Graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.
 - h. The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer:
 - ◇ Configuration
 - ◇ Commissioning
 - ◇ Data Archiving
 - ◇ Monitoring
 - ◇ Commanding
 - ◇ System Diagnostics
 - i. Systems that require workstation software or modified web browsers are not acceptable.
 - j. The NAE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.
4. Processor – The NAE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NAE size and capability shall be sufficient to fully meet the requirements of this Specification.
5. Memory – Each NAE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.
6. Hardware Real Time Clock – The NAE shall include an integrated, hardware-Based, real-time clock.
7. The NAE shall include troubleshooting LED indicators to identify the following conditions:
- a. Power - On/Off
 - b. Ethernet Traffic – Ethernet Traffic/No Ethernet Traffic
 - c. Ethernet Connection Speed – 10 Mbps/100 Mbps
 - d. FC Bus – Normal Communications/No Field Communications
 - e. Peer Communication – Data Traffic between NAE Devices
 - f. Run – NAE Running/NAE in Startup/NAE Shutting Down/Software Not Running
 - g. Bat Fault – Battery Defective, Data Protection Battery Not Installed
 - h. Fault – General Fault
 - i. Modem RX – NAE Modem Receiving Data
 - j. Modem TX – NAE Modem Transmitting Data
8. Communications Ports – The NAE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator's terminals.
- a. USB port
 - b. RS-232 serial data communication port
 - c. RS-485 port

- d. Ethernet port
9. Diagnostics – The NAE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Automation Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.
10. Power Failure – In the event of the loss of normal power, The NAE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.
- a. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.
 - b. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.
11. Certification – The NAE shall be listed by Underwriters Laboratories (UL).
12. Controller network – The NAE shall support all three (3) the following communication protocols on the controller network:
- a. The NAE shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
 - ◇ The NAE shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
 - ◇ The NAE shall be tested and certified as a BACnet Building Controller (B-BC).
 - ◇ A BACnet Protocol Implementation Conformance Statement shall be provided for the NAE.
 - ◇ The Conformance Statements shall be submitted 10 days prior to bidding.
 - ◇ The NAE shall support a minimum of 100 control devices.
 - b. The NAE shall support LonWorks enabled devices using the Free Topology Transceiver FTT10.
 - ◇ All LonWorks controls devices shall be LonMark certified.
 - ◇ The NAE shall support a minimum of 127 LonWorks enabled control devices.
 - c. The NAE shall support the Johnson Controls N2 Field Bus.
 - ◇ The NAE shall support a minimum of 100 N2 control devices.
 - ◇ The Bus shall conform to Electronic Industry Alliance (EIA) Standard RS-485.
 - ◇ The Bus shall employ a master/slave protocol where the NAE is the master.
 - ◇ The Bus shall employ a four (4) level priority system for polling frequency.
 - ◇ The Bus shall be optically isolated from the NAE.
 - ◇ The Bus shall support the Metasys Integrator System.

C. Network Automation Engine (NAE 55XX)

1. The Network Automation Engine (NAE) shall be a fully user-programmable, supervisory controller. The NAE shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.
2. Automation network – The NAE shall reside on the automation network and shall support a subnet of system controllers.
3. User Interface – Each NAE shall have the ability to deliver a web based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.
 - a. The web based UI software shall be imbedded in the NAE. Systems that require a local copy of the system database on the user's personal computer are not acceptable.
 - b. The NAE shall support up a minimum of four (4) concurrent users.
 - c. The web based user shall have the capability to access all system data through one NAE.
 - d. Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one NAE.
 - e. Systems that require the user to address more than one NAE to access all system information are not acceptable.
 - f. NAE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NAE.
 - g. Systems that support UI Graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.
 - h. The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer:
 - ◇ Configuration
 - ◇ Commissioning
 - ◇ Data Archiving
 - ◇ Monitoring
 - ◇ Commanding
 - ◇ System Diagnostics
 - i. Systems that require workstation software or modified web browsers are not acceptable.
 - j. The NAE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.
4. Processor – The NAE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NAE size and capability shall be sufficient to fully meet the requirements of this Specification.
5. Memory – Each NAE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.
6. Hardware Real Time Clock – The NAE shall include an integrated, hardware-based, real-time clock.

7. The NAE shall include troubleshooting LED indicators to identify the following conditions:
 - a. Power - On/Off
 - b. Ethernet Traffic – Ethernet Traffic/No Ethernet Traffic
 - c. Ethernet Connection Speed – 10 Mbps/100 Mbps
 - d. FC Bus A – Normal Communications/No Field Communications
 - e. FC Bus B – Normal Communications/No Field Communications
 - f. Peer Communication – Data Traffic between NAE Devices
 - g. Run – NAE Running/NAE in Startup/NAE Shutting Down/Software Not Running
 - h. Bat Fault – Battery Defective, Data Protection Battery Not Installed
 - i. 24 VAC – 24 VAC Present/Loss Of 24VAC
 - j. Fault – General Fault
 - k. Modem RX – NAE Modem Receiving Data
 - l. Modem TX – NAE Modem Transmitting Data
8. Communications Ports – The NAE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator’s terminals.
 - a. Two (2) USB port
 - b. Two (2) URS-232 serial data communication port
 - c. Two (2) RS-485 port
 - d. One (1) Ethernet port
9. Diagnostics – The NAE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Automation Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.
10. Power Failure – In the event of the loss of normal power, The NAE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.
 - a. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.
 - b. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.
11. Certification – The NAE shall be listed by Underwriters Laboratories (UL).
12. Controller network – The NAE shall support the following communication protocols on the controller network:
 - a. The NAE shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
 - ◇ The NAE shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
 - ◇ The NAE shall be tested and certified as a BACnet Building Controller (B-BC).

- ◇ A BACnet Protocol Implementation Conformance Statement shall be provided for the NAE.
 - ◇ The Conformance Statements shall be submitted 10 days prior to bidding.
 - ◇ The NAE shall support a minimum of 100 control devices.
 - b. The NAE shall support LonWorks enabled devices using the Free Topology Transceiver FTT10.
 - ◇ All LonWorks controls devices shall be LonMark certified.
 - ◇ The NAE shall support a minimum of 255 LonWorks enabled control devices.
 - c. The NAE shall support the Johnson Controls N2 Field Bus.
 - ◇ The NAE shall support a minimum of 100 N2 control devices.
 - ◇ The Bus shall conform to Electronic Industry Alliance (EIA) Standard RS-485.
 - ◇ The Bus shall employ a master/slave protocol where the NAE is the master.
 - ◇ The Bus shall employ a four (4) level priority system for polling frequency.
 - ◇ The Bus shall be optically isolated from the NAE.
 - ◇ The Bus shall support the Metasys Integrator System.
- D. Network Automation Engine (NAE 85XX)
1. The Network Automation Engine (NAE) shall be a fully user-programmable, supervisory controller. The NAE shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.
 2. Automation network – The NAE shall reside on the automation network and shall support a subnet of system controllers.
 3. User Interface – Each NAE shall have the ability to deliver a web based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.
 - a. The web based UI software shall be imbedded in the NAE. Systems that require a local copy of the system database on the user’s personal computer are not acceptable.
 - b. The NAE shall support a minimum of ten (10) concurrent users.
 - c. The web based user shall have the capability to access all system data through one NAE.
 - d. Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one NAE.
 - e. Systems that require the user to address more than one NAE to access all system information are not acceptable.
 - f. The NAE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NAE.
 - g. Systems that support UI Graphics from a central database or require the graphics to reside on the user’s personal computer are not acceptable.

- h. The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer:
 - ◇ Configuration
 - ◇ Commissioning
 - ◇ Data Archiving
 - ◇ Monitoring
 - ◇ Commanding
 - ◇ System Diagnostics
- i. Systems that require workstation software or modified web browsers are not acceptable.
- j. The NAE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.
- 4. Processor – The NAE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NAE size and capability shall be sufficient to fully meet the requirements of this Specification.
- 5. Memory – Each NAE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.
- 6. Hardware Real Time Clock – The NAE shall include an integrated, hardware-Based, real-time clock.
- 7. Communications Ports – The NAE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator’s terminals.
 - a. Two (2) USB ports
 - b. Two (2) Ethernet ports
- 8. Diagnostics – The NAE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Automation Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.
- 9. Power Failure – In the event of the loss of normal power, The NAE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.
 - a. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.
 - b. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.
- 10. Certification – The NAE shall be listed by Underwriters Laboratories (UL).

2.05 Network Integration Engines

- A. Network Integration Engine (NIE 55XX)

1. The Network Integration Engine (NIE) shall be a fully user-programmable, supervisory controller. The NAE shall monitor the network of distributed application-specific controllers on the N1 Network, provide global strategy and direction, and communicate on a peer-to-peer basis with other NAE and NIE controllers.
2. Automation network – The NIE shall reside on the automation network.
3. Metasys N1 Network Integration - The NIE shall connect Metasys N1 based building automation systems to an Internet Protocol (IP) Ethernet network. The Network Integration Engine shall communicate over the automation network on a peer-to-peer basis with NAE and NIE controllers.
 - a. The NIE shall monitor and control one or more NCM controllers and transfer point data to provide the following features:
 - ◇ Alarming and alarm limit management
 - ◇ Point history and Trend data collection
 - ◇ Totalization of events, run time, and analog rate value
 - ◇ Event management and Scheduling
 - ◇ Energy management
 - ◇ Data sharingIn a manner consistent with the Network Automation Engines
 - b. The NIE shall record the following user actions on the Metasys N1 network and include them in an audit log.
 - ◇ Logging on and off
 - ◇ Commands to equipment
 - ◇ Parameter changes
 - ◇ Changes to the system configuration
 - c. The following capabilities defined in the Metasys N1 network shall remain fully operational until deleted at the M5 Workstation/OWS.
 - ◇ Totalization
 - ◇ Scheduling
 - ◇ Trend collection capabilities
 - ◇ Event messaging
 - ◇ Interlocking
 - ◇ Control Processes
 - ◇ Optimal Start
 - d. The NIE shall monitor and control one or more Network Control Modules (NCM) and transfer point data to provide the following features:
 - ◇ Alarming and alarm limit management
 - ◇ Point history and Trend data collection
 - ◇ Totalization of events, run time, and analog rate value
 - ◇ Event management and Scheduling
 - ◇ Energy management
 - ◇ Data sharingIn a manner consistent with the NAE
 - e. The NIE shall record the following user actions on the Metasys N1 network and include them in an audit log.
 - ◇ Logging on and off

- ◇ Commands to equipment
- ◇ Parameter changes
- ◇ Changes to the system configuration
- f. The following capabilities defined in the Metasys N1 network shall remain fully operational until deleted at the M5 Workstation/OWS.
 - ◇ Totalization
 - ◇ Scheduling
 - ◇ Trend collection capabilities
 - ◇ Event messaging
 - ◇ Interlocking
 - ◇ Control Processes
 - ◇ Optimal Start
- 4. User Interface – Each NAE shall have the ability to deliver a web based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.
 - a. The web based UI software shall be imbedded in the NIE. Systems that require a local copy of the system database on the user’s personal computer are not acceptable.
 - b. The NIE shall support a minimum of two (2) concurrent users.
 - c. The web based user shall have the capability to access all system data through one NIE.
 - d. Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one NIE.
 - e. Systems that require the user to address more than one NIE to access all system information are not acceptable.
 - f. The NIE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NIE.
 - g. Systems that support UI Graphics from a central data base or require the graphics to reside on the user’s personal computer are not acceptable.
 - h. The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer:
 - ◇ Configuration
 - ◇ Commissioning
 - ◇ Data Archiving
 - ◇ Monitoring
 - ◇ Commanding
 - ◇ System Diagnostics
 - i. Systems that require workstation software or modified web browsers are not acceptable.
 - j. The NIE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.
- 5. Processor – The NIE shall be microprocessor-based with a minimum word size of 32 bits. The NIE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NIE size and capability shall be sufficient to fully meet the requirements of this Specification.

6. Memory – Each NIE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.
 7. Hardware Real Time Clock – The NIE shall include an integrated, hardware-Based, real-time clock.
 8. The NIE shall include troubleshooting LED indicators to identify the following conditions:
 - a. Power - On/Off
 - b. Ethernet Traffic – Ethernet Traffic/No Ethernet Traffic
 - c. Ethernet Connection Speed – 10 Mbps/100 Mbps
 - d. FC Bus A – Normal Communications/No Field Communications
 - e. FC Bus B – Normal Communications/No Field Communications
 - f. Peer Communication – Data Traffic between Automation Network Devices
 - g. Run – NIE Running/NIE in Startup/NIE Shutting Down/Software Not Running
 - h. Bat Fault – Battery Defective, Data Protection Battery Not Installed
 - i. 24 VAC – 24 VAC Present/Loss Of 24VAC
 - j. Fault – General Fault
 - k. Modem RX – NIE Modem Receiving Data
 - l. Modem TX – NIE Modem Transmitting Data
 9. Communications Ports – The NIE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator’s terminals.
 - a. Two (2) USB port
 - b. Two (2) URS-232 serial data communication port
 - c. One (1) Ethernet port
 10. Diagnostics – The NIE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The NIE shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.
 11. Power Failure – In the event of the loss of normal power, The NIE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.
 - a. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.
 - b. Upon restoration of normal power and after a minimum off-time delay, the NIE shall automatically resume full operation without manual intervention through a normal soft-start sequence.
 12. Certification – The NIE shall be listed by Underwriters Laboratories (UL).
- B. Network Integration Engine (NIE 85XX)**
1. The Network Integration Engine (NIE) shall be a fully user-programmable, supervisory controller. The NAE shall monitor the network of distributed application-specific controllers on the N1 Network, provide global strategy and

direction, and communicate on a peer-to-peer basis with other NAE and NIE controllers.

2. Automation network – The NIE shall reside on the automation network.
3. Metasys N1 Network Integration - The NIE shall connect Metasys N1 based building automation systems to an Internet Protocol (IP) Ethernet network. The Network Integration Engine shall communicate over the automation network on a peer-to-peer basis with NAE and NIE controllers.
 - a. The NIE shall monitor and control one or more NCM controllers and transfer point data to provide the following features:
 - ◇ Alarming and alarm limit management
 - ◇ Point history and Trend data collection
 - ◇ Totalization of events, run time, and analog rate value
 - ◇ Event management and Scheduling
 - ◇ Energy management
 - ◇ Data sharingIn a manner consistent with the NAE
 - b. The NIE shall record the following user actions on the Metasys N1 network and include them in an audit log.
 - ◇ Logging on and off
 - ◇ Commands to equipment
 - ◇ Parameter changes
 - ◇ Changes to the system configuration
 - c. The following capabilities defined in the Metasys N1 network shall remain fully operational until deleted at the M5 Workstation/OWS.
 - ◇ Totalization
 - ◇ Scheduling
 - ◇ Trend collection capabilities
 - ◇ Event messaging
 - ◇ Interlocking
 - ◇ Control Processes
 - ◇ Optimal Start
 - d. The NIE shall monitor and control one or more Network Control Modules (NCM) and transfer point data to provide the following features:
 - ◇ Alarming and alarm limit management
 - ◇ Point history and Trend data collection
 - ◇ Totalization of events, run time, and analog rate value
 - ◇ Event management and Scheduling
 - ◇ Energy management
 - ◇ Data sharingIn a manner consistent with the NAE
 - e. The NIE shall record the following user actions on the Metasys N1 network and include them in an audit log.
 - ◇ Logging on and off
 - ◇ Commands to equipment
 - ◇ Parameter changes
 - ◇ Changes to the system configuration

- f. The following capabilities defined in the Metasys N1 network shall remain fully operational until deleted at the M5 Workstation/OWS.
 - ◇ Totalization
 - ◇ Scheduling
 - ◇ Trend collection capabilities
 - ◇ Event messaging
 - ◇ Interlocking
 - ◇ Control Processes
 - ◇ Optimal Start
- 4. User Interface – Each NAE shall have the ability to deliver a web based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.
 - a. The web based UI software shall be imbedded in the NIE. Systems that require a local copy of the system database on the user’s personal computer are not acceptable.
 - b. The NIE shall support a minimum of two (2) concurrent users.
 - c. The web based user shall have the capability to access all system data through one NIE.
 - d. Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one NIE.
 - e. Systems that require the user to address more than one NIE to access all system information are not acceptable.
 - f. The NIE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NIE.
 - g. Systems that support UI Graphics from a central data base or require the graphics to reside on the user’s personal computer are not acceptable.
 - h. The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer:
 - ◇ Configuration
 - ◇ Commissioning
 - ◇ Data Archiving
 - ◇ Monitoring
 - ◇ Commanding
 - ◇ System Diagnostics
 - i. Systems that require workstation software or modified web browsers are not acceptable.
 - j. The NIE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.
- 5. Processor – The NIE shall be microprocessor-based with a minimum word size of 32 bits. The NIE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NIE size and capability shall be sufficient to fully meet the requirements of this Specification.
- 6. Memory – Each NIE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.

7. Hardware Real Time Clock – The NIE shall include an integrated, hardware-Based, real-time clock.
8. Communications Ports – The NIE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator’s terminals.
 - a. Three (3) USB ports
 - b. Two (2) Ethernet ports
 - ◇ BAS Network Port – 1GB
 - ◇ Enterprise Network – 100 MB
 - c. One (1) Video Monitor Port
 - d. One (1) 9 pin Serial Port
9. Diagnostics – The NIE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The NIE shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.
10. Power Failure – In the event of the loss of normal power, The NIAE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.
 - a. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.
 - b. Upon restoration of normal power and after a minimum off-time delay, the NIE shall automatically resume full operation without manual intervention through a normal soft-start sequence.
11. Certification – The NIE shall be listed by Underwriters Laboratories (UL).

2.06 Network Control Engine (NCE 25XX)

1. The Network Control Engine (NCE) shall be a fully user-programmable, supervisory controller. The NCE shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.
2. The Network Control Engine (NCE) shall be a fully user-programmable, digital controller that includes a minimum of 33 I/O points.
3. Automation Network – The NCE shall reside on the automation network and shall support a subnet of 32 Field controllers.
4. User Interface – Each NCE shall have the ability to deliver a web based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.
 - a. The web based UI software shall be imbedded in the NCE. Systems that require a local copy of the system database on the user’s personal computer are not acceptable.
 - b. The NCE shall support a minimum of two (2) concurrent users.
 - c. The NCE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NCE.

- d. Systems that support UI Graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.
- e. The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer:
 - ◇ Configuration
 - ◇ Commissioning
 - ◇ Data Archiving
 - ◇ Monitoring
 - ◇ Commanding
 - ◇ System Diagnostics
- f. Systems that require workstation software or modified web browsers are not acceptable.
- g. The NCE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.
5. The NCE shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.
6. The NCE shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only, shall not be acceptable.
7. The NCE shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
8. The NCE shall support the following number and types of inputs and outputs:
 - a. Ten Universal Inputs - shall be configured to monitor any of the following:
 - ◇ Analog Input, Voltage Mode
 - ◇ Analog Input, Current Mode
 - ◇ Analog Input, Resistive Mode
 - ◇ Binary Input, Dry Contact Maintained Mode
 - ◇ Binary Input, Pulse Counter Mode
 - b. Eight Binary Inputs - shall be configured to monitor either of the following:
 - ◇ Dry Contact Maintained Mode
 - ◇ Pulse Counter Mode
 - c. Four Analog Outputs - shall be configured to output either of the following:
 - ◇ Analog Output, Voltage Mode
 - ◇ Analog Output, Current Mode
 - d. Seven Binary Outputs - shall output the following:
 - ◇ 24 VAC Triac
 - e. Four Configurable Outputs - shall be configured to output either of the following:
 - ◇ Analog Output, Voltage Mode
 - ◇ Binary Output, 24 VAC Triac Mode
9. The NCE shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).

- a. The SA Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.
 - b. The SA Bus shall support a minimum of 10 devices.
 - c. The SA Bus shall operate at a maximum distance of 1,200 Ft. between the NCE and the furthest connected device.
10. The NCE shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the Field Trunk or the SA Bus.
 11. The NCE shall support, but not be limited to, the following applications:
 - a. Central Equipment including chillers and boilers
 - b. Lighting and electrical distribution
 - c. Built-up air handling units for special applications
 - d. Power generation and energy monitoring equipment
 - e. Interfaces to security and fire detection systems
 12. The NCE shall support a Local Controller Display (DIS1710) either as an integral part of the NCE or as a remote device communicating over the SA Bus.
 - a. The Display shall use a BACnet Standard SSPC-135, clause 9 Master-Slave/Token-Passing protocol.
 - b. The Display shall allow the user to view monitored points without logging into the system.
 - c. The Display shall allow the user to view and change setpoints, modes of operation, and parameters.
 - d. The Display shall provide password protection with user adjustable password timeout.
 - e. The Display shall be menu driven with separate paths for:
 - ◇ Input/Output
 - ◇ Parameter/Setpoint
 - ◇ Overrides
 - f. The Display shall use easy-to-read English text messages.
 - g. The Display shall allow the user to select the points to be shown and in what order.
 - h. The Display shall support a back lit Liquid Crystal Display (LCD) with adjustable contrast and brightens and automatic backlight brightening during user interaction.
 - i. The display shall be a minimum of 4 lines and a minimum of 20 characters per line
 - j. The Display shall have a keypad with no more than 6 keys.
 - k. The Display shall be panel mountable.
 13. The NCE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NCE size and capability shall be sufficient to fully meet the requirements of this Specification.
 14. The NCE shall employ an industrial single board computer.
 15. Each NCE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.

16. The NCE shall include an integrated, hardware-based, real-time clock.
17. The NCE shall employ nonvolatile Flash memory to store all programs and data. The NCE shall employ a data protection battery to save data and power the real time clock when primary power is interrupted.
18. The NCE shall provide removable, color coded, screw terminal blocks for 24 VAC power, communication bus and I/O point field wiring.
19. The NCE shall include troubleshooting LED indicators to identify the following conditions:
 - a. Power
 - b. Fault
 - c. .SA Bus
 - d. FC Bus
 - e. Modem TX
 - f. Modem RX
 - g. Battery Fault
 - h. Ethernet
 - i. 10 LNK
 - j. 100 LNK
 - k. Run
 - l. Peer Com
20. Communications Ports – The NCE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator’s terminals.
 - a. USB port
 - b. RS-232 serial data communication port
 - c. RS-485 port
 - d. RJ-45 Ethernet port
 - e. RJ-12 jack
21. The NCE shall support an optional internal modem with RJ-12 6-pin telephone line connector.
22. Diagnostics – The NCE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Control Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.
23. Power Failure – In the event of the loss of normal power, The NCE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.
 - a. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.
 - b. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.

24. Certification – The NCE shall be listed by Underwriters Laboratories (UL).File E107041, CCN PAZX, UL 916, Energy Management Equipment. FCC Compliant to CFR47, Part 15, Subpart B, Class A
25. Field Controller Bus – The NCE shall support the following communication protocols on the Field Controller Bus:
 - a. The NCE shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
 - ◇ The NCE shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
 - ◇ The NAE shall be tested and certified as a BACnet Building Controller (B-BC).
 - ◇ A BACnet Protocol Implementation Conformance Statement shall be provided for the NCE.
 - ◇ The Conformance Statements shall be submitted 10 days prior to bidding.
 - ◇ The NCE shall support a minimum of 32 control devices.
 - b. The NCE shall support LonWorks enabled devices using the Free Topology Transceiver FTT10 on the Field Controller Bus (LonWorks Network).
 - ◇ All LonWorks controls devices shall be LonMark certified.
 - ◇ The NCE shall support a minimum of 32 LonWorks enabled control devices.
 - c. The NCE shall support the N2 devices on the Field Controller Bus (Johnson Controls N2 Bus).
 - ◇ The NCE shall support a minimum of 32 N2 control devices.
 - ◇ The Bus shall conform to Electronic Industry Alliance (EIA) Standard RS-485.
 - ◇ The Bus shall employ a master/slave protocol where the NCE is the master.
 - ◇ The Bus shall employ a four (4) level priority system for polling frequency.
 - ◇ The Bus shall be optically isolated from the NCE.
 - ◇ The Bus shall support the Metasys Integrator System.

2.07 DDC System Controllers

A. Field Equipment Controller (FEC X610)

1. The Field Equipment Controller (FEC) shall be a fully user-programmable, digital controller that communicates via BACnet MS/TP protocol.
 - a. The FEC shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
 - ◇ The FEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
 - ◇ The FEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
 - ◇ A BACnet Protocol Implementation Conformance Statement shall be provided for the FEC.

- ◇ The Conformance Statement shall be submitted 10 days prior to bidding.
- 2. The FEC shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.
- 3. Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable. The FEC shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
- 4. The FEC shall include a removable base to allow pre-wiring without the controller.
- 5. The FEC shall include troubleshooting LED indicators to identify the following conditions:
 - a. Power On
 - b. Power Off
 - c. Download or Startup in progress, not ready for normal operation
 - d. No Faults
 - e. Device Fault
 - f. Field Controller Bus - Normal Data Transmission
 - g. Field Controller Bus - No Data Transmission
 - h. Field Controller Bus - No Communication
 - i. Sensor-Actuator Bus - Normal Data Transmission
 - j. Sensor-Actuator Bus - No Data Transmission
 - k. Sensor-Actuator Bus - No Communication
- 6. The FEC shall accommodate the direct wiring of analog and binary I/O field points.
- 7. The FEC shall support the following types of inputs and outputs:
 - a. Universal Inputs - shall be configured to monitor any of the following:
 - ◇ Analog Input, Voltage Mode
 - ◇ Analog Input, Current Mode
 - ◇ Analog Input, Resistive Mode
 - ◇ Binary Input, Dry Contact Maintained Mode
 - ◇ Binary Input, Pulse Counter Mode
 - b. Binary Inputs - shall be configured to monitor either of the following:
 - ◇ Dry Contact Maintained Mode
 - ◇ Pulse Counter Mode
 - c. Analog Outputs - shall be configured to output either of the following
 - ◇ Analog Output, Voltage Mode
 - ◇ Analog Output, current Mode
 - d. Binary Outputs - shall output the following:
 - ◇ 24 VAC Triac
 - e. Configurable Outputs - shall be capable of the following:
 - ◇ Analog Output, Voltage Mode

- ◇ Binary Output Mode
- 8. The FEC shall have the ability to reside on a Field Controller Bus (FC Bus).
 - a. The FC Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting b.BACnet Standard protocol SSPC-135, Clause 9.
 - c. The FC Bus shall support communications between the FECs and the NAE.
 - d. The FC Bus shall also support Input/Output Module (IOM) communications with the FEC and with the NAE.
 - e. The FC Bus shall support a minimum of 100 IOMs and FECs in any combination.
 - f. The FC Bus shall operate at a maximum distance of 15,000 Ft. between the FEC and the furthest connected device.
- 9. The FEC shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).
 - a. The SA Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard Protocol SSPC-135, Clause 9.
 - b. The SA Bus shall support a minimum of 10 devices per trunk.
 - c. The SA Bus shall operate at a maximum distance of 1,200 Ft. between the FEC and the furthest connected device.
- 10. The FEC shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the FC Bus or the SA Bus.
- 11. The FEC shall support, but not be limited to, the following:
 - a. Chilled water/central plant automation applications including but not limited to the selection and sequencing of up to 8 chillers of different sizes (constant or variable speed capacity control), 8 primary and secondary chilled water pumps, as well as selection and sequencing of cooling towers and bypass valve. Sequencing of the devices shall consider user-defined efficiency ratings, runtime equalization and number-of-starts/number-of - stops.
 - b. Heating central plant applications
 - c. Built-up air handling units for special applications
 - d. Terminal units
 - e. Special programs as required for systems control
- 12. The FEC shall support a Local Controller Display (DIS1710) either as an integral part of the FEC or as a remote device communicating over the SA Bus.
 - a. The Display shall use a BACnet Standard SSPC-135, clause 9 Master-Slave/Token-Passing protocol.
 - b. The Display shall allow the user to view monitored points without logging into the system.
 - c. The Display shall allow the user to view and change setpoints, modes of operation, and parameters.
 - d. The Display shall provide password protection with user adjustable password timeout.
 - e. The Display shall be menu driven with separate paths for:
 - ◇ Input/Output

- ◇ Parameter/Setpoint
- ◇ Overrides
- f. The Display shall use easy-to-read English text messages.
- g. The Display shall allow the user to select the points to be shown and in what order.
- h. The Display shall support a back lit Liquid Crystal Display (LCD) with adjustable contrast and brightens and automatic backlight brightening during user interaction.
- i. The display shall be a minimum of 4 lines and a minimum of 20 characters per line
- j. The Display shall have a keypad with no more than 6 keys.
- k. The Display shall be panel mountable.

2.08 Field Devices

A. Input/Output Module (IOM X710)

1. The Input/Output Module (IOM) provides additional inputs and outputs for use in the FEC.
2. The IOM shall communicate with the FEC over the FC Bus or the SA Bus.
3. The IOM shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
 - a. The IOM shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
 - b. The IOM shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
 - c. A BACnet Protocol Implementation Conformance Statement shall be provided for the FEC.
 - d. The Conformance Statement shall be submitted 10 days prior to bidding.
4. The IOM shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
5. The IOM shall have a minimum of 4 points to a maximum of 17 points.
6. The IOM shall support the following types of inputs and outputs:
 - a. Universal Inputs - shall be configured to monitor any of the following:
 - ◇ Analog Input, Voltage Mode
 - ◇ Analog Input, Current Mode
 - ◇ Analog Input, Resistive Mode
 - ◇ Binary Input, Dry Contact Maintained Mode
 - ◇ Binary Input, Pulse Counter Mode
 - b. Binary Inputs - shall be configured to monitor either of the following:
 - ◇ Dry Contact Maintained Mode
 - ◇ Pulse Counter Mode
 - c. Analog Outputs - shall be configured to output either of the following
 - ◇ Analog Output, Voltage Mode
 - ◇ Analog Output, current Mode

- d. Binary Outputs - shall output the following:
 - ◇ 24 VAC Triac
 - e. Configurable Outputs - shall be capable of the following:
 - ◇ Analog Output, Voltage Mode
 - ◇ Binary Output Mode
 - 7. The IOM shall include troubleshooting LED indicators to identify the following conditions:
 - a. Power On
 - b. Power Off
 - c. Download or Startup in progress, not ready for normal operation
 - d. No Faults
 - e. Device Fault
 - f. Normal Data Transmission
 - g. No Data Transmission
 - h. No Communication
- B. Networked Thermostat (TEC 26X6) (used for all cabinet unit heaters and fan coil units)
- 1. The networked thermostat shall be capable of controlling two- or four-pipe fan coils, cabinet unit heaters or other similar equipment.
 - 2. The TEC shall communicate over the Field Controller Bus using BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9.
 - 3. The TEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
 - a. The TEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
 - b. A BACnet Protocol Implementation Conformance Statement shall be provided for the TEC.
 - c. The Conformance Statement shall be submitted 10 days prior to bidding.
 - 4. The Networked Thermostat shall support remote read/write and parameter adjustment from the web based User Interface through a Network Automation Engine.
 - 5. The Networked Thermostat shall include an intuitive User Interface providing plain text messages.
 - a. Two line, 8 character backlit display
 - b. LED indicators for Fan, Heat, and Cool status
 - c. Five (5) User Interface Keys
 - ◇ Mode
 - ◇ Fan
 - ◇ Override
 - ◇ Degrees C/F
 - ◇ Up/Down
 - d. The display shall continuously scroll through the following parameters:
 - ◇ Room Temperature
 - ◇ System Mode
 - ◇ Schedule Status – Occupied/Unoccupied/Override
 - ◇ Applicable Alarms

6. The Networked Thermostat shall provide the flexibility to support any one of the following inputs:
 - a. Integral Indoor Air Temperature Sensor
 - b. Duct Mount Air Temperature Sensor
 - c. Remote Indoor Air Temperature Sensor with Occupancy Override and LED Indicator
 - d. Two configurable binary inputs
 7. The Networked Thermostat shall provide the flexibility to support any one of the following outputs:
 - a. Three Speed Fan Control
 - b. Two On/Off
 - c. Two Floating
 - d. Two Proportional (0 to 10V)
 8. The Networked Thermostat shall provide a minimum of six (6) levels of keypad lockout.
 9. The Networked Thermostat shall provide the flexibility to adjust the following parameters:
 - a. Adjustable Temporary Occupancy from 0 to 24 hours
 - b. Adjustable heating/cooling deadband from 2° F to 5° F
 - c. Adjustable heating/cooling cycles per hour from 4 to 8
 10. Where required by application and indicated on plans or room schedules provide the Networked Thermostat with an integral Passive Infra-Red (PIR) occupancy sensor.
 11. The Networked Thermostat shall employ nonvolatile electrically erasable programmable read-only memory (EEPROM) for all adjustable parameters.
- C. Networked Thermostat (TEC 26X7) (used in all class rooms and VAV systems)
1. The Networked Thermostat shall be capable of controlling a pressure independent Variable Air Volume System or other similar zoning type systems employing reheat including local hydronic reheat valves.
 2. The Networked Thermostat shall communicate over the FC Bus using BACnet Standard protocol SSPC-135, Clause 9.
 3. The TEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
 - a. The TEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
 - b. A BACnet Protocol Implementation Conformance Statement shall be provided for the TEC.
 - c. The Conformance Statement shall be submitted 10 days prior to bidding.
 4. The Networked Thermostat shall be capable of remote read/write and parameter adjustment from the web based User Interface (UI) through an NAE.
 5. The Networked Thermostat shall include an intuitive UI providing plain text messages.
 - a. Two line, 8 character backlit display
 - b. LED indicators for Heating, and cooling status
 - c. Three (3) User Interface Keys

- ◇ Override
 - ◇ Up
 - ◇ Down
 - d. The display shall continuously scroll through the following parameters:
 - ◇ Room Temperature
 - ◇ System Mode
 - ◇ Schedule Status – Occupied/Unoccupied/Override
 - ◇ Applicable Alarms
 - 6. The Networked Thermostat shall provide the flexibility to support any one of the following inputs:
 - a. Integral Indoor Air Temperature Sensor
 - b. Duct Mount Air Temperature Sensor
 - c. Remote Indoor Air Temperature Sensor with Occupancy Override and LED Indicator
 - d. Two configurable binary inputs
 - 7. The Networked Thermostat shall provide the flexibility to support either of the following outputs:
 - a. Two On/Off or Floating
 - b. Two Proportional (0 to 10V)
 - 8. The Networked Thermostat shall provide a minimum of six (6) levels of keypad lockout.
 - 9. The Networked Thermostat shall provide the flexibility to adjust the following parameters:
 - a. Adjustable Temporary Occupancy from 0 to 24 hours
 - b. Adjustable heating/cooling deadband from 2° F to 5° F
 - c. Adjustable heating/cooling cycles per hour from 4 to 8
 - 10. The Networked Thermostat shall employ nonvolatile electrically erasable programmable read-only memory (EEPROM) for all adjustable parameters.
- D. Networked Thermostat (TEC 26X5) (used for all unit heaters MER spaces)
 - 1. The Networked Thermostat shall be capable of controlling a two pipe fan coil, cabinet unit heater or other similar equipment with single-speed fan control.
 - 2. The TEC shall communicate over the Field Controller Bus using BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9.
 - 3. The TEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
 - a. The TEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
 - b. A BACnet Protocol Implementation Conformance Statement shall be provided for the TEC.
 - c. The Conformance Statement shall be submitted 10 days prior to bidding.
 - 4. The Networked Thermostat shall communicate over the FC Bus using BACnet Standard protocol SSPC-135, Clause 9.
 - 5. The Networked Thermostat shall be capable of remote read/write and parameter adjustment from the web based User Interface (UI) through an NAE.

6. The Networked Thermostat shall include an intuitive UI providing plain text messages.
 - a. Two line, 8 character backlit display
 - b. LED indicators for Fan, Heat, and Cool status
 - c. Five (5) User Interface Keys
 - ◇ Mode
 - ◇ Fan
 - ◇ Override
 - ◇ Up
 - ◇ Down
 - d. The display shall continuously scroll through the following parameters:
 - ◇ Room Temperature
 - ◇ System Mode
 - ◇ Schedule Status – Occupied/Unoccupied/Override
 - ◇ Applicable Alarms
 7. The Networked Thermostat shall provide the flexibility to support any one of the following inputs:
 - a. Integral Indoor Air Temperature Sensor
 - b. Duct Mount Air Temperature Sensor
 - c. Indoor Air Temperature Sensor with Occupancy Override and LED Indicator
 - d. Two configurable binary inputs
 8. The Networked Thermostat shall provide the flexibility to support either of the following outputs:
 - a. One (1) fan control
 - b. One Proportional (0 to 10V)
 9. The Networked Thermostat shall provide a minimum of six (6) levels of keypad lockout.
 10. The Networked Thermostat shall provide the flexibility to adjust the following parameters:
 - a. Adjustable Temporary Occupancy from 0 to 24 hours
 - b. Adjustable heating/cooling deadband from 2° F to 5° F
 - c. Adjustable heating/cooling cycles per hour from 4 to 8
 11. Where required by application and indicated on plans or room schedules provide the Networked Thermostat with an integral Passive Infra-Red (PIR) occupancy sensor.
 12. The Networked Thermostat shall employ nonvolatile electrically erasable programmable read-only memory (EEPROM) for all adjustable parameters.
- E. VAV Modular Assembly (VMA 16X0)
1. The VAV Modular Assembly shall provide both standalone and networked direct digital control of pressure-independent, variable air volume terminal units. It shall address both single and dual duct applications.
 2. The VMA shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.

- a. The VMA shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
 - b. A BACnet Protocol Implementation Conformance Statement shall be provided for the VMA.
 - c. The Conformance Statement shall be submitted 10 days prior to bidding.
3. The VAV Modular Assembly shall communicate over the FC Bus using BACnet Standard protocol SSPC-135, Clause 9.
 4. The VAV Modular Assembly shall have internal electrical isolation for AC power, DC inputs, and MS/TP communications. An externally mounted isolation transformer shall not be acceptable.
 5. The VAV Modular Assembly shall be a configurable digital controller with integral differential pressure transducer and damper actuator. All components shall be connected and mounted as a single assembly that can be removed as one piece.
 6. The VAV Modular Assembly shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
 7. The integral damper actuator shall be a fast response stepper motor capable of stroking 90 degrees in 30 seconds for quick damper positioning to speed commissioning and troubleshooting tasks.
 8. The controller shall determine airflow by dynamic pressure measurement using an integral dead-ended differential pressure transducer. The transducer shall be maintenance-free and shall not require air filters.
 9. Each controller shall have the ability to automatically calibrate the flow sensor to eliminate pressure transducer offset error due to ambient temperature / humidity effects.
 10. The controller shall utilize a proportional plus integration (PI) algorithm for the space temperature control loops.
 11. Each controller shall continuously, adaptively tune the control algorithms to improve control and controller reliability through reduced actuator duty cycle. In addition, this tuning reduces commissioning costs, and eliminates the maintenance costs of manually re-tuning loops to compensate for seasonal or other load changes.
 12. The controller shall provide the ability to download and upload VMA configuration files, both locally and via the communications network. Controllers shall be able to be loaded individually or as a group using a zone schedule generated spreadsheet of controller parameters.
 13. Control setpoint changes initiated over the network shall be written to VMA non-volatile memory to prevent loss of setpoint changes and to provide consistent operation in the event of communication failure.
 14. The controller firmware shall be flash-upgradeable remotely via the communications bus to minimize costs of feature enhancements.
 15. The controller shall provide fail-soft operation if the airflow signal becomes unreliable, by automatically reverting to a pressure-dependent control mode.
 16. The controller shall interface with balancer tools that allow automatic recalculation of box flow pickup gain ("K" factor), and the ability to directly command the airflow control loop to the box minimum and maximum airflow setpoints.

17. Controller performance shall be self-documenting via on-board diagnostics. These diagnostics shall consist of control loop performance measurements executing at each control loop's sample interval, which may be used to continuously monitor and document system performance. The VMA shall calculate exponentially weighted moving averages (EWMA) for each of the following. These metrics shall be available to the end user for efficient management of the VAV terminals.
 - ◇ Absolute temperature loop error
 - ◇ Signed temperature loop error
 - ◇ Absolute airflow loop error
 - ◇ Signed airflow loop error
 - ◇ Average damper actuator duty cycle
18. The controller shall detect system error conditions to assist in managing the VAV zones. The error conditions shall consist of:
 - ◇ Unreliable space temperature sensor
 - ◇ Unreliable differential pressure sensor
 - ◇ Starved box
 - ◇ Actuator stall
 - ◇ Insufficient cooling
 - ◇ Insufficient heating
19. The controller shall provide a flow test function to view damper position vs. flow in a graphical format. The information would alert the user to check damper position. The VMA would also provide a method to calculate actuator duty cycle as an indicator of damper actuator runtime.
20. The controller shall provide a compliant interface for ASHRAE Standard 62-1989 (indoor air quality), and shall be capable of resetting the box minimum airflow Based on the percent of outdoor air in the primary air stream.
21. The controller shall comply with ASHRAE Standard 90.1 (energy efficiency) by preventing simultaneous heating and cooling, and where the control strategy requires reset of airflow while in reheat, by modulating the box reheat device fully open prior to increasing the airflow in the heating sequence.
22. Inputs:
 - a. Analog inputs with user defined ranges shall monitor the following analog signals, without the addition of equipment outside the terminal controller cabinet:
 - ◇ 0-10 VDC Sensors
 - ◇ 1000ohm RTDs
 - ◇ NTC Thermistors
 - b. Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input "bouncing."
 - c. For noise immunity, the inputs shall be internally isolated from power, communications, and output circuits.
 - d. Provide side loop application for humidity control.
23. Outputs
 - a. Analog outputs shall provide the following control outputs:
 - ◇ 0-10 VDC

- b. Binary outputs shall provide a SPST Triac output rated for 500mA at 24 VAC.
 - c. For noise immunity, the outputs shall be internally isolated from power, communications, and other output circuits.
24. Application Configuration
- a. The VAV Modular Assembly shall be configured with a software tool that provides a simple Question/Answer format for developing applications and downloading.
25. Sensor Support
- a. The VAV Modular Assembly shall communicate over the Sensor-Actuator Bus (SA Bus) with a Network Sensor.
 - b. The VMA shall support an LCD display room sensor.
 - c. The VMA shall also support standard room sensors as defined by analog input requirements.
 - d. The VMA shall support humidity sensors defined by the AI side loop.
- F. Network Sensors (NS-XXX-700X)
- 1. The Network Sensors (NS) shall have the ability to monitor the following variables as required by the systems sequence of operations:
 - a. Zone Temperature
 - b. Zone Humidity
 - c. Zone Setpoint
 - d. Discharge Air Temperature
 - e. Zone CO2
 - 2. The NS shall transmit the information back to the controller on the Sensor-Actuator Bus (SA Bus) using BACnet Standard protocol SSPC-135, Clause 9.
 - 3. The NS shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
 - 4. The NS shall be tested and certified as a BACnet Smart Sensors (B-SS).
 - 5. A BACnet Protocol Implementation Conformance Statement shall be provided for the NS.
 - 6. The Conformance Statement shall be submitted 10 days prior to bidding.
 - 7. The Network Zone Temperature Sensors shall include the following items:
 - 8. A backlit Liquid Crystal Display (LCD) to indicate the Temperature, Humidity and Setpoint
 - a. An LED to indicate the status of the Override feature
 - b. A button to toggle the temperature display between Fahrenheit and Celsius
 - c. A button to initiate a timed override command
 - d. Available in either surface mount or wall mount
 - e. Available with either screw terminals or phone jack
 - 9. The Network Discharge Air Sensors shall include the following:
 - a. 4 inch or 8 inch duct insertion probe
 - b. 10 foot pigtail lead
 - c. Dip Switches for programmable address selection
 - d. Ability to provide an averaging temperature from multiple locations
 - e. Ability to provide a selectable temperature from multiple locations

10. The Network CO2 Zone Sensors shall include the following:
 - a. Available in either surface mount or wall mount
 - b. Available with screw terminals or phone jack
- G. Many-To-One Wireless Room Temperature Sensor System (WRS-XTX-0000) (Not Used)
 1. The Many-To-One System Receiver (WRS Receiver) shall receive wireless Radio Frequency (RF) signals containing temperature data from multiple Wireless Room Temperature Sensors (WRS Sensors).
 - a. The WRS Receiver shall use direct sequence spread spectrum RF technology.
 - b. The WRS Receiver shall operate on the 2.4 GHZ ISM Band.
 - c. The WRS Receiver shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
 - d. The WRS Receiver shall be FCC compliant to CFR Part 15 subpart B Class A.
 - e. The WRS Receiver shall operate as a bidirectional transceiver with the sensors to confirm and synchronize data transmission.
 - f. The WRS Receiver shall be capable of communication with WRS Sensors up to a distance of 200 Feet.
 - g. The WRS Receiver shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.
 - h. The WRS Receiver shall have LED indicators to provide information regarding the following conditions:
 - ◇ Power On/Off
 - ◇ Ethernet – Receiver Activity/No Activity
 - ◇ Wireless Normal Mode – Transmission from sensors/No Transmission
 - ◇ Wireless Rapid Transmit Mode – No transmission/ weak signal/Adequate signal/Excellent signal
 - ◇ Ethernet Connection – No connection/10Mbps connection/100Mbps connection
 - ◇ Network Activity – No Network Activity/Half-Duplex Communication/Full-Duplex Communication
 2. The WRS Sensors shall sense and report room temperatures to the WRS Receiver.
 - a. The WRS Sensors shall use direct sequence spread spectrum RF technology.
 - b. The WRS Sensors shall operate on the 2.4 GHZ ISM Band.
 - c. The WRS Sensors shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
 - d. The WRS sensors shall be FCC compliant to CFR Part 15 subpart B Class A.
 - e. The WRS sensors shall be available with
 - ◇ Warmer/Cooler Set Point Adjustment
 - ◇ No Set Point Adjustment
 - ◇ Set Point Adjustment Scale – 55 to 85° F.
 - f. The WRS sensors shall be assembled in NEMA 1 plastic housings.
- H. ZFR1800 Series Wireless Field Bus System (Not Used)

1. The ZFR1800 Series System shall employ ZigBee technology to create a wireless mesh network to provide wireless connectivity for Metasys BACnet devices at multiple system levels. This includes communications from FEC and VMA field controllers to sensors and from engines to these field controllers. Wireless devices shall co-exist on the same network with hardwired devices. Hardwired controllers shall be capable of retrofit to wireless devices with no special software.
2. The ZFR1810 Wireless Field Bus Coordinator shall provide a wireless interface between supported field controllers and an NAE35/45/55 or NCE25 supervisory controller via the BACnet MS/TP field bus. Each wireless mesh network shall be provided with a ZFR1810 Coordinator for initiation and formation of the network
 - a. The ZFR Coordinator shall use direct sequence spread spectrum RF technology.
 - b. The ZFR Coordinator shall operate on the 2.4 GHZ ISM Band.
 - c. The ZFR Coordinator shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
 - d. The ZFR Coordinator shall be FCC compliant to CFR Part 15 subpart B Class A.
 - e. The ZFR Coordinator shall operate as a bidirectional transceiver with the sensors and routers to confirm and synchronize data transmission.
 - f. The ZFR Coordinator shall be capable of communication with sensors and routers up to a maximum distance of 250 Feet (line of sight).
 - g. The ZFR Coordinator shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.
 - h. The ZFR Coordinator shall have LED indicators to provide diagnostic information required for efficient operation and commissioning.
3. The ZFR1811 Wireless Field Bus Router shall be used with any model Field Equipment Controller (FEC) or VMA1600 series VAV Modular Assembly to provide a wireless interface to supervisory engines, via the ZFR1810 Coordinator, and associated WRZ Wireless Mesh Room Temperature Sensors. .
 - a. The ZFR1811 Router shall use direct sequence spread spectrum RF technology.
 - b. The ZFR1811 Router shall operate on the 2.4 GHZ ISM Band.
 - c. The ZFR1811 Router shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
 - d. The ZFR1811 Router shall be FCC compliant to CFR Part 15 subpart B Class A.
 - e. The ZFR1811 Router shall operate as a bidirectional transceiver with other mesh network devices to ensure network integrity.
 - f. The ZFR1811 Router shall be capable of communication with other mesh network devices at a maximum distance of 250 feet (line of sight).
 - g. The ZFR1811 Router shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.
 - h. The ZFR1811 Router shall provide LED indication for use in commissioning and troubleshooting that can be disabled.

4. The WRZ-TT Series Wireless Room Temperature Sensors shall sense and transmit room temperatures, room set point, room occupancy notification low battery condition to an associated ZFR1811 Router.
 - a. The WRZ Sensors shall use direct sequence spread spectrum RF technology.
 - b. The WRZ Sensors shall operate on the 2.4 GHZ ISM Band.
 - c. The WRZ Sensors shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
 - d. The WRZ sensors shall be FCC compliant to CFR Part 15 subpart B Class A.
 - e. The WRZ sensors shall be available with
 - ◇ Warmer/Cooler Set Point Adjustment
 - ◇ No Set Point Adjustment
 - ◇ Set Point Adjustment Scale – 55 to 85° F.
 - f. Wireless sensors shall be provided with display of room temperature, signal strength, fan mode, occupancy and network status as required by application and indicated on plans or in schedules.
 - g. The WRZ sensors shall be assembled in NEMA 1 plastic housings.
- I. One-to-One Wireless Room Temperature Sensor System (WRZ)
 1. The One-To-One Wireless Receiver (WRS Receiver) shall receive wireless Radio Frequency (RF) signals containing temperature data from multiple Wireless Room Temperature Sensors (WRZ Sensors) and communicate this information to either FEC or VMA controllers via the Sensor/Actuator (SA) Bus.
 - a. The WRZ Receiver shall use direct sequence spread spectrum RF technology.
 - b. The WRZ Receiver shall operate on the 2.4 GHZ ISM Band.
 - c. The WRZ Receiver shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
 - d. The WRZ Receiver shall be FCC compliant to CFR Part 15 subpart B Class A.
 - e. The WRZ Receiver shall operate as a bidirectional transceiver with the sensors to confirm and synchronize data transmission.
 - f. The WRZ Receiver shall be capable of communication with from one to five WRZ Sensors up to a distance of 200 Feet.
 - g. The WRZ Receiver shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.
 - h. The WRZ Receiver shall have LED indicators to provide information regarding the following conditions:
 - ◇ Power
 - ◇ SA Bus – Receiver Activity/No Activity
 - ◇ Wireless RF – Transmission from sensors/No Transmission
 - ◇ Wireless Rapid Transmit Mode – No transmission/ weak signal/Adequate signal/Excellent signal
 2. The WRZ Sensors shall sense and report room temperatures to the WRZ Receiver.
 - a. The WRZ Sensors shall use direct sequence spread spectrum RF technology.

- b. The WRZ Sensors shall operate on the 2.4 GHZ ISM Band.
- c. The WRZ Sensors shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
- d. The WRZ sensors shall be FCC compliant to CFR Part 15 subpart B Class A.
- e. The WRZ sensors shall be available with
 - ◇ Warmer/Cooler Set Point Adjustment
 - ◇ No Set Point Adjustment
 - ◇ Set Point Adjustment Scale – 55 to 85° F.
- f. The WRZ sensors shall be assembled in NEMA 1 plastic housings.

2.09 System Tools

A. System Configuration Tool (SCT)

- 1. The Configuration Tool shall be a software package enabling a computer platform to be used as a stand-alone engineering configuration tool for a Network Automation Engine (NAE) or a Network Integration Engine (NIE).
- 2. The configuration tool shall provide an archive database for the configuration and application data.
- 3. The configuration tool shall have the same look-and-feel at the User Interface (UI) regardless of whether the configuration is being done online or offline.
- 4. The configuration tool shall include the following features:
 - a. Basic system navigation tree for connected networks
 - b. Integration of Metasys N1, LonWorks, and BACnet enabled devices
 - c. Customized user navigation trees
 - d. Point naming operating parameter setting
 - e. Graphic diagram configuration
 - f. Alarm and event message routing
 - g. Graphical logic connector tool for custom programming
 - h. Downloading, uploading, and archiving databases
- 5. The configuration tool shall have the capability to automatically discover field devices on connected buses and networks. Automatic discovery shall be available for the following field devices:
 - a. BACnet Devices
 - b. LonWorks devices
 - c. N2 Bus devices
 - d. Metasys N1 networks
- 6. The configuration tool shall be capable of programming the Field Equipment Controllers.
 - a. The configuration tool shall provide the capability to configure, simulate, and commission the Field Equipment Controllers.
 - b. The configuration tool shall allow the FECs to be run in Simulation Mode to verify the applications.
 - c. The configuration tool shall contain a library of standard applications to be used for configuration.

7. The configuration tool shall be capable of programming the field devices.
 - a. The configuration tool shall provide the capability to configure, simulate, and commission the field devices.
 - b. The configuration tool shall allow the field devices to be run in Simulation Mode to verify the applications.
 - c. The configuration tool shall contain a library of standard applications to be used for configuration
 8. A wireless access point shall allow a wireless enabled portable PC to make a temporary Ethernet connection to the automation network.
 - a. The wireless connection shall allow the PC to access configuration tool through the web browser using the User Interface (UI).
 - b. The wireless use of configuration tool shall be the same as a wired connection in every respect.
 - c. The wireless connection shall use the Bluetooth Wireless Technology.
- B. Wireless MS/TP Converter (BTCVT)
- a. The converter shall provide a temporary wireless connection between the SA or FC Bus and a wireless enabled portable PC.
 - b. The converter shall support downloading and troubleshooting FEC and field devices from the PC over the wireless connection.
 - c. The converter shall employ Bluetooth Wireless Technology.
 - d. The converter shall be powered through a connection to either the Sensor-Actuator (SA) or the Field Controller (FC) Bus.
 - e. The converter shall operate over a minimum of thirty three (33) feet within a building.
 - f. The converter shall have LED indicators to provide information regarding the following conditions:
 - ◇ Power - On/Off
 - ◇ Fault – Fault/No Fault
 - ◇ SA/FC Bus – Bus Activity/ No Bus Activity
 - ◇ Blue – Bluetooth Communication Established/ Bluetooth Communication Not Established
 - g. The SWCVT shall comply with FCC Part 15.247 regulations for low-power unlicensed transmitters.
- C. Handheld VAV Balancing Sensor (ATV7003)
- a. The sensor shall be a light weight portable device of dimensions not more than 3.2 x 3.2 x 1.0 inches.
 - b. The sensor shall be capable of displaying data and setting balancing parameters for VAV control applications.
 - c. The sensor shall be powered through a connection to either the Sensor-Actuator (SA) or the Field Controller (FC) Bus.
 - d. The sensor shall be a menu driven device that shall modify itself automatically depending upon what type of application resides in the controller.
 - e. The sensor shall contain a dial and two buttons to navigate through the menu and to set balancing parameters.

- f. The sensor shall provide an adjustable time-out parameter that will return the controller to normal operation if the balancing operation is aborted or abandoned.
- g. The sensor shall include the following
 - ◇ 5 foot retractable cable
 - ◇ Laminated user guide
 - ◇ Nylon caring case
- h. The sensor shall be Underwriters Laboratory UL 916 listed and CSA certified C22.2 N. 205, CFR47.

2.10 Input Devices

A. General Requirements

- 1. Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements.

B. Temperature Sensors

1. General Requirements:

- a. Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.
- b. The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD.
- c. The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:

| Point Type | Accuracy |
|------------------------------|----------|
| Chilled /Hot/Condenser Water | ± .5°F. |
| Room Temp | ± .5°F. |
| Duct Temperature | ± .5°F. |
| All Others | ± .75°F. |

2. Room Temperature Sensors

- a. Room sensors shall be constructed for either surface or wall box mounting.
- b. Room sensors shall have the following options when specified:
 - ◇ Setpoint reset slide switch providing a ±3 degree (adjustable) range.
 - ◇ Individual heating/cooling setpoint slide switches.
 - ◇ A momentary override request push button for activation of after-hours operation.
 - ◇ Analog thermometer.

3. Room Temperature Sensors with Integral Display

- a. Room sensors shall be constructed for either surface or wall box mounting.
- b. Room sensors shall have an integral LCD display and four button keypad with the following capabilities:
 - ◇ Display room and outside air temperatures.
 - ◇ Display and adjust room comfort setpoint.

- ◇ Display and adjust fan operation status.
 - ◇ Timed override request push button with LED status for activation of after-hours operation.
 - ◇ Display controller mode.
 - ◇ Password selectable adjustment of setpoint and override modes.
4. Thermo wells
 - a. When thermo wells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and Greenfield fitting.
 - b. Thermo wells shall be pressure rated and constructed in accordance with the system working pressure.
 - c. Thermo wells and sensors shall be mounted in a threadolet or 1/2" NPT saddle and allow easy access to the sensor for repair or replacement.
 - d. Thermo wells shall be constructed of 316 stainless steel.
 5. Outside Air Sensors
 - a. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.
 - b. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.
 - c. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.
 6. Duct Mount Sensors
 - a. Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.
 - b. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
 - c. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.
 7. Averaging Sensors
 - a. For ductwork greater in any dimension than 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.
 - b. For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment.
 - c. Capillary supports at the sides of the duct shall be provided to support the sensing string.
 8. Acceptable Manufacturers: Johnson Controls, Setra.
- C. Humidity Sensors
1. The sensor shall be a solid-state type, relative humidity sensor of the Bulk Polymer Design. The sensor element shall resist service contamination.

2. The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 4-20 mA, 0-100% linear proportional output.
 3. The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. 3% between 20% and 80% RH @ 77 Deg F unless specified elsewhere.
 4. Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with sealtite fittings and stainless steel bushings.
 5. A single point humidity calibrator shall be provided, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.
 6. Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.
 7. Acceptable Manufacturers: Johnson Controls, Veris Industries, and Mamac.
- D. Differential Pressure Transmitters
1. General Air and Water Pressure Transmitter Requirements:
 - a. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.
 - b. Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.
 - c. Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device, and shall be supplied with Tee fittings and shut-off valves in the high and low sensing pick-up lines to allow the balancing Contractor and Owner permanent, easy-to-use connection.
 - d. A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible.
 2. Low Differential Water Pressure Applications (0" - 20" w.c.)
 - a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of flow meter differential pressure or water pressure sensing points.
 - b. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
 - ◇ .01-20" w.c. input differential pressure range.
 - ◇ 4-20 mA output.
 - ◇ Maintain accuracy up to 20 to 1 ratio turndown.
 - ◇ Reference Accuracy: +0.2% of full span.
 - c. Acceptable Manufacturers: Setra and Mamac.
 3. Medium to High Differential Water Pressure Applications (Over 21" w.c.)
 - a. The differential pressure transmitter shall meet the low pressure transmitter specifications with the following exceptions:
 - ◇ Differential pressure range 10" w.c. to 300 PSI.

- ◇ Reference Accuracy: $\pm 1\%$ of full span (includes non-linearity, hysteresis, and repeatability).
- b. Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.
- c. Acceptable Manufacturers: Setra and Mamac.
- 4. Building Differential Air Pressure Applications (-1" to +1" w.c.)
 - a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.
 - b. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
 - ◇ -1.00 to +1.00 w.c. input differential pressure ranges. (Select range appropriate for system application)
 - ◇ 4-20 mA output.
 - ◇ Maintain accuracy up to 20 to 1 ratio turndown.
 - ◇ Reference Accuracy: +0.2% of full span.
 - c. Acceptable Manufacturers: Johnson Controls and Setra.
- 5. Low Differential Air Pressure Applications (0" to 5" w.c.)
 - a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.
 - b. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
 - ◇ (0.00 - 1.00" to 5.00") w.c. input differential pressure ranges. (Select range appropriate for system application.)
 - ◇ 4-20 mA output.
 - ◇ Maintain accuracy up to 20 to 1 ratio turndown.
 - ◇ Reference Accuracy: +0.2% of full span.
 - c. Acceptable Manufacturers: Johnson Controls and Setra.
- 6. Medium Differential Air Pressure Applications (5" to 21" w.c.)
 - a. The pressure transmitter shall be similar to the Low Air Pressure Transmitter, except that the performance specifications are not as severe. Differential pressure transmitters shall be provided that meet the following performance requirements:
 - ◇ Zero & span: (c/o F.S./Deg. F): .04% including linearity, hysteresis and repeatability.
 - ◇ Accuracy: 1% F.S. (best straight line) Static Pressure Effect: 0.5% F.S. (to 100 PSIG.
 - ◇ Thermal Effects: $<+.033$ F.S./Deg. F. over 40°F. to 100°F. (calibrated at 70°F.).

- b. Standalone pressure transmitters shall be mounted in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings shall be provided.
 - c. Acceptable manufacturers: Johnson Controls and Setra.
- E. Flow Monitoring
- 1. Air Flow Monitoring
 - a. Fan Inlet Air Flow Measuring Stations
 - ◇ At the inlet of each fan and near the exit of the inlet sound trap, airflow traverse probes shall be provided that shall continuously monitor the fan air volumes and system velocity pressure.
 - ◇ Each traverse probe shall be of a dual manifolded, cylindrical, type 3003 extruded aluminum configuration, having an anodized finish to eliminate surface pitting and unnecessary air friction. The multiple total pressure manifold shall have sensors located along the stagnation plane of the approaching airflow. The manifold should not have forward projecting sensors into the air stream. The static pressure manifold shall incorporate dual offset static tops on the opposing sides of the averaging manifold so as to be insensitive to flow-angle variations of as much as $\pm 20^\circ$ in the approaching air stream.
 - ◇ The airflow traverse probe shall not induce a measurable pressure drop, nor shall the sound level within the duct be amplified by its singular or multiple presence in the air stream. Each airflow-measuring probe shall contain multiple total and static pressure sensors placed at equal distances along the probe length. The number of sensors on each probe and the quantity of probes utilized at each installation shall comply with the ASHRAE Standards for duct traversing.
 - ◇ Airflow measuring stations shall be manufactured by Air Monitor Corp., Tek-Air Systems, Inc., Ebtron, or Dietrich Standard.
 - b. Single Probe Air Flow Measuring Sensor
 - ◇ The single probe airflow-measuring sensor shall be duct mounted with an adjustable sensor insertion length of up to eight inches. The transmitter shall produce a 4-20 mA or 0-10 VDC signal linear to air velocity. The sensor shall be a hot wire anemometer and utilize two temperature sensors and a heater element temperature. The other sensor shall measure the downstream air temperature. The temperature differential shall be directly related to airflow velocity.
 - c. Duct Air Flow Measuring Stations
 - ◇ Each device shall be designed and built to comply with, and provide results in accordance with, accepted practice as defined for system testing in the ASHRAE Handbook of fundamentals, as well as in the Industrial Ventilation Handbook.

- ◇ Airflow measuring stations shall be fabricated of 14-gauge galvanized steel welded casing with 90 Deg. connecting flanges in configuration and size equal to that of the duct into which it is mounted. Each station shall be complete with an air directionalizer and parallel cell profile suppressor (3/4" maximum cell) across the entering air stream and mechanically fastened to the casing in such a way to withstand velocities up to 6000 feet per minute. This air directionalizer and parallel cell honeycomb suppressor shall provide 98% free area, equalize the velocity profile, and eliminate turbulent and rotational flow from the air stream prior to the measuring point.
- ◇ The total pressure measurement side (high side) will be designed and spaced to the Industrial Ventilation Manual 16th Edition, Page 9-5. The self-averaging manifolding will be manufactured of brass and copper components.
- ◇ The static pressure sensing probes (low side) shall be bullet-nosed shaped, per detailed radius, as illustrated in Industrial Ventilation Manual 16th Edition, Page 9-5.
- ◇ The main take-off point from both the total pressure and the static pressure manifolds must be symmetrical.
- ◇ Total and static pressure manifolds shall terminate with external ports for connection to control tubing. An identification label shall be placed on each unit casing, listing model number, size, area, and specified airflow capacity.
- ◇ Installation Considerations
 - The maximum allowable pressure loss through the Flow and Static Pressure elements shall not exceed .065" w.c. at 1000 feet per minute, or .23" w.c. at 2000 feet per minute. Each unit shall measure the airflow rate within an accuracy of plus 2% as determined by U.S. – GSA certification tests, and shall contain a minimum of one total pressure sensor per 36 square inches of unit measuring area.
 - The units shall have a self-generated sound rating of less than NC40, and the sound level within the duct shall not be amplified nor shall additional sound be generated.
 - Where the stations are installed in insulated ducts, the airflow passage of the station shall be the same size as the inside airflow dimension of the duct. Station flanges shall be two inch to three inch to facilitate matching connecting ductwork.
 - Where control dampers are shown as part of the airflow measuring station, opposed blade precision controlled volume dampers integral to the station and complete with actuator, pilot positioner, and linkage shall be provided.

- Stations shall be installed in strict accordance with the manufacturer's published requirements, and in accordance with ASME Guidelines affecting non-standard approach conditions.
- ◊ Acceptable manufacturers: Air Monitor Corp., Tek-Air, Ebtron, and Dietrich Standard.
- d. Static Pressure Traverse Probe
 - ◊ Duct static traverse probes shall be provided where required to monitor duct static pressure. The probe shall contain multiple static pressure sensors located along exterior surface of the cylindrical probe.
 - ◊ Acceptable manufacturers: Cleveland Controls
- e. Shielded Static Air Probe
 - ◊ A shielded static pressure probe shall be provided at each end of the building. The probe shall have multiple sensing ports, an impulse suppression chamber, and airflow shielding. A suitable probe for indoor and outdoor locations shall be provided.
- 2. Water Flow Monitoring
 - ◊ Water flow meters shall be electromagnetic type with integral microprocessor-Based electronics. The meter shall have an accuracy of 0.25%.
 - ◊ Acceptable manufacturers: Onicon
- F Power Monitoring Devices
 - 1. Current Measurement (Amps)
 - a. Current measurement shall be by a combination current transformer and a current transducer. The current transformer shall be sized to reduce the full amperage of the monitored circuit to a maximum 5 Amp signal, which will be converted to a 4-20 mA DDC compatible signal for use by the Facility Management System.
 - b. Current Transformer – A split core current transformer shall be provided to monitor motor amps.
 - ◊ Operating frequency – 50 - 400 Hz.
 - ◊ Insulation – 0.6 Kv class 10Kv BIL.
 - ◊ UL recognized.
 - ◊ Five amp secondary.
 - ◊ Select current ration as appropriate for application.
 - ◊ Acceptable manufacturers: Veris Industries
 - c. Current Transducer – A current to voltage or current to mA transducer shall be provided. The current transducer shall include:
 - ◊ 6X input over amp rating for AC inrushes of up to 120 amps.
 - ◊ Manufactured to UL 1244.
 - ◊ Accuracy: +.5%, Ripple +1%.
 - ◊ Minimum load resistance 30kOhm.
 - ◊ Input 0-20 Amps.
 - ◊ Output 4-20 mA.
 - ◊ Transducer shall be powered by a 24VDC regulated power supply (24 VDC +5%).

◇ Acceptable manufacturers: Veris Industries

G. Refrigerant Leak Detectors

1. The refrigerant leak detector shall be a standalone device and shall provide a SPDT output to directly energize the refrigeration room exhaust ventilation fans. The detector shall include a sensor or sensors connected to a control panel. Two relay contacts at the control panel shall provide trouble and alarm indication to the Facility Management System. The alarm relay contact shall also directly energize the exhaust fans.
2. The refrigerant leak detector shall sense the type of refrigerant used in the specified chillers. Multiple sensors shall be required to detect different refrigerants and/or provide proper sensing coverage for the area of the refrigeration room.
3. Acceptable manufacturers: Johnson Controls, MSA Instruments

H. Smoke Detectors

1. Ionization type air duct detectors shall be furnished as specified elsewhere in Division 16 for installation under Division 15. All wiring for air duct detectors shall be provided under Division 16, Fire Alarm System.

I. Status and Safety Switches

1. General Requirements
 - a. Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.
2. Current Sensing Switches
 - a. The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.
 - b. Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.
 - c. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.
 - d. Acceptable manufacturers: Veris Industries
3. Air Filter Status Switches
 - a. Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.
 - b. A complete installation kit shall be provided, including: static pressure tops, tubing, fittings, and air filters.
 - c. Provide appropriate scale range and differential adjustment for intended service.
 - d. Acceptable manufacturers: Johnson Controls, Cleveland Controls

4. Air Flow Switches
 - a. Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.
 - b. Acceptable manufacturers: Johnson Controls, Cleveland Controls
5. Air Pressure Safety Switches
 - a. Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120VAC.
 - b. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.
 - c. Acceptable manufacturers: Johnson Controls, Cleveland Controls
6. Water Flow Switches
 - a. Water flow switches shall be equal to the Johnson Controls P74.
7. Low Temperature Limit Switches
 - a. The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.
 - b. The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.
 - c. For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.
 - d. The low temperature limit switch shall be equal to Johnson Controls A70.

2.11 Output Devices

A. Actuators

1. General Requirements
 - a. Damper and valve actuators shall be electronic and/or pneumatic, as specified in the System Description section.
2. Electronic Damper Actuators
 - a. Electronic damper actuators shall be direct shaft mount.
 - b. Modulating and two-position actuators shall be provided as required by the sequence of operations. Damper sections shall be sized Based on actuator manufacturer's recommendations for face velocity, differential pressure and damper type. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the dampers, as required. All actuators (except terminal units) shall be furnished with mechanical spring return unless otherwise specified in the sequences of operations. All actuators shall have external adjustable stops to limit the travel in either direction, and a gear release to allow manual positioning.
 - c. Modulating actuators shall accept 24 VAC or VDC power supply, consume no more than 15 VA, and be UL listed. The control signal shall be 2-10

VDC or 4-20 mA, and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal and may be used to parallel other actuators and provide true position indication. The feedback signal of one damper actuator for each separately controlled damper shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.

- d. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Isolation, smoke, exhaust fan, and other dampers, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop associated fan. Two-position actuators, as specified in sequences of operations as “quick acting,” shall move full stroke within 20 seconds. All smoke damper actuators shall be quick acting.
 - e. Acceptable manufacturers: Johnson Controls, Mamac, Belimo
3. Electronic Valve Actuators
- a. Electronic valve actuators shall be manufactured by the valve manufacturer.
 - b. Each actuator shall have current limiting circuitry incorporated in its design to prevent damage to the actuator.
 - c. Modulating and two-position actuators shall be provided as required by the sequence of operations. Actuators shall provide the minimum torque required for proper valve close-off against the system pressure for the required application. The valve actuator shall be sized Based on valve manufacturer’s recommendations for flow and pressure differential. All actuators shall fail in the last position unless specified with mechanical spring return in the sequence of operations. The spring return feature shall permit normally open or normally closed positions of the valves, as required. All direct shaft mount rotational actuators shall have external adjustable stops to limit the travel in either direction.
 - d. Modulating Actuators shall accept 24 VAC or VDC and 120 VAC power supply and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal, and may be used to parallel other actuators and provide true position indication. The feedback signal of each valve actuator (except terminal valves) shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.
 - e. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Butterfly isolation and other valves, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop the associated pump or chiller.
 - f. Acceptable manufacturers: Johnson Controls, Belimo

B. Control Dampers

1. The BMS Contractor shall furnish all automatic dampers. All automatic dampers shall be sized for the application by the BMS Contractor or as specifically indicated on the Drawings.

2. All dampers used for throttling airflow shall be of the opposed blade type arranged for normally open or normally closed operation, as required. The damper is to be sized so that, when wide open, the pressure drop is a sufficient amount of its close-off pressure drop to shift the characteristic curve to near linear.
3. All dampers used for two-position, open/close control shall be parallel blade type arranged for normally open or closed operation, as required. Modulating dampers shall be opposed blade.
4. Damper frames and blades shall be constructed of either galvanized steel or aluminum. Maximum blade length in any section shall be 60". Damper blades shall be 16-gauge minimum and shall not exceed eight (8) inches in width. Damper frames shall be 16-gauge minimum hat channel type with corner bracing. All damper bearings shall be made of reinforced nylon, stainless steel or oil-impregnated bronze. Dampers shall be tight closing, low leakage type, with synthetic elastomer seals on the blade edges and flexible stainless steel side seals. Dampers of 48"x48" size shall not leak in excess of 8.0 cfm per square foot when closed against 4" w.g. static pressure when tested in accordance with AMCA Std. 500.
5. Airfoil blade dampers of double skin construction with linkage out of the air stream shall be used whenever the damper face velocity exceeds 1500 FPM or system pressure exceeds 2.5" w.g., but no more than 4000 FPM or 6" w.g. Acceptable manufacturers are Johnson Controls D-7250 D-1250 or D-1300, Ruskin CD50, and Vent Products 5650.
6. One piece rolled blade dampers with exposed or concealed linkage may be used with face velocities of 1500 FPM or below. Acceptable manufacturers are: Johnson Controls D-1600, Ruskin CD36, and Vent Products 5800.
7. Multiple section dampers may be jack-shafted to allow mounting of piston pneumatic actuators and direct connect electronic actuators. Each end of the jackshaft shall receive at least one actuator to reduce jackshaft twist.

C. Control Relays

1. Control Pilot Relays
 - a. Control pilot relays shall be of a modular plug-in design with retaining springs or clips.
 - b. Mounting Bases shall be snap-mount.
 - c. DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.
 - d. Contacts shall be rated for 10 amps at 120VAC.
 - e. Relays shall have an integral indicator light and check button.
 - f. Acceptable manufacturers: Johnson Controls, Lectro
2. Lighting Control Relays
 - a. Lighting control relays shall be latching with integral status contacts.
 - b. Contacts shall be rated for 20 amps at 277 VAC.
 - c. The coil shall be a split low-voltage coil that moves the line voltage contact armature to the ON or OFF latched position.
 - d. Lighting control relays shall be controlled by:
 - ◇ Pulsed Tri-state Output – Preferred method.
 - ◇ Pulsed Paired Binary Outputs.

- ◇ A Binary Input to the Facility Management System shall monitor integral status contacts on the lighting control relay. Relay status contacts shall be of the “dry-contact” type.
- e. The relay shall be designed so that power outages do not result in a change-of-state, and so that multiple same state commands will simply maintain the commanded state. Example: Multiple OFF command pulses shall simply keep the contacts in the OFF position.

D. Control Valves

1. All automatic control valves shall be fully proportioning and provide near linear heat transfer control. The valves shall be quiet in operation and fail-safe open, or in their last position. All valves shall operate in sequence with another valve when required by the sequence of operations. All control valves shall be sized by the control manufacturer, and shall be guaranteed to meet the heating and cooling loads, as specified. All control valves shall be suitable for the system flow conditions and close against the differential pressures involved. Body pressure rating and connection type (sweat, screwed, or flanged) shall conform to the pipe schedule elsewhere in this Specification.
2. Chilled water control valves shall be modulating , ball, or globe, as required by the specific application. Modulating water valves shall be sized per manufacturer’s recommendations for the given application. In general, valves (2 or 3-way) serving variable flow air handling unit coils shall be sized for a pressure drop equal to the actual coil pressure drop, but no less than 5 PSI. Valves (3-way) serving constant flow air handling unit coils with secondary circuit pumps shall be sized for a pressure drop equal to 25% the actual coil pressure drop, but no less than 2 PSI. Mixing valves (3-way) serving secondary water circuits shall be sized for a pressure drop of no less than 5 PSI. Valves for terminal reheat coils shall be sized for a 2 PSIG pressure drop, but no more than a 5 PSI drop.
3. Ball valves shall be used for hot and chilled water applications, water terminal reheat coils, radiant panels, unit heaters, package air conditioning units, and fan coil units except those described hereinafter.
4. Modulating globe water valves of the single-seat type with equal percentage flow characteristics shall be used for all special applications. Valve discs shall be composition type. Valve stems shall be stainless steel.
6. Acceptable manufacturers: Johnson Controls, Belimo, B&G

E. Electronic Signal Isolation Transducers

1. A signal isolation transducer shall be provided whenever an analog output signal from the BMS is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input signal from a remote system.
2. The signal isolation transducer shall provide ground plane isolation between systems.
3. Signals shall provide optical isolation between systems.
4. Acceptable manufacturers: Advanced Control Technologies

F. External Manual Override Stations

1. External manual override stations shall provide the following:

- a. An integral HAND/OFF/AUTO switch shall override the controlled device pilot relay.
- b. A status input to the Facility Management System shall indicate whenever the switch is not in the automatic position.
- c. A Status LED shall illuminate whenever the output is ON.
- d. An Override LED shall illuminate whenever the HOA switch is in either the HAND or OFF position.
- e. Contacts shall be rated for a minimum of 1 amp at 24 VAC.

G. Electronic/Pneumatic Transducers

1. Electronic to Pneumatic transducers shall provide:
 - a. Output: 3-15 PSIG.
 - b. Input: 4-20 mA or 0-10 VDC.
 - c. Manual output adjustment.
 - d. Pressure gauge.
 - e. External replaceable supply air filter.
 - f. Acceptable manufacturers: Johnson Controls, Mamac

2.12 Miscellaneous Devices

A. Variable Frequency Motor Speed Control Drives – refer to specification section 23 29 13

B. Local Control Panels

1. All control panels shall be factory constructed, incorporating the BMS manufacturer's standard designs and layouts. All control panels shall be UL inspected and listed as an assembly and carry a UL 508 label listing compliance. Control panels shall be fully enclosed, with perforated sub-panel, hinged door, and slotted flush latch.
2. In general, the control panels shall consist of the DDC controller(s), display module as specified and indicated on the plans, and I/O devices—such as relays, transducers, and so forth—that are not required to be located external to the control panel due to function. Where specified the display module shall be flush mounted in the panel face unless otherwise noted.
3. All I/O connections on the DDC controller shall be provide via removable or fixed screw terminals.
4. Low and line voltage wiring shall be segregated. All provided terminal strips and wiring shall be UL listed, 300-volt service and provide adequate clearance for field wiring.
5. All wiring shall be neatly installed in plastic trays or tie-wrapped.
6. A convenience 120 VAC duplex receptacle shall be provided in each enclosure, fused on/off power switch, and required transformers.

C. Power Supplies

1. DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75% of the rated capacity of the power supply.
2. Input: 120 VAC +10%, 60Hz.

3. Output: 24 VDC.
4. Line Regulation: +0.05% for 10% line change.
5. Load Regulation: +0.05% for 50% load change.
6. Ripple and Noise: 1 mV rms, 5 mV peak to peak.
7. An appropriately sized fuse and fuse block shall be provided and located next to the power supply.
8. A power disconnect switch shall be provided next to the power supply.

D. Thermostats

1. Electric room thermostats of the heavy-duty type shall be provided for unit heaters, cabinet unit heaters, and ventilation fans, where required. All these items shall be provided with concealed adjustment. Finish of covers for all room-type instruments shall match and, unless otherwise indicated or specified, covers shall be manufacturer's standard finish.

E. Lighting Controllers:

1. Lighting controllers shall provide direct control of 20 Amp, 277 VAC lighting circuits using mechanically held, latching relays. Controllers will contain from 8 to 48 circuits per enclosure. Each controller shall also contain inputs for direct connection to light switches and motion detectors.
2. Each controller shall have the capability for time of day scheduling, occupancy mode control, after hour operation, alarming, and trending .
3. LCPs shall be mounted in NEMA 1 standard, locking steel enclosures. Enclosures shall include knockouts and a separate wiring bay for both high- and low-voltage terminations, separated by an appropriate barrier per U. L. and NEC requirements. LCP enclosures shall be provided with a multi-tap transformer capable of accepting 120/277 VAC, 50/60 Hz input power supply. Transformer shall provide all necessary power requirements to switch LCP relays and power LCP controller circuitry. LCP Enclosures shall be sized for 16 or 32 relay capacity.
4. LCPs shall include relays capable of switching lighting circuitry downstream of the building electrical service panel. Relays shall be electrically held or mechanically latched, and rated for 20A, 277 VAC loads. Low-voltage relay control wiring shall be pre-wired and tested by the manufacturer. Each LCP shall have a minimum of spare relays for future use. Refer to electrical plans for lighting circuit list.
5. LCPs shall include a mechanical override switch capable of overriding all relays independently of the intelligent controller board circuitry. Mechanical override switch shall provide local control during startup until low-voltage input wiring and controller database programming have been completed. Mechanical override switch shall be mounted inside the locking LCP enclosure.
6. LCP intelligent controller board shall include a realtime clock, capable of maintaining time and date for a period of one year after a loss of power.
7. The LCP database shall be retained in memory for a period of one year after a loss of power.

8. The controller board shall include a serial communication port for direct connection to a laptop service tool or 2400 baud data modem.
9. The LCP shall include a status LED for each output relay, network communications, panel diagnostic and panel power. LEDs shall be visible through a display in the front cover of the LCP enclosure.
10. The LCP controller shall support the following standard applications programs. These applications shall be programmed off-line using database programming software and downloaded to LCPs.
11. Input / Output Linkages
 - a. LCP database software shall link any <R>input to any combination of outputs.
 - b. Software link shall provide direct, reverse, or blink warning relay response to input requests.
 - c. Selected LCP inputs shall initiate after-hours override of HVAC equipment.
 - d. LCP database software shall provide the capability to group outputs into as many as 32 independent lighting zones.
12. Time of Day Scheduling
 - a. LCP outputs shall be controlled by BMS time of day schedules.
 - b. LCPs shall support optional local time of day scheduling.
13. Blink Warning
 - a. Selected outputs shall turn the lights Off for one second, then turn them back On for ten minutes prior to executing an Off command. User override from a valid input during the ten-minute window shall maintain the lights On, and begin an override timeout timer.
14. Input Enable / Disable
 - a. Selected inputs shall be disabled during specified periods to lockout user override.
 - b. Each input shall respond to multiple lockout schedules.
 - c. Each LCP shall provide up to eight (8) independent lockout schedules.
15. Override Timeout
 - a. Selected inputs shall initiate an override timeout which will automatically command connected circuits OFF when the timer has expired.
 - b. Override timeout shall be programmable for each relay up to 240 minutes.
16. LCPs shall include a keypad interface capable of local user override and basic programming. Interface shall be full nine-key calculator type with LED display. Local keypad interface shall support the following functions.

- a. Local override of individual relay outputs.
 - b. Display and edit system time and date.
 - c. Review and edit input / output linkages.
 - d. Set holiday dates.
 - e. Review and edit local time of day schedules.
17. A communications network shall connect all LCPs to the user interfaces as previously described in this sections. allowing inputs at one panel to control outputs in other panels. All LCPs shall be networked
19. LCPs shall accept low-voltage binary inputs from wall switches, occupancy sensors, or photocells. Each LCP shall accommodate up to thirty-two (32) low-voltage binary inputs. Terminations at the LCP intelligent controller board shall be to a removable terminal block. Inputs shall be momentary (three-wire) or maintained (two-wire) dry contacts. Power for the switched inputs (24 VDC, 12 Ma) shall be supplied by the LCP controller board. Pilot light switches shall be supported, with power for the switch and pilot light supplied by the LCP controller board.
20. Telephone Interface
- a. LCP system shall include a touch-tone telephone interface for remote user override.
 - b. Telephone interface shall connect to the LCP network communications link and broadcast commands to all connected devices.
 - c. Telephone interface shall prompt users via an interactive, voice-synthesized message.
 - d. Telephone interface shall provide override from a standard touch-tone telephone.
 - e. Access to the telephone interface shall be password protected.
 - f. Telephone interface shall double as a data modem to support communications between LCPs and a remote laptop service tool with edit software.
 - g. A short instruction guide shall be provided for each user of the telephone interface.

Part 3 – Performance / Execution

3.01 BMS Specific Requirements

A. Graphic Displays

1. Provide a color graphic system flow diagram display for each system with all points as indicated on the point list. All terminal unit graphic displays shall be from a standard design library.
2. User shall access the various system schematics via a graphical penetration scheme and/or menu selection. .

B. Custom Reports:

1. Provide custom reports as required for this project:

C. Actuation / Control Type

1. Primary Equipment
 - a. Controls shall be provided by equipment manufacturer as specified herein.
 - b. All damper and valve actuation shall be electric.
2. Air Handling Equipment
 - a. All air handlers shall be controlled with a HVAC-DDC Controller
 - b. All damper and valve actuation shall be electric.
3. Terminal Equipment:
 - a. Terminal Units (VAV, UV, etc.) shall have electric damper and valve actuation.
 - b. All Terminal Units shall be controlled with HVAC-DDC Controller)

3.02 Installation Practices

A. BMS Wiring

1. All conduit, wiring, accessories and wiring connections required for the installation of the Building Management System, as herein specified, shall be provided by the BMS Contractor unless specifically shown on the Electrical Drawings under Division 26 Electrical. All wiring shall comply with the requirements of applicable portions of Division 26 and all local and national electric codes, unless specified otherwise in this section.
2. All BMS wiring materials and installation methods shall comply with BMS manufacturer recommendations.
3. The sizing, type and provision of cable, conduit, cable trays, and raceways shall be the design responsibility of the BMS Contractor. If complications arise, however, due to the incorrect selection of cable, cable trays, raceways and/or conduit by the BMS Contractor, the Contractor shall be responsible for all costs incurred in replacing the selected components.
4. Class 2 Wiring
 - a. All Class 2 (24VAC or less) wiring shall be installed in conduit unless otherwise specified.
 - b. Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5' from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements.
5. Class 2 signal wiring and 24VAC power can be run in the same conduit. Power wiring 120VAC and greater cannot share the same conduit with Class 2 signal wiring.
6. Provide for complete grounding of all applicable signal and communications cables, panels and equipment so as to ensure system integrity of operation. Ground cabling and conduit at the panel terminations. Avoid grounding loops.

B. BMS Line Voltage Power Source

1. 120-volt AC circuits used for the Building Management System shall be taken from panel boards and circuit breakers provided by Division 16.
 2. Circuits used for the BMS shall be dedicated to the BMS and shall not be used for any other purposes.
 3. DDC terminal unit controllers may use AC power from motor power circuits.
- C. BMS Raceway
1. All wiring shall be installed in conduit or raceway except as noted elsewhere in this specification. Minimum control wiring conduit size 1/2”.
 2. Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Architect.
 3. All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the surface to which they are attached.
 4. Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls. Flexible Metal Conduit shall be UL listed.
- D. Penetrations
1. Provide fire stopping for all penetrations used by dedicated BMS conduits and raceways.
 2. All openings in fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.
 3. All wiring passing through penetrations, including walls shall be in conduit or enclosed raceway.
 4. Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true, and square.
- E. BMS Identification Standards
1. Node Identification. All nodes shall be identified by a permanent label fastened to the enclosure. Labels shall be suitable for the node location.
Cable types specified in Item A shall be color coded for easy identification and troubleshooting.
- F. BMS Panel Installation
1. The BMS panels and cabinets shall be located as indicated at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer’s recommendations.
 2. The BMS contractor shall be responsible for coordinating panel locations with other trades and electrical and mechanical contractors.
- G. Input Devices
1. All Input devices shall be installed per the manufacturer recommendation
 2. Locate components of the BMS in accessible local control panels wherever possible.
- H. HVAC Input Devices – General
1. All Input devices shall be installed per the manufacturer recommendation

2. Locate components of the BMS in accessible local control panels wherever possible.
3. The mechanical contractor shall install all in-line devices such as temperature wells, pressure taps, airflow stations, etc.
4. Input Flow Measuring Devices shall be installed in strict compliance with ASME guidelines affecting non-standard approach conditions.
5. Outside Air Sensors
 - a. Sensors shall be mounted on the North wall to minimize solar radiant heat impact or located in a continuous intake flow adequate to monitor outside air conditions accurately.
 - b. Sensors shall be installed with a rain proof, perforated cover.
6. Water Differential Pressure Sensors
 - a. Differential pressure transmitters used for flow measurement shall be sized to the flow-sensing device.
 - b. Differential pressure transmitters shall be supplied with tee fittings and shut-off valves in the high and low sensing pick-up lines.
 - c. The transmitters shall be installed in an accessible location wherever possible.
7. Medium to High Differential Water Pressure Applications (Over 21" w.c.):
 - a. Air bleed units, bypass valves and compression fittings shall be provided.
8. Building Differential Air Pressure Applications (-1" to +1" w.c.):
 - a. Transmitters exterior sensing tip shall be installed with a shielded static air probe to reduce pressure fluctuations caused by wind.
 - b. The interior tip shall be inconspicuous and located as shown on the drawings.
9. Air Flow Measuring Stations:
 - a. Where the stations are installed in insulated ducts, the airflow passage of the station shall be the same size as the inside airflow dimension of the duct.
 - b. Station flanges shall be two inch to three inch to facilitate matching connecting ductwork.
10. Duct Temperature Sensors:
 - a. Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement.
 - b. The sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate.
 - c. For ductwork greater in any dimension than 48 inches or where air temperature stratification exists such as a mixed air plenum, utilize an averaging sensor.
 - d. The sensor shall be mounted to suitable supports using factory approved element holders.
11. Space Sensors:
 - a. Shall be mounted per ADA requirements.
 - b. Provide lockable tamper-proof covers in public areas and/or where indicated on the plans.

12. Low Temperature Limit Switches:
 - a. Install on the discharge side of the first water or steam coil in the air stream.
 - b. Mount element horizontally across duct in a serpentine pattern insuring each square foot of coil is protected by 1 foot of sensor.
 - c. For large duct areas where the sensing element does not provide full coverage of the air stream, provide additional switches as required to provide full protection of the air stream.
 13. Air Differential Pressure Status Switches:
 - a. Install with static pressure tips, tubing, fittings, and air filter.
 14. Water Differential Pressure Status Switches:
 - a. Install with shut off valves for isolation.
- I. HVAC Output Devices
1. All output devices shall be installed per the manufacturers recommendation. The mechanical contractor shall install all in-line devices such as control valves, dampers, airflow stations, pressure wells, etc.
 2. Actuators: All control actuators shall be sized capable of closing against the maximum system shut-off pressure. The actuator shall modulate in a smooth fashion through the entire stroke. When any pneumatic actuator is sequenced with another device, pilot positioners shall be installed to allow for proper sequencing.
 3. Control Dampers: Shall be opposed blade for modulating control of airflow. Parallel blade dampers shall be installed for two position applications.
 4. Control Valves: Shall be sized for proper flow control with equal percentage valve plugs. The maximum pressure drop for water applications shall be 5 PSI. The maximum pressure drop for steam applications shall be 7 PSI.
 5. Electronic Signal Isolation Transducers: Whenever an analog output signal from the Building Management System is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input a signal from a remote system, provide a signal isolation transducer. Signal isolation transducer shall provide ground plane isolation between systems. Signals shall provide optical isolation between systems

3.03 Training

- A. The BMS contractor shall provide the following training services:
1. One day of on-site orientation by a system technician who is fully knowledgeable of the specific installation details of the project. This orientation shall, at a minimum, consist of a review of the project as-built drawings, the BMS software layout and naming conventions, and a walk through of the facility to identify panel and device locations.

3.04 Commissioning

- A. Fully commission all aspects of the Building Management System work.
- B. Acceptance Check Sheet
1. Prepare a check sheet that includes all points for all functions of the BMS as indicated on the point list included in this specification.

2. Submit the check sheet to the Engineer for approval
 3. The Engineer will use the check sheet as the basis for acceptance with the BMS Contractor.
- C. VAV box performance verification and documentation:
1. The BMS Contractor shall test each VAV box for operation and correct flow. At each step, after a settling time, box air flows and damper positions will be sampled. Following the tests, a pass/fail report indicating results shall be produced. Possible results are Pass, No change in flow between full open and full close, Reverse operation or Maximum flow not achieved. The report shall be submitted as documentation of the installation.
 2. The BMS Contractor shall issue a report based on a sampling of the VAV calculated loop performance metrics. The report shall indicate performance criteria, include the count of conforming and non-conforming boxes, list the non-conforming boxes along with their performance data, and shall also include graphical representations of performance.
- D. Point to Point Checkout.
- Each I/O device (both field mounted as well as those located in FIPs) shall be inspected and verified for proper installation and functionality. A checkout sheet itemizing each device shall be filled out, dated and approved by the Project Manager for submission to the owner or owner's representative.
- E. Controller and Workstation Checkout.
- A field checkout of all controllers and front end equipment (computers, printers, modems, etc.) shall be conducted to verify proper operation of both hardware and software. A checkout sheet itemizing each device and a description of the associated tests shall be prepared and submitted to the owner or owner's representative by the completion of the project.
- F. System Acceptance Testing
1. All application software will be verified and compared against the sequences of operation. Control loops will be exercised by inducing a setpoint shift of at least 10% and observing whether the system successfully returns the process variable to setpoint. Record all test results and attach to the Test Results Sheet.
 2. Test each alarm in the system and validate that the system generates the appropriate alarm message, that the message appears at all prescribed destinations (workstations or printers), and that any other related actions occur as defined (i.e. graphic panels are invoked, reports are generated, etc.). Submit a Test Results Sheet to the owner.
 3. Perform an operational test of each unique graphic display and report to verify that the item exists, that the appearance and content are correct, and that any special features work as intended. Submit a Test Results Sheet to the owner.
 4. Perform an operational test of each third party interface that has been included as part of the automation system. Verify that all points are properly polled, that alarms have been configured, and that any associated graphics and reports have been completed. If the interface involves a file transfer over Ethernet, test any logic that controls the transmission of the file, and verify the content of the specified information.
- G. Promptly rectify all listed deficiencies and submit to the Engineer that this has been done.

3.05 Hardware Installation

A. Installation Practices for Wiring

1. All controllers are to be mounted vertically and per the manufacturer's installation documentation.
2. The 120VAC power wiring to each Ethernet or Remote Site controller shall be a dedicated run, with a separate breaker. Each run will include a separate hot, neutral and ground wire. The ground wire will terminate at the breaker panel ground. This circuit will not feed any other circuit or device.
3. A true earth ground must be available in the building. Do not use a corroded or galvanized pipe, or structural steel.
4. Wires are to be attached to the building proper at regular intervals such that wiring does not droop. Wires are not to be affixed to or supported by pipes, conduit, etc.
5. Conduit in finished areas, will be concealed in ceiling cavity spaces, plenums, furred spaces and wall construction. Exception; metallic surface raceway may be used in finished areas on masonry walls. All surface raceway in finished areas must be color matched to the existing finish within the limitations of standard manufactured colors.
6. Conduit, in non-finished areas where possible, will be concealed in ceiling cavity spaces, plenums, furred spaces, and wall construction. Exposed conduit will run parallel to or at right angles to the building structure.
7. Wires are to be kept a minimum of three (3) inches from hot water, steam, or condensate piping.
8. Where sensor wires leave the conduit system, they are to be protected by a plastic insert.
9. Wire will not be allowed to run across telephone equipment areas.

B. Installation Practices for Field Devices

1. Well-mounted sensors will include thermal conducting compound within the well to insure good heat transfer to the sensor.
2. Actuators will be firmly mounted to give positive movement and linkage will be adjusted to give smooth continuous movement throughout 100 percent of the stroke.
3. Relay outputs will include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.
4. Water line mounted sensors shall be removable without shutting down the system in which they are installed.
5. For duct static pressure sensors, the high pressure port shall be connected to a metal static pressure probe inserted into the duct pointing upstream. The low pressure port shall be left open to the plenum area at the point that the high pressure port is tapped into the ductwork.
6. For building static pressure sensors, the high pressure port shall be inserted into the space via a metal tube. Pipe the low pressure port to the outside of the building.

C. Enclosures

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

2. FIPs shall contain power supplies for sensors, interface relays and contactors, and safety circuits.
3. The FIP enclosure shall be of steel construction with baked enamel finish, NEMA 1 rated with a hinged door and keyed lock. The enclosure will be sized for twenty percent spare mounting space. All locks will be keyed identically.
4. All wiring to and from the FIP will be to screw type terminals. Analog or communications wiring may use the FIP as a raceway without terminating. The use of wire nuts within the FIP is prohibited.
5. All outside mounted enclosures shall meet the NEMA-4 rating.
6. The wiring within all enclosures shall be run in plastic track. Wiring within controllers shall be wrapped and secured.

D. Identification

1. Identify all control wires with labeling tape or sleeves using either words, letters, or numbers that can be exactly cross-referenced with as-built drawings.
2. All field enclosures, other than controllers, shall be identified with a bakelite nameplate. The lettering shall be in white against a black or blue background.
3. Junction box covers will be marked to indicate that they are a part of the BAS system.
4. All I/O field devices (except space sensors) that are not mounted within FIP's shall be identified with name plates.
5. All I/O field devices inside FIP's shall be labeled.

E. Existing Controls. (not used)

Existing controls which are to be reused must each be tested and calibrated for proper operation. Existing controls which are to be reused and are found to be defective requiring replacement, will be noted to the Owner. The Owner will be responsible for all material and labour costs associated with their repair.

F. Control System Switch-over (not Used)

1. Demolition of the existing control system will occur after the new temperature control system is in place including new sensors and new field interface devices.
2. Switch-over from the existing control system to the new system will be fully coordinated with the Owner. A representative of the Owner will be on site during switch-over.
3. The Contractor shall minimize control system downtime during switch-over. Sufficient installation mechanics will be on site so that the entire switch-over can be accomplished in a reasonable time frame.

G. Location

1. The location of sensors is per mechanical and architectural drawings.
2. Space humidity or temperature sensors will be mounted away from machinery generating heat, direct light and diffuser air streams.
3. Outdoor air sensors will be mounted on the north building face directly in the outside air. Install these sensors such that the effects of heat radiated from the building or sunlight is minimized.
4. Field enclosures shall be located immediately adjacent to the controller panel(s) to which it is being interfaced.

3.06 Software Installation

A. General.

The Contractor shall provide all labor necessary to install, initialize, start-up and debug all system software as described in this section. This includes any operating system software or other third party software necessary for successful operation of the system.

B. Database Configuration.

The Contractor will provide all labor to configure those portions of the database that are required by the points list and sequence of operation.

C. Color Graphic Displays.

Unless otherwise directed by the owner, the Contractor will provide color graphic displays as depicted in the mechanical drawings for each system and floor plan. For each system or floor plan, the display shall contain the associated points identified in the point list and allow for setpoint changes as required by the owner.

D. Reports.

The Contractor will configure a minimum of 8 reports for the owner as listed below:

1. boiler Plant Status Report
2. Chilled water plant report
3. Condenser water plant
4. Air Handler Status Report
5. fan coils, unit and cabinet heaters and convectors
6. VAV Status Report
7. Pumps
8. Exhaust and Return fans
9. Space Temperature Report
10. AC unit reports
11. Specialty Equipment Status Report

E. Documentation

As built software documentation will include the following:

1. Descriptive point lists
2. Application program listing
3. Application programs with comments.
4. Printouts of all reports.
5. Alarm list.
6. Printouts of all graphics

SECTION 230993 - SEQUENCE OF OPERATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Sequence of operation:
 - 1. Summer winter change over
 - 2. Boiler Plant
 - 3. Two-Pipe Variable Speed Pumping System Control.
 - 4. Variable Volume Air Conditioning Units
 - 5. Cabinet and Unit Heater
 - 6. Fin Tube Radiation and Radiant Panels
 - 7. General and toilet exhaust fans
 - 8. Fan Coil Units
 - 9. Ductless split systems
 - 10. Kitchen exhaust fan and MUA unit
 - 11. De-Humidifier
 - 12. Chilled water plant
 - 13. Cooling Tower
 - 14. Duct heating coils
 - 15. Miscellaneous.

1.02 RELATED SECTIONS

- A. Section 23 0901 - Digital Control Equipment.
- B. Section 230900 - Instruments and Control for HVAC.

1.03 SYSTEM DESCRIPTION

- A. This Section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other Sections.
- B. Provide DDC based electronic controls, panels, wiring and all accessories required to achieve the specified control sequences and establish a complete independent system for all new equipment and existing equipment. In general the equipment shall be controlled through Standalone Digital Control Units (SDCUs).

Provide the necessary quantity and types of SDCUs to meet the requirements of the project for mechanical equipment control including air handlers, central plant control, and terminal unit control. Each SDCU will operate completely standalone, containing all of the I/O and programs to control its associated equipment.

Certain controls are specified to be furnished with the equipment. This contractor shall provide all components to communicate with factory furnished controls and connect them to the building automation control system. The contractor shall also provide all controls, wiring and auxiliaries required to operate equipment not furnished with factory controls. Work required includes, but is not limited to the following:

1. Control wiring between factory mounted unit panels and factory supplied remote panels.
 2. Installation and wiring for factory supplied devices requiring field installation.
 3. Panel mounted transformers and control power wiring for all controllers and control devices.
 4. Control wiring to each remote device (room thermostats, outdoor air sensors, static pressure controllers, control actuators, control panels, etc.).
 6. All control valves, motorized dampers thermostats, relays, sensors, etc. unless furnished as an integral part of the equipment.
 7. All interlock control wiring (24 volt and 120 volt) between units, fans, etc.
- C. All control and interlock wiring shall be run in EMT for indoor locations and in galvanized conduit for outdoor locations.
- D. **All new controllers, hardware and accessories shall be Johnsons Metasys version 5.0 all new hardware, software and programming shall be compatible with the existing this system**

1.04 SUBMITTALS FOR REVIEW

- A. Division 1 - Submittals: Procedures for submittals.
- B. Shop Drawings: Indicate mechanical system controlled and control system components.
1. Label with settings, adjustable range of control and limits. Include written description of control sequence.
 2. Include flow diagrams for each control system, graphically depicting control logic.
 3. Include draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.
 4. Submit a complete written sequence of operation for each and every controlled piece of equipment.

1.05 SUBMITTALS AT PROJECT CLOSEOUT

- A. Operation and Maintenance Data.
- B. Project Record Documents: Record actual locations of components and set-points of controls, including changes to sequences made after submission of shop drawings.

1.06 QUALITY ASSURANCE

- A. Design system under direct supervision of a Professional Engineer experienced in design of this Work and licensed in the State of New York.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.01 Summer/Winter Change Over

The Building automation System (BAS) shall index the hot and chilled water system equipment into either summer or winter control based upon outdoor air temperature. Below 65 F, (adjustable), outside air temperature, the chilled water system shall be disabled. Above 55F, (adjustable), outside air temperature the hot water system shall be disabled. The system operator shall have capacity of over riding the system for manual change over. A minimum time delay, (24 hrs adjustable), between summer/winter changes over shall prevent cycling between the 2 modes. During heating mode the chillers shall be locked out.

3.02 Boiler Plant:

Boilers shall be operated through an application specific unitary controller and the boiler manufactures sequencing controller. Refer to section 235216 for all safeties and combustion control sequences. The controller shall be microprocessor based system engineered and programmed exclusively for the operation of multiple hot water boilers.

The communications protocol for the boiler controls shall be based on ASHRA/ANSI BACNET Standard 135-1995. Provide required modules to allow open communication, integration and interoperability with other DDC system. The ATC contractor and boiler manufacturer shall coordinate their work to insure compatibility prior to installation.

The ATC system shall enable the hot water system, and change the system from cooling to heating operation based on outdoor air temperature. Set point shall be 55 degrees, adjustable for heating. The hot water circulation pumps shall be interlocked to run continuously when boilers are started. Furnish a flow switch in the supply water header arranged to prevent boiler operation if flow is not proved.

The ATC shall sequence the hot water boilers to maintain the hot water loop temperature set-point. The set-point shall be reset by the outdoor air temperature sensor. Reset schedule to be 150 F to 120 F hot water supply temperature as outside air varies from 10 F to 55 F. (adjustable). Lead boiler selection shall be made by the ATC according to a rotating seven day schedule.

- BMS status and alarms;
- Common failure alarm for each boiler.
- High temperature
- Low temperature

Pump failure
Low water level
High water level

3.03 Variable Speed Pumping System Control (Typical for chilled or hot water HWP 1,2 and CHWP 1,2)

When the heating or chilled water plants are enabled the lead, variable speed pump will be enabled to operate at its lowest speed setting, (40% of maximum flow). If the lead variable speed drive pump fails to operate the lag variable speed pump will start and an alarm will be generated at the pump control panel and the BMS. Furnish a flow switch in the header of each pump with adjustable time delay. The ATC system shall rotate the lead and lag pumps for equal running time on a weekly or daily basis, (adjustable). The pump shall be arranged to start at the lowest allowable speed and shall “ramp” up to set point over a two minute period, (adjustable).

Differential pressure, shall be measured across the supply and return of each two-pipe secondary system in tow location (typical for 2 zones) using a five point manifold differential pressure sensor. The differential pressure will be measured near the ends of each piping run for each of two systems, where indicated on the floor plans. The speed of the pump will be controlled to maintain the differential pressure at (28 psi adjustable). The zone calling for the greatest demand shall reset the pump speed. If the differential pressure drops below set point, the pump speed shall increase proportionately, if differential pressure rises above set point, the pump speed shall be decreased proportionately. The minimum speed set point shall be determined such that the speed corresponds to 40% of the maximum flow at 28 psi differential. The actual set point shall be determined in the field when all water balancing has been completed. DP set point shall be determined when design flow is achieved at the lowest available pump speed. Arrange a differential bypass on both the HW and chilled water systems arranged to open and allow minimum flow through the boiler and chiller plants should the pumps slow to minimum speed and DP is still above 28psi.

3.04 VAV Air conditioning Units: AHU-1 through AHU-10

The units shall be supplied with, and operated through a unit mounted or remote DDC unitary control panel, capable of providing set-point adjustments and all programming control sequences. Controls shall include all motorized dampers and valves, damper motors, motor starters, wiring, sensors and all hardware accessories for a complete system. Furnish wall mounted room thermostats with automatic summer/winter change over, and temperature adjustments.

Units Off: The outside air intake and relief air dampers shall be closed, and the return air damper shall be full open. The automatic 2-way valve on the heating coil shall be open.

Summer Operation: Upon start up, the control circuits energized. The supply fan shall run continuously. The outside air intake, and relief air dampers shall open to minimum position the return damper shall open to the maximum position. A temperature sensor in the unit discharge duct shall be reset by a return air temperature sensor, (master-sub-

master), arranged to modulate the chilled water cooling coil capacity to maintain a constant discharge air temperature. Set the discharge temperature at 56°F to 60°F range (adjustable). The discharge air temperature set-point shall be determined through a comparison of the return air temperature and SA set-point, and shall be reset according or cooling demand. Hot water heating coil control valve shall be closed. VAV boxes shall operate in the summer mode. The packaged unitary controller shall control compressors and condenser section as required.

Winter Operation: Upon start up, the control circuits shall be energized. The supply fan shall run continuously. The outside air intake, and relief air dampers shall open to minimum position the return damper shall open to the maximum position. The heating coil valve shall be arranged to maintain a discharge temperature at 65°F to 67°F range (adjustable). VAV boxes shall operate in the winter mode.

Economizer Operation: On a call for cooling when outdoor air conditions permit, (56 deg adjustable), the unit supplied enthalpy control shall modulate the outside air intake, exhaust and return air dampers, to maintain room set-point. The discharge air temperature set-point shall be determined through a comparison of the space temperature and set-point, and reset according to cooling demand. Heating coil control valve shall be closed. Control action shall be that an increase in SA temperature will cause the outside air and exhaust air dampers to modulate towards the open position and the return air damper to modulate towards the closed position. A drop in below set point temperature will cause the reverse to take place. When the outdoor air damper reaches the full open position a further call for cooling shall cause chilled water system to operate. When ambient conditions are no longer suitable for economizer operation the unit controls shall revert to normal summer operation. The power exhaust fan shall run continuously.

Morning Warm-up Operation: Unit shall start and operate for a predetermined period as programmed into the unit controllers. During this cycle outside intake and exhaust air dampers shall remain closed, and return air damper shall be full open. The heating valve shall modulate to maintain set point. When the zone temperature(s) comes to within 2 degrees of set point the unit shall operate in occupied mode. By pass dampers around the enthalpy wheel shall be open.

Morning Cool-Down Operation: Unit shall start and operate for a predetermined period as programmed into the unit controllers. During this cycle outside intake and spill air dampers shall remain closed, and return air damper shall remain open. The cooling coil shall modulate to maintain discharge air temperature set point. When the zone temperature comes to within 2 degrees of set point the unit shall operate in occupied mode. By pass dampers around the enthalpy wheel shall be open.

Unoccupied Operation: Unit supply/return fans and heating coils and chilled water cooling shall cycle on a call for cooling or heating. During this cycle the unit shall operate with 100% re-circulated air. Unit controls shall allow complete shutdown if desired. Set point shall be 65° in the heating season and 95 in the cooling season.

Limit Controls: Provide a High/low limit control(s) in the supply fan discharge arranged to override temperature controls and prevent discharge temperature from dropping below 50°F and rising above 110°F(adjustable).

Freezestat: Provide each air handling unit with a manual reset type freezestat,(set at 35° adjustable),arranged to shut down the unit and sound an audio and visual alarm at the BAS operator station should the set point be reached. The freezestat element shall be the capillary type with lowest point temperature sensing.

Static Pressure Controls: (AHU-3,4,5,6,7,8,9,10)

Provide static pressure sensors in the supply ductwork for each ac unit located approximately two-thirds downstream of the unit. Sensors shall be arranged to vary the speed of the supply and return fans in response to supply duct static pressure. An increase in static pressure shall cause the fans to slow down a decrease shall cause the fans to speed up. The outside air dampers shall be arranged to modulate open from the minimum position as fan speed decreases. This shall be done through an air flow measuring station located in the outside air intake plenum to insure constant ventilation air rate through the range of fan speeds. Refer to the schedules for minimum outside air flow rates. For units with CO2 monitoring the outside air rate shall be reset according to the sequence given below. Refer to demand controlled ventilation. The return fan shall be interlocked to modulate speed proportionally with supply fan speed.

Fan Speed Control: AHU-1, AHU-2 and AHU-2A

Fan speed shall be arranged so that speed modulate in direct relation with space load. In the cooling mode on a rise in space temperature above set point the fan speed shall increase and the chilled water CV shall modulate toward open in sequence with fan speed. On a drop in space temperature below set point the opposite shall take place. In the heating mode on a drop in space temperature below set point the fan speed shall increase and the HW water CV shall modulate toward open in sequence with fan speed. On rise in space temperature above set point the opposite shall take place. Separate **RF-1 and RF-2A** shall be arranged to be interlocked with and arranged to modulate speed in sequence the respective AHU supply fan. Integral return fans for units **2b, 3,4,10** as well integral exhaust fans for units **5,7,8,9** shall be arranged to be interlocked with and arranged to modulate speed in sequence the respective AHU supply fans.

VAV Boxes: Furnish and install electronic controllers for pressure independent operation. Room thermostats / sensors shall be heating / cooling automatic change over type with dual maximum proportional control. Winter operation; on a drop in space temperature below set point the VAV box shall modulate towards the open position, the hot water radiant heating panel control valve and VAV box heating coil control valve shall modulate open proportionately to maintain set space point. On a rise in space temperature the opposite shall take place. Summer operation, the VAV box shall modulate open to increase airflow on a rise in space temperature above set point. On a drop in space temperature the box shall modulate toward the minimum position.

Miscellaneous: Whenever units are shutdown the outside air intake, return air and exhaust air dampers shall be closed. The power exhaust fan shall be energized by a space static pressure sensor set at +.1". The fan shall be arranged to cycle when static pressure increases above set point.

- Low temperature detection (freezestat)
- Return/exhaust fan failure

- Supply fan failure (current relay or sail switch)
- Hi discharge air temperature (temperature sensor)
- Low discharge air temperature (temperature sensor)
- Dirty filter
- Smoke detection

Purge cycle: shall be initiated manually at the unitary controller panel. During this cycle the supply fan and exhaust fan shall operate at 100% capacity. The outside air and exhaust air dampers shall be fully opened. The return air damper shall be closed.

Energy Recovery Operation:

The energy recovery section shall be operation through the unitary control panel. The energy recover exhaust fan shall be arranged to run when ever the unit is running in the occupied mode. The exhaust fan shall be constant volume constant speed. When the unit is in morning warm up, unoccupied mode dampers shall be arranged so that return air will bypass the energy recovery heat exchanger. In the economizer mode outside air and exhaust air shall by pass the energy recovery heat exchanger and the exhaust fan shall run.

Demand Controlled Ventilation: Furnish combination space temperture/CO2 sensors for each AC system where shown on plans. Furnish one CO2 sensor located outdoors on the roof near the outside air intake shaft hood. The outdoor air CO2 sensor shall be used to establish a base line for outdoor CO2 levels, approximately 400 PPM. The CO2 sensors in each space shall have a set point no greater then 400 PPM above the base line, approximately 800 PPM. Each air-handling unit's unitary control panel shall, (through proportional integral algorithms), calculate outside air intake damper positioning in response to space CO2 levels. Control action shall be that when any space CO2 level rises to within 100 PPM of set point, the outside air intake and spill dampers shall modulate toward open and the RA damper shall modulate toward closed. Upon a drop in space CO2 levels below set point, the opposite shall take place.

The outside air intake dampers normal minimum positions shall be established based on the schedules contained herein. When operating in demand controlled ventilation mode the outside air damper minimum position may be reset according to the above.

3.05 Cabinet Heaters and Unit heaters (hot water and electric): FCU-A,B,C,D and UH-A Provide a space thermostat set at 72°F adjustable for each hot water cabinet and unit heater. Upon a drop in space temperature below set-point the unit fan shall cycle on and the hot water control valve shall open (*or the electric heating element shall be energized*). On a rise in space temperature above set point the reverse shall take place. Provide a strap-on-aquastat to prevent fan and valve operation when hot water is not detected. In summer mode the control valve shall be closed. All control valves positions shall be monitored and indicated on the BMS

3.06 Finned Tube Radiation and Radiant heating panels: Provide a control valve room thermostats where indicated on plan set at 72°F for each zone of hot water fin tube radiation, and radiant heating panel. Upon a drop in space temperature below set-point the CV valve shall cycle open. On a rise in space temperature above set point the reverse shall take place. For those zones served by VAV boxes and FTR or radiant panels the controls shall be arranged to operate the VAV box CV and FTR or radiant panels CV in sequence. All control valves positions shall be monitored and indicated on the BMS

3.07 General Exhaust And Toilet Fans:

Toilet exhaust fans TX-1 through TX-10 shall run as scheduled through the BMS system during occupied periods

KFE-1 shall be manually started and stopped through a push button motor starter located in the kiln room near the kiln. The starter shall have a green running light to indicate the fan is energized.

EF-1, 5, 6 shall run as scheduled through the BMS system during occupied periods.

EF-2, 3, and 4 shall be arranged to start through a room thermostat. Upon a rise in space temperature above set point the associated OAI dampers shall open and the fan shall start. Upon a drop in space temperature below set point the opposite shall happen. EF-4 shall also be interlocked to run with refrigerant leak detection system as indicated in specification section 232350.

3.08 Fan Coil units: (FCU-1 through 6),

Each unit shall be supplied with, and operated through a unit mounted DDC unitary control panel, capable of providing set-point adjustments and all programming control sequences. Controls shall include all motorized dampers, damper motors, control valves, actuators, motor starters, wiring, sensors and all hardware accessories for a complete system. Units shall be provided with all required modules and accessories to allow open communications, and integration with other DDC Control systems. Fan speed and temperature set point shall be controlled by a space thermostat.

Units Off: The outside air intake damper, shall be closed and the return air damper shall be full open. The automatic 2-way valve on the heating coil shall be open to the coil in winter and closed summer.

Fan Operation - The supply fan shall start in high speed for approximately five seconds, then, operate continuously at its selected speed, while in the occupied mode

Winter Operation: Supply fan shall run continuously, outside air intake damper shall open and the HW water control valve shall modulate to maintain space temperature at 72°. On a drop in space temperature below set point the valve shall modulate open. On a rise in space temperature above set point the opposite shall take place.

Summer Operation: Supply fan shall run continuously, outside air intake damper shall open and the chilled water control valve shall modulate to maintain space temperature at 75°. On a rise in space temperature above set point the valve shall modulate open. On a drop in space temperature below set point the opposite shall take place

Morning Warm-up Operation: Unit shall start and operate for a predetermined period as programmed into the unit controllers. During this cycle outside intake air damper, shall remain closed, and return air damper shall remain open. The heating valve shall modulate

to maintain set point. When the zone temperature comes to within 2 degrees of the room set point the unit shall operate in occupied mode.

Unoccupied Operation: Unit supply fan and heating coils shall cycle to maintain space setpoint. During this cycle the unit shall operate with 100% re-circulated air. Unit controls shall allow complete shutdown if desired. Set point shall be 65°.

Limit Controls: Provide a High/low limit control(s) in the supply fan discharge arranged to override temperature controls and prevent discharge temperature from dropping below 50°F and rising above 110°F(adjustable).

Freezestat: Provide each unit with a manual reset type freezestat,(set at 36° adjustable), arranged to shut down the unit and sound an audio and visual alarm at the BAS operator station should the set point be reached. The freezestat element shall be the capillary type with lowest point temperature sensing.

3.09 Ductless split system: AC-A and AC-B

Shall be started and stopped through a space mounted electronic microcomputer-based room thermostat, capable of providing set-point adjustments and all programming control sequences. The BMS system shall enable and disable each unit as programmed for the operating schedule. The units shall be started and stopped manually via the space thermostat for manual over ride. Each unit's fans and compressors shall cycle to maintain room temperature set point 75° when indexed to the auto mode. All condenser, and compressor operations shall be controlled by the AC unit's built in unitary temperature controller. All units shall be

3.10 Kitchen Exhaust KX-1, and MAU-1: KX-1 shall be manually started and stopped through a push button motor starter located in the kitchen near the hood. The starter shall have a green running light to indicate the fan is energized. MAU-1 shall be energized, it's OAI dampers shall open and the fan shall start. The unit's gas fired heating coil shall be modulated to maintain a discharge air temperature set point of 68 degrees adjustable. Kx-2 shall run as schedule during occupiers hours through the DDC systems.

3.11 Dehumidifier: The dehumidifier shall be energized to run thorough a manual starter. A wall mounted humidistat shall cycle the unit's fans and compressors as required to maintain space humidity.

3.12 Chiller plant:

The cooling plant shall be manually or automatically started through the DDC system

The chiller shall be arranged to automatically start and stop through a Universal Programmable Control Module, (PCM), furnished by the chiller manufacture and installed and wired by the contractor. The PCM shall be arranged to "soft start" the chiller bringing on one compressor at a time as applicable.

Furnish the chilled water pumps with combination motor starter disconnect with hand-off-auto switch. When indexed to the hand position the pumps shall run continuously. When indexed to the auto position the pumps shall operate through the automatic control

system. The chilled water pumps shall be interlocked, and arranged to run upon activation of the chiller. The lead, variable speed pump will be enabled to operate. If the lead variable speed drive pump fails to operate the lag variable speed pump will start and an alarm will be generated at the pump control panel and the BMS. Furnish a flow switch in the header of each pump with adjustable time delay. The ATC system shall rotate the lead and lag pumps for equal running time on a weekly or daily basis, (adjustable)

Provide a flow switch in chilled water and condenser water piping connection to the chiller. Upon establishment of flow the factory control panel shall allow the chiller to run and maintain chilled water temperature through temperature sensors located in the chilled water supply and return header. On a call for cooling the PCM shall control chiller shall modulate its capacity until it is fully loaded. A decrease in chilled water demand shall cause the reverse operating sequence.

Once enabled, the BAS chiller sequencing software shall perform the following control strategies and support their specified monitoring and diagnostics.

System Scheduling - The chiller sequencing software will start the chiller system based upon an 8 day (7 + Holiday) time of day schedule. The chiller plant shall start in response to the optimum start, night setback or timed override operation of any system air handler.

Chilled Water Reset - Provide reset of the chilled water supply temperature set point based on return chilled water temperature. The reset parameters shall be user selectable.

Chiller Status Report - Provide an operating status report for each chiller. The report(s) shall provide the present status of all binary information and for analog information present value, today's average, and the month to date average for the following information to provide the operator with critical chiller operating data.

Chiller On/Off Status.

Chiller Starts/Run Hours - Compressor A, B.

Phase 1/2/3 Percent RLA - Compressor A,B.

Active Chiller Diagnostics or Alarms.

Leaving Chilled Water Temperature.

Entering Chilled Water Temperature.

Chilled Water Set point.

Entering condenser water temperature

Leaving Condenser water temperature.

Refrigerant Temperature Evaporator/Condenser - Circuit 1, 2.

Operating Mode.

Chiller Model and Serial Number.

Percent RLA/Percent Current Limit.

Outside Air Temperature.

Chilled Water Reset - Provide reset of the chilled water supply temperature set point based on return chilled water temperature or outdoor air temperature. The reset parameters shall be user selectable. The reset schedule shall be as follow:

| Chilled water reset schedule | |
|------------------------------|----------|
| OAT (F) | CHWS (F) |
| 44 | 92 |
| 45 | 90 |
| 46 | 88 |
| 47 | 86 |
| 48 | 84 |
| 49 | 82 |
| 50 | 80 |
| 51 | 78 |
| 52 | 76 |
| 53 | 74 |
| 54 | 72 |
| 55 | 70 |
| 56 | 68 |

3.13 Cooling Tower:

The cooling tower shall be enabled to run when ever the plant is indexed to the cooling mode either manually or automatically. The primary condensers water pump shall run continuously. Furnish a flow switch with time delay in the pump header to determine flow. If flow is not proved then the running pump shall be stopped, stand by pump shall automatically be started. Condenser water temperature shall be maintained by automatically varying the cooling tower fan speed. A vibration detection switch shall be arranged to generate an alarm at the BMS when vibration is sensed above set point.

Alarms;
High condenser water temp
Low condenser water temp
Tower Vibration
Condenser water pump failure
Cooling tower fan failure

3.14 Duct mounted heating coils

Duct mounted heating coils shall be arranged modulate in response to space thermostats. Upon a drop in space temperature below set-point the CV on the hot water control valve shall open . On a rise in space temperature above set point the reverse shall take place.

3.15 Miscellaneous

Motor starters shall be supplied for each Air Handler, H & V Unit, Fan, pump, etc. When starters are located at the unit,(factory or field installed), or within line of site of the unit combination Starters/disconnects shall be used. All starters shall be equipped with H-O-A switches and pilot lights in cover. For units with remote mounted starters,(i.e. roof-top exhaust fans)furnish disconnects at the unit.

All safety devices shall be interlocked with “hand” and “Automatic” positions in series with motor controller holding coil circuit. Interlocking with other fans and equipment of system shall be through “Automatic” position “Hand” position shall be for maintenance only. Remote starting shall be from through “automatic” position only.

All air handling units 2,000 cfm or greater shall have a duct mounted smoke detector arranged to stop the unit and position all dampers and valves in the “unit off” sequence as described in this section, upon detecting smoke.

All air handling units, unit ventilators, cabinet unit heaters, unit heaters, fans, and fan coil units, shall be interlocked to the building fire alarm system. Upon building fire alarm all units shall shut down and damper and valves shall go to “unit off” positions.

END OF SECTION