ADDENDUM NO.: 3 **DATE OF ADDENDUM: July 23, 2015**

Manufacturing Center Addition – Quinebaug Valley Community College
742 Upper Maple Street, Danielson, CT 06239
BI – CTC – 471

Original Bid Due Date / Time: **July 29, 2015** **1:00 PM**

Previous Addenda: Addendum No. 1: July 1, 2015; Addendum No. 2: July 8, 2015

TO: **Prospective Bid Proposers:**
This Addendum forms part of the "Contract Documents" and modifies or clarifies the original "Contract Documents" for this Project dated June 5, 2015. Prospective Bid Proposers shall acknowledge receipt of the total number the Addenda issued for this Project on the space provided on Section 00 41 00 Bid Proposal Form. Failure to do may subject Bid Proposers to disqualification.

The following clarifications are applicable to drawings and specifications for the project referenced above.

Item 1
See Attached RFI's and associated answers and clarifications.

Item 2
In Section 102800, Paragraph 2.2/C/1 revise Bobrick, No. B-2888 to the following: B-2111.

Item 3
In Section 084413, Paragraph 2.12/E revise Single Blade System to the following:
Versoleil SunShade Outrigger System for Curtain Wall, pending verification that product is an FM Global approved product.

Item 4
In Section 088000, Paragraph 2.12/E (GL-13) revise to read as follows: Low-E coated, insulating, tempered glass.

Item 5
In Section 088000, Paragraph 2.12/F (GL-14) revise to read as follows: Low-E coated, insulating, tempered spandrel glass.

Item 6
Specification Section 033000 / 2.7 / A - Cast-in-Place Concrete: Add Viper VaporCheck II 15-Mil "Class A" to list of Manufacturers and Products, pending verification that product is an FM Global approved product.

Item 7
Specification Section 074213.23 / 2.2 / B / 4 - Metal Composite Material Wall Panels: Add Alucoil North America, LLC Metal Composite Material Wall Panels 4mm FR Core to list of Manufacturers and acceptable products, pending verification that product is an FM Global approved product.

Item 8
Changes to Drawing M301:

Ground Source Heat Pump Schedule
GSHP-1: Change the Outside Air CFM at Maximum Occupancy to 1,675 cfm
GSHP-2: Change the Outside Air CFM at Maximum Occupancy to 1,000 cfm

GSHP-2 Single Duct Air Terminal Unit Schedule
VAV 2-1: Change the Minimum CFM at deadband to 425 CFM
VAV 2-2: Change the Minimum CFM at deadband to 230 CFM

ADDENDUM NO.: 3 **DATE OF ADDENDUM: July 23, 2015**

Item 9
DELETE Drawing A130 in its entirety.
ADD revised Drawing A130, attached as part of this Addendum.

Item 10
Specification Section 072100 / 2.3 / C/1/d – Thermal Insulation**:** Add Johns Manville Fiberglass Insulation to list of Manufacturers, pending verification that product is an FM Global approved product.

Item 11
Changes to Drawing E301:

Add the following Notes: Install an energy sub-meter to monitor KWh and demand (KW) at panels 'NPP-1' (E20-480800-J-D-KIT) & 'NRP-4' (E20-208200-J-D-KIT) manufactured by 'E-Mon D-Mon' or approved equal. Both meters shall also be wired to the BMS system.

Item 12
DELETE Drawing A720 in its entirety.
ADD revised Drawing A720, attached as part of this Addendum.

Item 13
DELETE Specification Section 262923 "Variable Frequency Motor Controllers" in its entirety.

Item 14
In Section 220500/1.5/ add the following:

"D. All products coming in contact with potable water systems shall be NSF 372 Lead-Free ANSI 3rd Party Certified, except for products specifically exempted from such certification by NSF 372. Where such NSF 372 Lead-Free requirement is in conflict with any specification in the contract documents for product(s) coming in contact with potable water, NSF 372 compliance shall take precedence, and the cost for NSF 372 compliant product(s) shall be carried in the Base Bid."

Item 15
In Section 220719/3.10/C replace "2006" with "2009" in all occurrences.

Item 16
DELETE Drawing P101 in its entirety.
ADD revised Drawing P101, attached as part of this Addendum.

Item 17
DELETE Drawing FP101 in its entirety.
ADD revised Drawing FP101, attached as part of this Addendum.

Item 18
DELETE Specification Section 220519 "Meters and Gages for Plumbing Piping" in its entirety.
ADD revised Specification Section 220519 "Meters and Gages for Plumbing Piping", attached as part of this Addendum.

Item 19
DELETE Specification Section 230900 "Instrumentation and Control" in its entirety.
ADD revised Specification Section 230900 "Instrumentation and Control", attached as part of this Addendum.

Item 20
DELETE Specification Section 230933 "Sequence of Operations" in its entirety.
ADD revised Specification Section 230933 "Sequence of Operations", attached as part of this Addendum.

ADDENDUM NO.: 3 **DATE OF ADDENDUM: July 23, 2015**

All questions must be in writing (not phone) and must be forwarded to the consulting Architect/Engineer (Silver/Petrucelli + Associates, e-mail: rabrahams@silverpetrucelli.com) with copies sent to the DCS Project Manager (Robert Dexter, e-mail: Robert.Dexter@ct.gov) and Construction Manager (Ed Barrett, e-mail: ebarrett@morganti.com)

End of Addendum No. 3

Mellanee Walton, Associate Fiscal Administrative Officer
Department of Administrative Services
On Behalf of the Division of Construction Services

ADDENDUM NO.: 3 **DATE OF ADDENDUM: July 21, 2015**

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End of Addendum No. 3

Mellanee Walton, Associate Fiscal Administrative Officer
Department of Administrative Services
On Behalf of the Division of Construction Services

ADDED SPECIFICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Liquid-in-glass thermometers.
   2. Thermowells.
   3. Dial-type pressure gages.
   4. Gage attachments.
   5. Domestic water meters.

B. Related Sections:
   1. Section 211313 "Wet-Pipe Sprinkler Systems" for fire protection pressure gages.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage, from manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:

   1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

      a. Trerice, H. O. Co.
      b. Dresser Industries, Inc.; Instrument Div.; Weksler Instruments Operating Unit

c. Palmer Instruments, Inc.

2. Standard: ASME B40.200.
3. Case: Cast aluminum; 6-inch nominal size.
4. Case Form: Back angle or straight for best readability where mounted.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass.
8. Stem: Aluminum or brass and of length to suit installation.

   a. Design for Thermowell Installation: Bare stem.

9. Connector: ¾ inch, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus one percent (+/- 1%) of scale range or one (1) scale division, to a maximum of one and one half percent (1.5%) of scale range.

2.2 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing**:** CNR.
4. Type: Stepped shank unless straight or tapered shank is indicated.
5. External Threads: NPS 1/2, NPS 3/4, or NPS 1, (DN 15, DN 20, or NPS 25,) ASME B1.20.1 pipe threads.
6. Internal Threads: ½, ¾, and 1 inch, with ASME B1.1 screw threads.
7. Bore: Diameter required to match thermometer bulb or stem.
8. Insertion Length: Length required to match thermometer bulb or stem.
9. Lagging Extension: Include on thermowells for insulated piping and tubing.
10. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.3 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

   a. AMETEK, Inc.; U.S. Gauge
   b. Ashcroft Inc.
   c. Palmer Wahl Instrumentation Group
   d. Trerice, H. O. Co.
   e. Weiss Instruments, Inc.

2. Standard: ASME B40.100.

3. Case: Cast aluminum or drawn steel, 4½-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube type, unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 (DN 8) ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Stainless steel.
11. Accuracy: Grade A, plus or minus one percent (+/- 1%) of middle half of scale range.

2.4 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass ball, with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads.

2.5 DOMESTIC WATER METERS

A. In-line-Mounted, Building Automation System (BAS) BacNet tie-in capable, Magnetic Drive - Type Water Meter:

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

    a. Badger Meter, Inc.
    b. Sensus Meters
    c. Neptune Technology Group
    d. Zenner Performance

2. Standard: AWWA C708

3. Minimum Temperature Range: 30 degF to 122 degF.

4. Visible Display Units: Gallons.

5. Materials, General: Comply with NSF 372.

6. Provide all couplings and or flange kits necessary to coordinate with piping systems.
7. Provide Digital Switch Output Mode; maximum current 20 mA; active signal on for 5-ms.
8. Meter size: For each meter, match pipe size at installation location indicated on drawings.
9. Basis of Design: Zenner Performance MultiJet

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

G. Install valve and snubber in piping for each pressure gage for fluids.

H. Install test plugs in piping tees.

I. Install thermometers in the following locations:

1. Outlet of each thermostatic mixing valve, if not furnished as part of the mixing valve package.

J. Install pressure gages in the following locations:

1. Inlet and outlet of each pressure-reducing valve.

2. Where indicated on the drawings in the general service compressed air system.

K. Install domestic water meters in the following locations:

1. On each domestic water pipe entering/leaving Manufacturing Lab addition from/to existing building.
    a. Locate immediately after entering (hot water and cold water) and immediately before leaving (hot water recirculating) Manufacturing Lab.

3.2 CONNECTIONS

A. Install meters and gages indicated to be adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

B. Provide shutoff and union upstream and downstream of each water meter.

C. Prior to ordering water meters, confirm with Automatic Controls Contractor required meter signal output required to interface with the BAS, and provide same.

3.3 ADJUSTING

A. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

A. Thermometers at outlet of each thermostatic mixing valve shall be the following:

1. Liquid-in-glass type.

B. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 150 deg F.

B. Scale Range for Domestic Hot-Water Piping: 0 to 250 deg F.

3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be the following:

1. Bourdon tube type, dry, direct mounted.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Water Piping: 0 to 200 psi.

B. Scale Range for Compressed Air: 0 to 300 psi.

END OF SECTION 220519

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 RELATED SECTIONS

A. This Section includes the Building Automation System (BAS) for HVAC systems and components, including open protocol control components for terminal heating and cooling units. Depending on the scope of the project, the complete specification may have numerous sections that interface to this section, including several from Division 25.

1.3 STANDARD TERMS

A. Standard
1. ASHRAE: American Society Heating, Refrigeration, Air Conditioning Engineers
2. BACnet: Building Automation Controls Network
3. BAS: Building Automation System
4. CUH: Cabinet Unite Heater
5. DDC: Direct Digital Control
6. EIA: Electronic Industries Alliance
7. GUI: Graphical User Interface
8. GSHP: Ground Source Heat Pump Unit
9. HVAC: Heating, Ventilation, and Air Conditioning
10. IEEE: Institute Electrical Electronic Engineers
11. MER: Mechanical Equipment Room
12. PID: Proportional, Integral, Derivative
13. UH : Unit Heater
14. VAV: Variable Air Volume Box

B. Communications and protocols
1. ARP: Address Resolution Protocol
2. CORBA: Common Object Request Broker Architecture
3. CSMA/CD: Carrier Sense Multiple Access/Collision Detect
4. DDE: Dynamic Data Exchange
5. FTT: Free Topology Transceivers
6. HTTP: Hyper Text Transfer Protocol
7. IIOP: Internet Inter-ORB Protocol
8. LAN: Local Area Network
9. LON: Echelon Communication – Local Operating Network
10. MS/TP: Master Slave Token Passing
11. ODBC: Open Database Connectivity

12. ORB: Object Request Broker
13. SNVT: Standard Network Variables Types
14. SQL: Structured Query Language
15. UDP: User Datagram Protocol
16. XML: eXtensible Markup Language

C. Controllers
1. ASD: Application Specific Device
2. AAC: Advanced Application Controller
3. ASC: Application Specific Controller.
4. CAC: Custom Application Controller.
5. DCU: Distributed Control Unit
6. LCM: Local Control Module
7. MC: MicroControllers
8. MCI: MicroInterface
9. MN-II: Microzone II direct digital controller
10. MN-FLO: Micronet 2000 Pressure Independent VAV Controller
11. NSC: Network Server Controller
12. PEM: Package Equipment Module
13. PPC: Programmable Process Controller
14. SDCU: Standalone Digital Control Units
15. SLC: Supervisory Logic Controller
16. UEC: Unitary Equipment Controller
17. VAVDDC: Variable Air Volume Direct Digital Controller

D. Tools and Software
1. AMBCx: Automated Monitoring Based Commissioning
2. APEO: Automated Predictive Energy Optimization
3. DR: Demand Response
4. CCDT: Configuration, Commissioning and Diagnostic Tool
5. BPES: BACnet Portable Engineering Station
6. LPES: LON Portable Engineering Station
7. POT: Portable Operator’s Terminal

1.4 QUALIFICATIONS OF BIDDER AND PRE-BID SUBMITTAL

A. All bidders must be building automation contractors in the business of installing direct digital control building automation systems for a minimum of 3 years.

B. The Building Automation System contractor shall have a full service facility within 100 miles of the project that is staffed with engineers trained and certified by the manufacturer in the configuration, programming and service of the automation system. The contractor’s technicians shall be fully capable of providing instructions and routine emergency maintenance service on all system components.
1. Any installing contractor, not listed as prequalified in the Approved Manufacturer's section, shall submit credentials as detailed in the Pre-bid Submittal section for the engineer’s review 2 weeks prior to bid date. Failure to follow the attached formats shall disqualify potential alternate bidders. Credentials must attest that the contractor meets all

requirements of the specification and the Engineers judgment regarding approval to bid as an acceptable installer after reviewing the data will be final.

C. All bidders must be authorized distributors or branch offices of the manufacturers specified.

D. The following bidders have been pre-qualified:
1. Schneider Electric
2. Or as approved by Owners.

E. Any installing contractors or manufacturers interested in participating as acceptable bidders for this project that are not pre-qualified shall furnish a detailed technical pre-bid submittal to the consulting engineer. All information must be submitted 2 weeks prior to the published bid date to allow the engineer adequate time to review the bidder's credentials.

F. The Pre-Bid submittal shall contain the following information as a minimum:
1. A profile of the manufacturer and the local installation and service/organization.
2. Description of how the system meets and achieves all the specified criteria in terms of configuration, operation, and control.
3. System Architecture with single line riser diagram showing all major components (digital controllers, routers, hubs, etc.) that will be required for this project.
4. Procedure for commissioning and time required to startup and commission each of the systems for this project.
5. Contractors approach for the project planning and management.
6. Product Data Sheets for all components, DDC panels, and all accessories listed per the appropriate specification sections herein.
7. Examples of actual graphic screens for other similar projects.
8. Number and types of DDC panels required for this installation.
9. Number and types of spare points provided with the proposed system.
10. Recommended spare parts list for components with list price schedule.
11. List of 2 similar systems in size, point capacity, total installed value, installed and commissioned by the local office with a list of the installers/manufacturers design team members for each project and the owners contact information.
12. Samples of service offerings and a list of current similar service contracts with contact information.
13. Resumes for the management team and all employees who will be involved with the project design, commissioning, project management, and after installation service. Resumes should include copies of manufacturer's certifications for the proposed product line.
14. Copy of this Control Specification in its entirety with a check mark beside each paragraph to signify that the manufacturer's equipment and software shall fully conform to the specified requirement. If the requirement cannot be met, indicate the reasons/limitations and the alternative proposed.
15. An interview may be conducted and the bidder will be requested to make a formal presentation concerning the proposed system and possibly provide an installed project tour prior to a final decision.

1.5 SCOPE OF WORK

A. The Contractor shall furnish and install a complete building automation system including all necessary hardware and all operating and applications software necessary to perform the control sequences of operation as called for in this specification. All components of the system – workstations, servers, application controllers, unitary controllers, etc. shall communicate using the BACnet protocol, as defined by ASHRAE Standard 135-2007. No gateways shall be used for communication to controllers furnished under this section. At a minimum, provide controls for the following:
   1. Ground Source Heat Pump Units
   2. Exhaust fans
   3. Geothermal system including pumps
   4. IT room air conditioning units
   5. Variable volume box control.
   6. Cabinet unit heater and unit heater controls
   7. Ventilation system.
   8. Power wiring to DDC devices, smoke control dampers and BAS panels except as otherwise specified.

B. Except as otherwise noted, the control system shall consist of all necessary Ethernet Network Controllers, Standalone Digital Control Units, workstations, software, sensors, transducers, relays, valves, dampers, damper operators, control panels, outside airflow monitoring station, 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. Except as otherwise specified, provide operators for equipment such as dampers if the equipment manufacturer does not provide these. Coordinate requirements with the various Contractors.

C. The BMS contractor shall review and study all HVAC drawings and the entire specification to familiarize themselves with the equipment and system operation and to verify the quantities and types of dampers, operators, alarms, etc. to be provided.

D. All interlocking wiring, wiring and installation of control devices associated with the equipment listed below shall be provided under this Contract. When the BMS is fully installed and operational, the BMS Contractor and representatives of the Owner will review and check out the system – see System Acceptance and Testing section of this document. 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.

E. Provide services and manpower necessary for commissioning of the system in coordination with the HVAC Contractor, Balancing Contractor and Owner's representative.

F. All work performed under this section of the specifications will comply with all governing codes, laws and governing bodies. If the drawings and/or specifications are in conflict with governing codes, the Contractor, with guidance from the engineer, 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.

1.6 SYSTEM DESCRIPTION

A. In accordance to the scope of work, the system shall also provide a graphical, web-based, operator interface that allows for instant access to any system through a standard browser. 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.

For this project, the system shall consist of the following components:

1. Administration and Programming Workstation(s): The BAS Contractor shall furnish (qty) Administration and Programming Workstation Computers 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 server 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. Web-Based Operator Workstations: The BAS Contractor shall furnish licenses for web connection to the BAS system. Web-based 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. All engineering work, such as trends, reports, graphics, etc. that are accomplished from the WorkStation shall be available for viewing through the web browser interface without additional changes. The web-based interface must conform to the B-OWS BACnet device profile. There will be no need for any additional computer based hardware to support the web-based user interface.
3. Ethernet-based Network Router and/or Network Server Controller(s): The BAS Contractor shall furnish Ethernet-based Network Server Controllers as described in Part 2 of the specification. These controllers will connect directly to the Operator Workstation over Ethernet at a minimum of 100mbps, and provide communication to the Standalone Digital Control Units and/or other Input/Output Modules. Network Server 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 Network Server 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 BACnet protocol SDCU shall conform to the BACnet device profile B-AAC.
   BACnet SDCUs shall be tested and certified by the BACnet Testing Laboratory (BTL) as Advanced Application Controllers (B-AAC).

B. The Local Area Network (LAN) shall be either a 10 or 100 Mpbs Ethernet network supporting BACnet, Modbus, Java, XML, HTTP, and CORBA IIOP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Server Controllers (NSCs), user workstations and a local host computer system.

C. The Enterprise Ethernet (IEEE 802.3) LAN shall utilize Carrier Sense Multiple/Access/Collision Detect (CSMA/CD), Address Resolution Protocol (ARP) and User Datagram Protocol (UDP) operating at 10 or 100 Mbps.

D. The system shall enable an open architecture that utilizes ANSI / ASHRAE™ Standard 135-2007, BACnet functionality to assure interoperability between all system components. Native support for the ANSI / ASHRAE™ Standard 135-2007, BACnet protocol are required to assure that the project is fully supported by the HVAC open protocols to reduce future building maintenance, upgrade, and expansion costs.

E. The system shall enable an architecture that utilizes a MS/TP selectable 9.6-76.8 KBaud protocol, as the common communication protocol between all controllers and integral ANSI / ASHRAE™ Standard 135-2008, BACnet functionality to assure interoperability between all system components. The AAC shall be capable of communicating as a MS/TP device or as a BACnet IP device communicating at 10/100 Mbps on a TCP/IP trunk. The ANSI / ASHRAE™ Standard 135-2008, BACnet protocol is required to assure that the project is fully supported by the leading HVAC open protocol to reduce future building maintenance, upgrade, and expansion costs.

F. The software tools required for network management of the ANSI / ASHRAE™ Standard 135-2008, BACnet protocol must be provided with the system. Drawings are diagrammatic only. Equipment and labor not specifically referred to herein or on the plans and are required to meet the functional intent, shall be provided without additional cost to the Owner. Minimum BACnet compliance is Level 4; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet IP or MS/TP.

G. The system shall support Modbus TCP and RTU protocols natively, and not require the use of gateways.

H. Complete temperature control system to be DDC with electronic sensors and electronic/electric actuation of Mechanical Equipment Room (MER) valves and dampers and electronic actuation of terminal equipment valves and actuators as specified herein. The BMS is intended to seamlessly connect devices throughout the building regardless of subsystem type, i.e. variable frequency drives, low voltage lighting systems, electrical circuit breakers, power metering and card access should easily coexist on the same network channel.
   1. The supplied system must incorporate the ability to access all data using Java enabled browsers without requiring proprietary operator interface and configuration programs.
   2. Data shall reside on a supplier-installed server for all database access.
   3. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer’s internal Intranet network.

I. All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the regular employment of the approved manufacturer's local field office. The approved manufacturer's local field office shall have a minimum of 3 years of installation experience with the manufacturer and shall provide documentation in the bid and submittal package verifying longevity of the installing company's relationship with the manufacturer when requested. Supervision, hardware and software engineering, calibration and checkout of the system shall be by the employees of the approved

manufacturer's local field office and shall not be subcontracted. The control contractor shall have an in place support facility within 100 miles of the site with factory certified technicians and engineers, spare parts inventory and all necessary test and diagnostic equipment for the installed system, and the control contractor shall have 24 hours/day, 7 days/week emergency service available.

J. Provide the Commissioning, configuration and diagnostic tool (CCDT), color display personnel computer, software, and interfaces to provide uploading/downloading of High Point Count Controllers (AAC), Unitary Equipment Controllers (UEC) and VAV controllers (VAVDDC) monitoring all BACnet objects, monitoring overrides of all controller physical input/output points, and editing of controller resident time schedules.

K. Provide a Portable Operator's Terminal (POT) color display personnel computer, software, and interfaces to provide uploading/downloading of Custom Application Controller and Application Specific Controllers databases, monitoring and overrides of all controller physical input/output points, and editing of controller resident time schedules. POT connectivity shall be via digital wall sensor connected to controller.

L. Deployed system must be configured to comply with United States DIACAP (Department of Defense Information Assurance Certification and Accreditation Process) so that no category 1 vulnerabilities are detected during the DIACAP process.

M. The system shall have the capability to provide a web-based AMBCx (automated monitoring based commissioning) system. The AMBCx system shall be able to interface directly with the project BAS and energy/performance metering system to provide information on HVAC systems that are being controlled. Pricing is to be a separate line item from the BAS proposal.

N. The system shall have the capability to provide a web-based APEO (automated predictive energy optimization) system and enable effective participation in local utility Demand Response (DR) programs. The vendor shall provide software and ongoing services that will identify actionable energy saving and peak reduction opportunities to assist the facility in achieving its energy and sustainability objectives, and automatically and continuously operate the systems necessary to achieve the targeted savings and reductions. Pricing is to be a separate line item from the BAS proposal.

1.7 WORK BY OTHERS

A. The BAS Contractor shall coordinate 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 others' work.

B. The BAS Contractor shall furnish all control valves, sensor wells, flow meters and other similar equipment for installation by the Mechanical Contractor.

C. The BAS Contractor shall provide field supervision to the designated contractor for the installation of the following:
   1. Automatic control dampers
   2. Blank-off plates for dampers that are smaller than duct size.

3. Sheet metal baffles plates to eliminate stratification.
4. The Electrical Contractor shall provide:
   a. All power wiring to motors, heat trace, junction boxes for power to BAS panels.
   b. Furnish smoke detectors and wire to the building fire alarm system. HVAC Contractor to mount devices. BAS Contractor to hardwire to fan shut down.
   c. Auxiliary contact (pulse initiator) on the electric meter for central monitoring of kWh and KW. Electrical Contractor shall provide the pulse rate for remote readout to the BAS. BAS contractor to coordinate this with the electrical contractor.

1.8 CODE COMPLIANCE

A. Provide BAS components and ancillary equipment, which are UL-916 listed and labeled.

B. 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.

C. All wiring shall conform to the National Electrical Code.

D. All smoke dampers shall be rated in accordance with UL 555S.

E. Comply with FCC rules, Part 15 regarding Class A radiation for computing devices and low power communication equipment operating in commercial environments.

F. Comply with FCC, Part 68 rules for telephone modems and data sets.

1.9 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 B 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. Typicals will be allowed where appropriate.

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. Information shall be bound or in a three ring binder with an index and tabs. Diagrams shall be on 11” by 17” foldouts. If color has been used to differentiate information, the printed copies shall be in color.

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. The following is a list of post construction submittals that shall be updated to reflect any changes during construction and re-submitted as "As-Built".
1. System architecture drawing.
2. Layout drawing for each control panel
3. Wiring diagram for individual components
4. System flow diagram for each controlled system
5. Instrumentation list for each controlled system
6. Sequence of control
7. Binding map
8. Operation and Maintenance Manuals
9. System Screenshots indicating all preset setpoints.

H. Information common to the entire system shall be provided. This shall include but not be limited to the following.
1. Product manuals for the key software tasks.
2. Operating the system.
3. Administrating the system.
4. Engineering the operator workstation.
5. Application programming.
6. Engineering the network.
7. Setting up the web server.
8. Report creation.
9. Graphics creation.
10. All other engineering tasks.
11. System Architecture Diagram.
12. List of recommended maintenance tasks associated with the system servers, operator workstations, data servers, web servers and web clients.
13. Define the task.
14. Recommend a frequency for the task.
15. Reference the product manual that includes instructions on executing the task.
16. Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
17. Licenses, guarantees, and warranty documents for equipment and systems.
18. Submit one copy for each building, plus two extra copies.

I. Information common to the systems in a single building shall be provided.
1. System architecture diagram for components within the building annotated with specific location information.
2. As-built drawing for each control panel.
3. As-built wiring design diagram for all components.

4. Installation design details for each I/O device.
5. As-built system flow diagram for each system.
6. Sequence of control for each system.
7. Binding map for the building.
8. Product data sheet for each component.
9. Installation data sheet for each component.
10. Submit two copies for each building and two extra copies.

J. Software shall be provided:
1. Submit a copy of all software installed on the servers and workstations.
2. Submit all licensing information for all software installed on the servers and workstations.
3. Submit a copy of all software used to execute the project even if the software was not installed on the servers and workstations.
4. Submit all licensing information for all of the software used to execute the project.
5. All software revisions shall be as installed at the time of the system acceptance.
6. Firmware Files
7. Submit a copy of all firmware files that were downloaded to or pre-installed on any devices installed as part of this project.
8. This does not apply to firmware that is permanently burned on a chip at the factory and can only be replaced by replacing the chip.
9. Submit a copy of all application files that were created during the execution of the project.
10. Submit a copy of all graphic page files created during the execution of the project.

1.10 COORDINATION

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

B. Coordinate equipment from other divisions including "Intrusion Detection," "Lighting Controls," "Motor Control Centers," "Panel boards," and "Fire Alarm" to achieve compatibility with equipment that interfaces with those systems.

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

D. Coordinate location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete".

E. Coordinate with the Owner's IT department on locations for UNC's, Ethernet communication cabling and TCP/IP addresses.

1.11 OWNERSHIP

A. The Owner shall retain licenses to software for this project.

B. The Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition off this contractor. Such license shall grant use of all programs and application software to the Owner as defined by the manufacturer's license agreement, but shall protect the manufacturer's rights to disclosure of Trade Secrets contained within such software.

C. The licensing agreement shall not preclude the use of the software by individuals under contract to the owner for commissioning, servicing or altering the system in the future. Use of the software by individuals under contract to the owner shall be restricted to use on the owner's computers and only for the purpose of commissioning, servicing, or altering the installed system.

D. All project developed software, files and documentation shall become the property of the Owner. These include but are not limited to:
1. Server and workstation software
2. Application programming tools
3. Configuration tools
4. Network diagnostic tools
5. Addressing tools
6. Application files
7. Configuration files
8. Graphic files
9. Report files
10. Graphic symbol libraries
11. All documentation

1.12 QUALITY ASSURANCE - SYSTEM STARTUP 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. Successful completion of the system test shall constitute the beginning of the warranty period. 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 geothermal 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 a technician for five (5) days 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 coordinate all requirements to provide a complete air balance with the Balancing Contractor and shall include all labor and materials in his contract.

D. Startup Testing shall be performed for each task on the startup test checklist, which shall be initialed by the technician and dated upon test was completion along with any recorded data

such as voltages, offsets or tuning parameters. Any deviations from the submitted installation plan shall also be recorded.

E. Required elements of the startup testing include:
1. Measurement of voltage sources, primary and secondary
2. Verification of proper controller power wiring.
3. Verification of component inventory when compared to the submittals.
4. Verification of labeling on components and wiring.
5. Verification of connection integrity and quality (loose strands and tight connections).
6. Verification of bus topology, grounding of shields and installation of termination devices.
7. Verification of point checkout.
8. Each I/O device is landed per the submittals and functions per the sequence of control.
9. Analog sensors are properly scaled and a value is reported
10. Binary sensors have the correct normal position and the state is correctly reported.
11. Analog outputs have the correct normal position and move full stroke when so commanded.
12. Binary outputs have the correct normal state and respond appropriately to energize/de-energize commands.
13. Documentation of analog sensor calibration (measured value, reported value and calculated offset).
14. Documentation of Loop tuning (sample rate, gain and integral time constant).

F. A performance verification test shall also be completed for the operator interaction with the system. Test elements shall be written to require the verification of all operator interaction tasks including, but not limited to the following.
1. Graphics navigation.
2. Trend data collection and presentation.
3. Alarm handling, acknowledgement and routing.
4. Time schedule editing.
5. Application parameter adjustment.
6. Manual control.
7. Report execution.
8. Automatic backups.
9. Web Client access.
10. A Startup Testing Report and a Performance Verification Testing Report shall be provided upon test completion.

1.13 WARRANTY AND MAINTENANCE

A. All components, system software, and parts furnished and installed by the BMS contractor shall be guaranteed against defects in materials and workmanship for 1 year of substantial completion. Labor to repair, reprogram, or replace these components shall be furnished by the BMS contractor at no charge during normal working hours during the warranty period. Materials furnished but not installed by the BMS contractor shall be covered to the extent of the product only. Installation labor shall be the responsibility of the trade contractor performing the installation. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software disks. The

Contractor shall respond to the owner's request for warranty service within 24 standard working hours.

1.14 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:

B. On-site training shall consist of a minimum of (40) hours of hands-on instruction geared at the operation and maintenance of the systems. The curriculum shall include
1. System Overview
2. System Software and Operation
3. System access
4. Software features overview
5. Changing setpoints and other attributes
6. Scheduling
7. Editing programmed variables
8. Displaying color graphics
9. Running reports
10. Workstation maintenance
11. Viewing application programming
12. Operational sequences including start-up, shutdown, adjusting and balancing.
13. Equipment maintenance.

PART 2 - PRODUCTS

2.1 Pre-approved Manufacturers

A. Subject to compliance with requirements, provide products by one of the following pre-qualified manufacturers:
1. Electric Components
   a. Schneider-Electric Field Devices
2. Electronic Components
   a. Schneider-Electric Field Devices
3. Direct Digital Control Systems Devices:
   a. Schneider-Electric I/A BACnet, Continuum BACnet series.

2.2 System Architecture

A. General
1. The Building Automation System (BAS) shall consist of Network Server/Controllers (NSCs), a family of Standalone Digital Control Units (SDCUs), Administration and Programming Workstations (APWs), and Web-based Operator Workstations (WOWs). The BAS shall provide control, alarm detection, scheduling, reporting and information management for the entire facility, and Wide Area Network (WAN) if applicable.

2. An Enterprise Level BAS shall consist of an Enterprise Server, which enables multiple NSCs (including all graphics, alarms, schedules, trends, programming, and configuration) to be accessible from a single Workstation simultaneously for operations and engineering tasks.
3. The Enterprise Level BAS shall be able to host up to 250 servers, or NSCs, beneath it.
4. For Enterprise reporting capability and robust reporting capability outside of the trend chart and listing ability of the Workstation, a Reports Server shall be installed on a Microsoft Windows based computer. The Reports Server can be installed on the same computer as the Enterprise Server.
5. The system shall be designed with a top-level 10/100bT Ethernet network, using the BACnet/IP protocol.
6. BACnet MS/TP, BACnet IP, and WebServices shall be native to the NSCs. There shall not be a need to provide multiple NSCs to support all the network protocols, nor should there be a need to supply additional software to allow all three protocols to be natively supported. A sub-network of SDCUs using the BACnet MS/TP protocol shall connect the local, stand-alone controllers with Ethernet-level Network Server Controllers/IP Routers.

B. TCP/IP Level
1. The TCP/IP layer connects all of the buildings on a single Wide Area Network (WAN) isolated behind the campus firewall. Fixed IP addresses for connections to the campus WAN shall be used for each device that connects to the WAN.

C. Fieldbus Level with Standalone Digital Control Units (SDCUs)
1. The fieldbus layer shall be support all of the following types of SDCUs:
   a. BACnet SDCU requirements: The system shall consist of one or more BACnet MS/TP field buses managed by the Network Server Controller. Minimum speed shall be 76.8kbps. The field bus layer consists of an RS485, token passing bus that supports up to 127 Standalone Digital Control Units (SDCUs) for operation of HVAC and lighting equipment. These devices shall conform to BACnet standard 135-2007. The NSCs shall be capable of at least two BACnet MS/TP field buses for a total capability of 254 SDCUs per NSC.
   b. NETWORK 8000 SDCU requirements: The system shall consist of one or more ASD or LCM field buses managed by the Network Server Controller. The field bus layer shall consist of up to 128 ASD SDCUs or 31 LCM SDCUs for operation of HVAC, power metering, and lighting equipment.

D. BAS LAN Segmentation
1. The BAS shall be capable of being segmented, through software, into multiple local area networks (LANs) distributed over a wide area network (WAN). Workstations can manage a single LAN (or building), and/or the entire system with all portions of that LAN maintaining its own, current database.

E. Standard Network Support
1. All NSCs, Workstation(s) and Servers shall be capable of residing directly on the owner's Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the NSC's, Workstation(s), and Server(s) shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches and hubs. With

this design the owner may utilize the investment of an existing or new enterprise network or structured cabling system. This also allows the option of the maintenance of the LAN/WAN to be performed by the owner's Information Systems Department as all devices utilize standard TCP/IP components.

F. System Expansion
1. The BAS system shall be scalable and expandable at all levels of the system using the same software interface, and the same TCP/IP level and fieldbus level controllers. Systems that require replacement of either the workstation software or field controllers in order to expand the system shall not be acceptable.
2. Web-based operation shall be supported directly by the NSCs and require no additional software, other than a Java supported network browser.
3. The system shall be capable of using graphical and/or line application programming language for the Network Server Controllers.

G. Support For Open Systems Protocols
1. All Network Server Controllers must natively support the BACnet IP, BACnet MS/TP protocols.

2.3 OPERATOR WORKSTATION REQUIREMENTS

A. General
1. The operator workstation portion of the BAS shall consist of one or more full-powered configuration and programming workstations, and one or more web-based operator workstations. For this project provide a minimum of 10 concurrent operator users and/or 2 concurrent engineering users within the enterprise server.
2. The programming and configuration workstation software shall allow any user with adequate permission to create and/or modify any or all parts of the NSC and/or Enterprise Server database.
3. All configuration workstations shall be personal computers operating under the Microsoft Windows operating system. The application software shall be capable of communication to all Network Server Controllers and shall feature high-resolution color graphics, alarming, trend charting. It shall be user configurable for all data collection and data presentation functions.
4. A minimum of 1 Workstation shall be allowed on the Ethernet network. In this client/server configuration, any changes or additions made from one workstation will automatically appear on all other workstations since the changes are accomplished to the databases within the NSC. Systems with a central database will not be acceptable.

B. Administration/Programming Workstation & Enterprise Server Requirements
1. The Enterprise Server shall consist of the following:
    a. Processor
        1) Minimum: 2.0 GHz
        2) Recommended: 2.6 GHz or higher
    b. Memory
        1) Minimum: 4GB
            a) Recommended: 4GB or higher
    c. Operating systems:

1) Microsoft Windows 7 32-bit (Professional, Enterprise, or Ultimate)
2) Microsoft Windows 7 64-bit (Professional, Enterprise, or Ultimate)
3) Microsoft Windows 8.1 32-bit (Professional or Enterprise)
4) Microsoft Windows 8.1 64-bit (Professional or Enterprise)
5) Microsoft Windows Server 2008 R2 64-bit (Standard, Enterprise, Datacenter, Web, or Itanium)
6) Microsoft Windows Server 2012 R2 64-bit (Standard, Datacenter, Essentials, or Foundation)

d. 10/100MBPS Ethernet NIC
e. 250 GB hard disk
f. Required additional software:
1) Microsoft .Net 4.5
g. License agreement for all applicable software

2. The workstation shall consist of the following:
a. Processor
1) Minimum: 1.0 GHz
2) Recommended: 2.0 GHz or higher
b. Memory
1) Minimum: 2GB
2) Recommended: 4GB or higher
c. Operating systems:
1) Microsoft Windows 7 32-bit (Professional, Enterprise, or Ultimate)
2) Microsoft Windows 7 64-bit (Professional, Enterprise, or Ultimate)
3) Microsoft Windows 8.1 32-bit (Professional or Enterprise)
4) Microsoft Windows 8.1 64-bit (Professional or Enterprise)
5) Microsoft Windows Server 2008 R2 64-bit (Standard, Enterprise, Datacenter, Web, or Itanium)
6) Microsoft Windows Server 2012 R2 64-bit (Standard, Datacenter, Essentials, or Foundation)
d. Serial port, parallel port, USB port
e. 10/100MBPS Ethernet NIC
f. 20 GB hard disk
g. DVD drive
h. High resolution (minimum 1280 x 1024), 17” flat panel display
i. Optical mouse and full function keyboard
j. Audio sound card and speakers
k. Required additional software:
1) Microsoft .Net 4.5
l. License agreement for all applicable software.

C. Web-Based Operator PC Requirements
1. Any user on the network can access the system, using the following software:
a. Internet Explorer 10 or 11
b. Mozilla Firefox 26
c. Java-enabled-7.0 Update 51 or newer

D. General Administration and Programming Workstation Software

1. System architecture shall be truly client server in that the Workstation shall operate as the client while the NSCs shall operate as the servers. The client is responsible for the data presentation and validation of inputs while the server is responsible for data gathering and delivery.
2. The workstation functions shall include monitoring and programming of all DDC controllers. Monitoring consists of alarming, reporting, graphic displays, long term data storage, automatic data collection, and operator-initiated control actions such as schedule and setpoint adjustments.
3. Programming of SDCUs shall be capable of being done either off-line or on-line from any operator workstation. All information will be available in graphic or text displays stored at the NSC. Graphic displays will feature animation effects to enhance the presentation of the data, to alert operators of problems, and to facilitate location of information throughout the DDC system. All operator functions shall be selectable through a mouse.

E. User Interface:
1. The BAS workstation software shall allow the creation of a custom, browser-style interface linked to the user when logging into any workstation. Additionally, it shall be possible to create customized workspaces that can be assigned to user groups. This interface shall support the creation of "hot-spots" that the user may link to view/edit any object in the system or run any object editor or configuration tool contained in the software. Furthermore, this interface must be able to be configured to become a user's "PC Desktop" – with all the links that a user needs to run other applications. This, along with the Windows user security capabilities, will enable a system administrator to setup workstation accounts that not only limit the capabilities of the user within the BAS software, but may also limit what a user can do on the PC and/or LAN/WAN. This might be used to ensure, for example, that the user of an alarm monitoring workstation is unable to shutdown the active alarm viewer and/or unable to load software onto the PC.
2. System shall be able to automatically switch between displayed metric vs. imperial units based on the workstation/webstations localization.
3. The BMS workstation/webstations shall be capable of multiple language display, including English, Spanish, German, French, Japanese, Finish, Swedish, and traditional and simplified Chinese.
4. Servers and clients shall have the ability to be located in different time zones, which are then synchronized via the NTP server.

F. User Security
1. The software shall be designed so that each user of the software can have a unique username and password. This username/password combination shall be linked to a set of capabilities within the software, set by and editable only by, a system administrator. The sets of capabilities shall range from View only, Acknowledge alarms, Enable/disable and change values, Program, and Administer. The system shall allow the above capabilities to be applied independently to each and every class of object in the system. The system must allow a minimum of 256 users to be configured per workstation. Additionally, the software shall enable the ability to add/remove users based upon Microsoft Windows Security Domains that enable the customer IT department to assist in user access.

G. Configuration Interface

1. The workstation software shall use a familiar Windows Explorer®-style interface for an operator or programmer to view and/or edit any object (controller, point, alarm, report, schedule, etc.) in the entire system. In addition, this interface shall present a "network map" of all controllers and their associated points, programs, graphics, alarms, and reports in an easy to understand structure. All object names shall be alphanumeric and use Windows long filename conventions.
2. The configuration interface shall also include support for user defined object types. These object types shall be used as building blocks for the creation of the BAS database. They shall be created form the base object types within the system input, output, string variables, setpoints, etc., alarm algorithms, alarm notification objects, reports, graphics displays, schedules, and programs. Groups of user defined object types shall be able to be set up as a predefined aggregate of subsystems and systems. The configuration interface shall support copying/pasting and exporting/importing portions of the database for additional efficiency. The system shall also maintain a link to all "child" objects created. If a user wishes to make a change to a parent object, the software shall ask the user if he/she wants to update all of the child objects with the change.

H. Color Graphic Displays
1. The system shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems, or building schematics. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition operators shall be able to command equipment or change setpoints from a graphic through the use of the mouse.
2. Requirements of the color graphic subsystem include:
   a. At a minimum, the user shall have the ability to import .gif, .png, .bmp, .jpeg, .tif, and CAD generated picture files as background displays, and layering shall be possible.
   b. It shall be possible for the user to use JavaScript to customize the behavior of each graphic.
   c. The editor shall use Scalable Vector Graphics (SVG) technology.
   d. A built-in library of animated objects such as dampers, fans, pumps, buttons, knobs, gauges, ad graphs which can be "dropped" on a graphic through the use of a software configuration "wizard". These objects shall enable operators to interact with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels.
   e. Using the mouse, operators shall be able to adjust setpoints, start or stop equipment, modify PID loop parameters, or change schedules.
   f. Status changes or alarm conditions must be able to be highlighted by objects changing screen location, size, color, text, blinking or changing from one display to another.
   g. Ability to link graphic displays through user defined objects, alarm testing, or the result of a mathematical expression. Operators must be able to change from one graphic to another by selecting an object with a mouse - no menus will be required.
   h. It shall be possible to create and save graphical components and JavaScript code in reusable and transferrable, customized libraries.
   i. Graphics should rescale based on whatever monitor or viewing device is being used.
   j. Be able to create graphics on varying layers the can be moved and repeated.

k. Be able to create graphics within varying window panes that can be moved and/or re-referenced. For example, creating the graphical menu within a pane and referencing it on every graphics page, therefore not rebuilding thus allowing for a single spot for updates that get pushed to all the pages that reference it.

3. Additionally, the Graphics Editor portion of the Engineering Software shall provide the following capabilities:
   a. Create and save pages.
   b. Group and ungroup symbols.
   c. Modify an existing symbol.
   d. Modify an existing graphic page.
   e. Rotate and mirror a symbol.
   f. Place a symbol on a page.
   g. Place analog dynamic data in decimal format on a page.
   h. Place binary dynamic data using state descriptors on a page.
   i. Create motion through the use of animated .gif files or JavaScript.
   j. Place test mode indication on a page.
   k. Place manual mode indication on a page.
   l. Place links using a fixed symbol or flyover on a page.
   m. Links to other graphics.
   n. Links to web sites.
   o. Links to notes.
   p. Links to time schedules.
   q. Links to any .exe file on the operator work station.
   r. Links to .doc files.
   s. Assign a background color.
   t. Assign a foreground color.
   u. Place alarm indicators on a page.
   v. Change symbol/text/value color as a function of an analog variable.
   w. Change a symbol/text/value color as a function of a binary state.
   x. Change symbol/text/value as a function of a binary state.
   y. All symbols used by Schneider Electric Buildings Business in the creation of graphic pages shall be saved to a library file for use by the owner.

I. Automatic monitoring
   1. The software shall allow for the automatic collection of data and reporting from any controller or NSC. The frequency of data collection shall be user-configurable.

J. Alarm Management
   1. The software shall be capable of accepting alarms directly from NSCs or controllers, or generating alarms based on evaluation of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm (regardless of its origination) will be integrated into the overall alarm management system and will appear in all standard alarm reports, be available for operator acknowledgment, and have the option for displaying graphics, or reports.
   2. Alarm management features shall include:
      a. A minimum of 1000 alarm notification levels. Each notification level will establish a unique set of parameters for controlling alarm display, distribution, acknowledgment, keyboard annunciation, and record keeping.

b. Automatic logging in the database of the alarm message, point name, point value, source device, timestamp of alarm, username and time of acknowledgement, username and time of alarm silence (soft acknowledgement)
c. Playing an audible sound on alarm initiation or return to normal.
d. Sending an email page to anyone specifically listed on the initial occurrence of an alarm. The ability to utilize email paging of alarms shall be a standard feature of the software integrated with the operating system's mail application interface (MAPI). No special software interfaces shall be required and no email client software must be running in order for email to be distributed.
e. Individual alarms shall be able to be re-routed to a user at user-specified times and dates. For example, a critical high temp alarm can be configured to be routed to a Facilities Dept. workstation during normal working hours (7am-6pm, Mon-Fri) and to a Central Alarming workstation at all other times.
f. An active alarm viewer shall be included which can be customized for each user or user type to hide or display any alarm attributes.
g. The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of user actions for certain alarms.
h. The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of causes for certain alarms. This ensures accountability (audit trail) for the response to critical alarms.
i. The active alarm viewer can be configured such that an operator must confirm that all of the steps in a check list have been accomplished prior to acknowledging the alarm.
j. The active alarm viewer shall, if filtered, show the quantity of visible and total number of alarms that are not equal to 'normal' and the quantity of disabled and hidden alarms.
k. An operator shall have the capability to assign an alarm to another user of the system.

K. Report Generation
1. The Reports Server shall be able to process large amounts of data and produce meaningful reports to facilitate analysis and optimization of each installation.
2. Reports shall be possible to generate and view from the operator Workstation, and/or Webstation, and/or directly from a reports-only web interface.
3. A library of predefined automatically generated reports that prompt users for input prior to generation shall be available. The properties and configurations made to these reports shall be possible to save as Dashboard reports, so that the configurations are saved for future used.
4. It shall be possible to create reports standard tools, such as Microsoft Report Builder 2.0 or Visual Studio, shall be used for customized reports.
5. Additional reports or sets of reports shall be downloadable, transferrable, and importable
6. All reports shall be able to be set up to automatically run or be generated on demand.
7. Each report shall be capable of being automatically emailed to a recipient in Microsoft Word, Excel, and/or Adobe .pdf format.
8. Reports can be of any length and contain any point attributes from any controller on the network.

9. Image management functionality shall be possible to enable the system administrators to easily upload new logos or images to the system.
10. It shall be possible to run other executable programs whenever a report is initiated.
11. Report Generator activity can be tied to the alarm management system, so that any of the configured reports can be displayed in response to an alarm condition.
12. Minimum supplied reports shall include:
    a. Activities Per Server Report
    b. Activities Per User Report
    c. Alarm Amount by Category Report
    d. Alarm Amount by Type Report
    e. Alarms Per Sever Report
    f. Current Alarm Report
    g. Most Active Alarm Report
    h. System Errors Per Server Report
    i. Top Activities Report
    j. Top Alarms Report
    k. Top System Errors Report
    l. Trend Log Comparison Report
    m. User Logins Report
    n. Users and Groups Reports
13. Minimum Energy Reports shall include:
    a. Energy Monitoring Calendar Consumption Report: Shall provide an interactive report that shows the energy usage on one or multiple selected days.
    b. Energy Monitoring Consumption Breakdown Report: Shall provide a report on energy consumption broken down using sub-metering.
    c. Energy Monitoring Consumption Report: Shall show the energy consumption against a specified target value.
14. Reports Server Hardware Requirements
    a. Processor
        1) Minimum: 2.0 GHz
        2) Recommended: 2.0 GHz or higher
    b. Memory
        1) Minimum: 6 GB
        2) Recommended: 8GB or higher
    c. Hard Disk: 500 GB
15. Reports Server Software Requirements
    a. Operating System:
        1) Microsoft Windows Server 2008 R2 64-bit (Standard, Enterprise, Datacenter, Web, or Itanium)
        2) Microsoft Windows Server 2012 R2 64-bit (Standard, Datacenter, Essentials, Foundation)
    b. SQL Versions:
        1) Microsoft SQL Server 2008 Express with Advanced Services (64-bit)
        2) Microsoft SQL Server 2008 R2 Standard (64-bit)
        3) Microsoft SQL Server 2012 Express or Standard Edition
    c. Additional required software”
        1) Microsoft .Net 4.5

L. Scheduling

1) From the workstation or webstation, it shall be possible to configure and download schedules for any of the controllers on the network.
2) Time of day schedules shall be in a calendar style and viewable in both a graphical and tabular view.
3) Schedules shall be programmable for a minimum of one year in advance.
4) To change the schedule for a particular day, a user shall simply select the day and make the desired modifications.
5) Additionally, from the operator webstations, each schedule will appear on the screen viewable as the entire year, monthly, week and day. A simple mouse click shall allow switching between views. It shall also be possible to scroll from one month to the next and view or alter any of the schedule times.
6) Schedules will be assigned to specific controllers and stored in their local RAM memory. Any changes made at the workstation will be automatically updated to the corresponding schedule in the controller.
7) It shall be possible to assign a lead schedule such that shadow/local schedules are updated based upon changes in the Lead.
8) It shall be possible to assign a list(s) of exception event days, dates, date ranges to a schedule.
9) It shall be possible to view combined views showing the calendar and all prioritized exemptions on one screen.
10) It should accommodate a minimum of 16 priority levels.
11) Values should be able to be controlled directly from a schedule, without the need for special program logic.

M. Programmer's Environment

1. Programming in the NSC shall be either in graphical block format or line-programming format or both.
2. Programming of the NSC shall be available offline from system prior to deployment into the field. All engineering tasks shall be possible, except, of course, the viewing of live tasks or values.
3. The programmer's environment will include access to a superset of the same programming language supported in the SDCUs.
4. NSC devices will support both script programming language as well as the graphical function block programming language. For both languages, the programmer will be able to configure application software for custom program development, and write global control programs.
5. It shall be possible to save custom programs as libraries for reuse throughout the system. A wizard tool shall be available for loading programs from a library file in the program editor.
6. It shall be possible to view graphical programming live and real-time from the Workstation.
7. The system shall be capable of creating ‘binding templates’ allowing the user to bind multiple points to multiple objects all at once.
8. Key terms should appear when typing (IntelliType).
9. Applications should be able to be assigned different priorities and cycle times for a prioritized execution of different function.

10. The system shall be able to create objects that allow common objects such as power meters, VFD drives, etc. to be integrated into the system with simple import actions without the need of complicated programming or configuration setups.

N. Saving/Reloading
   1. The workstation software shall have an application to save and restore NSC and field controller memory files.
   2. For the NSC, this application shall not be limited to saving and reloading an entire controller – it must also be able to save/reload individual objects in the controller. This allows off-line debugging of control programs, for example, and then reloading of just the modified information.

O. Audit Trail
   1. The workstation software shall automatically log and timestamp every operation that a user performs at a workstation, from logging on and off a workstation to changing a point value, modifying a program, enabling/disabling an object, viewing a graphic display, running a report, modifying a schedule, etc.
   2. It shall be possible to view a history of alarms, user actions, and commands for any system object individually or at least the last 5000 records of all events for the entire system from Workstation.
   3. It shall be possible to save custom filtered views of event information that are viewable and configurable in Workstation.
   4. It shall be capable to search and view all forced values within the system.

P. Fault Tolerant Enterprise Server Operation (Top level NSC)
   1. A single component failure in the system shall not cause the entire system to fail. All system users shall be informed of any detectable component failure via an alarm event. System users shall not be logged off as a result of a system failure or switchover.

Q. Web-based Operator Software
   1. General:
      a. Day-to-day operation of the system shall be accessible through a standard web browser interface, allowing technicians and operators to view any part of the system from anywhere on the network.
      b. The system shall be able to be accessed on site via a mobile device environment with, at a minimum, access to overwrite and view system values.
   2. Graphic Displays
      a. The browser-based interface must share the same graphical displays as the Administration and Programming Workstations, presenting dynamic data on site layouts, floor plans, and equipment graphics. The browser's graphics shall support commands to change setpoints, enable/disable equipment and start/stop equipment.
      b. Through the browser interface, operators must be able to navigate through the entire system, and change the value or status of any point in any controller. Changes are effective immediately to the controller, with a record of the change stored in the system database.
   3. Alarm Management
      a. Systems requiring additional client software to be installed on a PC for viewing the webstation from that PC will not be considered.

b. Through the browser interface, a live alarm viewer identical to the alarm viewer on the Administration and Programming workstation shall be presented, if the user's password allows it. Users must be able to receive alarms, silence alarms, and acknowledge alarms through a browser. If desired, specific operator text must be able to be added to the alarm record before acknowledgement, attachments shall be viewable, and alarm checklists shall be available.

R. Groups and Schedules
1. Through the browser interface, operators must be able to view pre-defined groups of points, with their values updated automatically.
2. Through the browser interface, operators must be able to change schedules – change start and stop times, add new times to a schedule, and modify calendars.

S. User Accounts and Audit Trail
1. The same user accounts shall be used for the browser interface and for the operator workstations. Operators must not be forced to memorize multiple passwords.
2. All commands and user activity through the browser interface shall be recorded in the system's activity log, which can be later searched and retrieved by user, date, or both.

T. Web Services
1. The installed system shall be able to use web services to "consume" information within the Network Server/Controllers (NSCs) with other products and systems. Inability to perform web services within the NSCs will be unacceptable.
   a. Shall be able to "consume" data into the system via SOAP and REST web services.
   b. Shall be able to "serve" and "consume" data from other Schneider Electric systems such as:
      1) StruxureWare Data Center Expert
      2) StruxureWare Power Monitoring Expert

2.4 NETWORK SERVER CONTROLLERS (NSCS)

A. Network Router Controllers shall combine both network routing functions, control functions, and server functions into a single unit.

B. The BACnet NSC shall be classified as a "native" BACnet device, supporting the BACnet Network Server Controller (B-BC) profile. Controllers that support a lesser profile such as B-SA are not acceptable. NSCs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Network Server Controllers (B-BC).

C. The Network Server Controller shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NRS.

D. They shall also be responsible for monitoring and controlling their own HVAC equipment such as an GSHP, pumps, Cabinet unit heaters, unit heater, fans.

E. They shall also contain graphics, trends, trend charts, alarm views, and other similar presentation objects that can be served to workstations or web-based interfaces. A sufficient number of NSCs shall be supplied to fully meet the requirements of this specification and the attached point list.

F. It shall be capable of executing application control programs to provide:
1. Calendar functions
2. Scheduling
3. Trending
4. Alarm monitoring and routing
5. Time synchronization by means of an Internet site including automatic synchronization
6. Native integration of BACnet controller data and Modbus controller data

G. Hardware Specifications
1. Memory:
   a. The operating system of the controller, application programs, and all other portions of the configuration database, shall be stored in non-volatile, FLASH memory. Servers/Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory.
2. Each NRC shall provide the following on-board hardware for communication:
   a. One 10/100bT Ethernet for communication to Workstations, other NRCs and onto the Internet
   b. Two RS-485 ports for communication to BACnet MSTP bus or serial Modbus (software configurable)
   c. One Device USB port
   d. Two host USB Ports
3. The NSC shall conform to a small footprint no larger than 100W x 125H x 75D mm (3.94W x 4.92H x 2.95D in).

H. Modular Expandability:
1. The system shall employ a modular I/O design to allow expansion. Input and output capacity is to be provided through plug-in modules of various types. It shall be possible to combine I/O modules as desired to meet the I/O requirements for individual control applications.
2. One shall be able to “hot-change” (hot-swap) the I/O modules preserving the system on-line without any intervention on the software; addressing and configuration shall be automatic
3. If for any reason the backplane of the modular I/O system were to fail, I/O module addresses will be protected.

I. Hardware Override Switches:
1. All digital outputs shall, optionally, include three position manual override switches to allow selection of the ON, OFF, or AUTO output state. These switches shall be built into the unit and shall provide feedback to the controller so that the position of the override switch can be obtained through software. In addition each analog output shall be equipped with an override potentiometer to allow manual adjustment of the analog output signal over its full range, when the 3 position manual override switch is placed in the ON position.

J. Universal Input Temperatures
   1. All universal inputs directly connected to the NSC via modular expansion shall be capable of using the following thermistors for use in the system without any external converters needed.
      a. 10 kohm Type I (Continuum)
      b. 10 kohm Type II (I/NET)
      c. 10 kohm Type III (Satchwell)
      d. 10 kohm Type IV (FD)
      e. Linearized 10 kohm Type V (FD w/11k shunt)
      f. Linearized 10 kohm (Satchwell)
      g. 1.8 kohm (Xenta)
      h. 1 kohm (Balco)
      i. 20 kohm (Honeywell)
      j. 2.2 kohm (Johnson)
   2. In addition to the above, the system shall be capable of using the below RTD sensors, however it is not required that all universal inputs be compatible with them.
      a. PT100 (Siemens)
      b. PT1000 (Sauter)
      c. Ni1000 (Danfoss)

K. Local Status Indicator Lamps:
   1. The NSC shall provide as a minimum LED indication of CPU status, Ethernet LAN status, and field bus status. For each input or output, provide LED indication of the value of the point (On/Off). The LED indication shall support software configuration to set whether the illumination of the LED corresponds to On or Off or whether the color when illuminated is Red or Green.

L. Real Time Clock (RTC):
   1. Each NSC shall include a battery-backed, real time clock, accurate to 10 seconds per day. The RTC shall provide the following: time of day, day, month, year, and day of week. Each NSC will allow for its own UTC offset, depending upon the time zone. When the time zone is set, the NSC will also store the appropriate times for daylight savings time.

M. Power Supply:
   1. The 24 VDC power supply for the NSCs shall provide 30 watts of available power for the NSC and associated IO modules. The system shall support the use of more than one power supply if heavily power consuming modules are required.
   2. The power supply, NSC, and I/O modules shall connect power wise and communication wise via the separate terminal base allowing for ease of replacement and no separate or loose wiring.

N. Automatic Restart After Power Failure:
   1. Upon restoration of power after an outage, the NSC shall automatically and without human intervention update all monitored functions, resume operation based on current, synchronize time and status, and implement special start-up strategies as required.

O. Battery backup:
   1. The NSC shall include an on-board battery to back up the controller's RAM memory. The battery shall provide accumulated backup of all RAM and clock functions for at least

30 days. In the case of a power failure, the NSC shall first try to restart from the RAM memory. If that memory is corrupted or unusable, then the NSC shall restart itself from its application program stored in its FLASH memory.

P. Software Specifications
1. The operating system of the controller, application programs, and all other portions of the configuration database such as graphics, trends, alarms, views, etc., shall be stored in non-volatile, FLASH memory. There will be no restrictions placed on the type of application programs in the system. Each NSC shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.
2. Each NSC shall have an available capacity of 4 GB of memory. This shall represent 2 GB for application and historical data and 2 GB dedicated for backup storage.

Q. User Programming Language:
1. The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be either a script-based structured text or graphical function block based and fully programmable by the user. The language shall be structured to allow for the configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, and histories. Users shall be able to place comments anywhere in the body of either script or function block programs.
2. Network Server Controllers that use a “canned” program method will not be accepted.

R. Control Software:
1. The NSC shall have the ability to perform the following pre-tested control algorithms:
   a. Proportional, Integral plus Derivative Control (PID)
   b. Two Position Control
   c. Digital Filter
   d. Ratio Calculator
   e. Equipment Cycling Protection

S. Mathematical Functions:
1. Each controller shall be capable of performing basic mathematical functions (+, -, *, /), squares, square roots, exponential, logarithms, Boolean logic statements, or combinations of both. The controllers shall be capable of performing complex logical statements including operators such as >, <, =, and, or, exclusive or, etc. These must be able to be used in the same equations with the mathematical operators and nested up to five parentheses deep.

T. NSCs shall have the ability to perform any or all of the following energy management routines:
1. Time of Day Scheduling
2. Calendar Based Scheduling
3. Holiday Scheduling
4. Temporary Schedule Overrides
5. Optimal Start

6. Optimal Stop
7. Night Setback Control
8. Enthalpy Switchover (Economizer)
9. Peak Demand Limiting
10. Temperature Compensated Duty Cycling
11. CFM Tracking
12. Heating/Cooling Interlock
13. Hot/Cold Deck Reset
14. Hot Water Reset
15. Chilled Water Reset
16. Condenser Water Reset
17. Chiller Sequencing

U. History Logging:
1. Each NSC controller shall be capable of LOCALLY logging any input, output, calculated value or other system variable either over user defined time intervals ranging from 1 second to 1440 minutes or based upon a user configurable change of value. A minimum of 1000 logs, with a minimum of 100,000 records, shall be stored. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to a higher level NSC long term archiving based upon user-defined time intervals, or manual command.
2. For extended trend logging a minimum of 1500 trends shall be capable, with a minimum number of 600,000 records within.
3. Management of a power meter replacement to ensure meter log data is accurate shall be possible in the NSC.
4. Every hardware input and output point, hosted within the NSC and attached I/O modules, shall be trended automatically without the requirement for manual creation, and each of these logs shall log values based upon a change of value and store at least 500 trend samples before replacing the oldest sample with new data.
5. The presentation of logged data shall be built into the server capabilities of the NSC Presentation can be in time stamped list formats or in a chart format with fully configurable pen colors, weights, scales and time spans.

V. Alarm Management:
1. For each system point, alarms can be created based on high/low limits or in comparison to other point values. All alarms will be tested each scan of the NSC and can result in the display of one or more alarm messages or reports.
2. There is no limit to the number of alarms that can be created for any point
3. Alarms can be configured to be generated based upon a single system condition or multiple system conditions.
4. Alarms will be generated based on an evaluation of the alarm conditions and can be presented to the user in a fully configurable order, by priority, by time, by category, etc. These configurable alarm views will be presented to a user upon logging into the system regardless of whether the log in takes place at a WorkStation or a Webstation.
5. The alarm management system shall support the ability to create and select cause and action notes to be selected and associated with an alarm event. Checklists shall also be possible in order to present to an operator a suggested mode of troubleshooting. When

acknowledging an alarm, it shall be possible to assign it to a user of the system such that the user is notified of the assignment and is made responsible for the alarm resolution.

6. Alarms must be capable of being routed to any BACnet workstation that conforms to the B-OWS device profile and uses the BACnet/IP protocol.

W. Embedded Web Server

1. Each NSC must have the ability to serve out web pages containing the same information that is available from the WorkStation. The development of the screens to accomplish shall not require any additional engineering labor over that required to show them at the WorkStation itself.

2.5 BACNET FIELDBUS AND BACNET SDCUS

A. Networking

1. IP Network: All devices that connect to the WAN shall be capable of operating at 10 megabits per second or 100 megabits per second.
2. IP To Field Bus Routing Devices
   a. A Network Server Controller shall be used to provide this functionality.
   b. These devices shall be configurable locally with IP crossover cable and configurable via the IP network.
   c. The routing configuration shall be such that only data packets from the field bus devices that need to travel over the IP level of the architecture are forwarded.

B. Field Bus Wiring and Termination

1. The wiring of components shall use a bus or daisy chain concept with no tees, stubs, or free topology.
2. Each field bus shall have a termination resistor at both ends of each segment.
3. The field bus shall support the use of wireless communications.

C. Repeaters

1. Repeaters are required to connect two segments.
2. Repeaters shall be installed in an enclosure. The enclosure may be in an interstitial space.

D. Field Bus Devices

1. General Requirements
   a. Devices shall have a light indicating that they are powered.
   b. Devices shall be locally powered. Link powered devices (power is furnished from a central source over the field bus cable) are not acceptable.
   c. Application programs shall be stored in a manner such that a loss of power does not result in a loss of the application program or configuration parameter settings. (Battery backup, flash memory, etc.)

E. Network Server Controllers (NSCs)

   a. If NSCs have embedded I/O, all of the requirements for I/O that are described under Advance Application Controllers shall apply.
   b. Shall support the export of data to NSCs from other vendors that support the data sharing, read property service.

c. Shall support the export of data using Change of Value (COV) initiation to NSCs from other vendors that support the subscription to data using the COV concept.
d. Shall support the export of data to any BACnet OWS that supports the data sharing, read property service.
e. Shall support the export of data using Change of Value (COV) initiation to any BACnet OWS that supports the subscription to data using the COV concept.
f. Shall provide trend log support for all of the devices on the field bus. They shall provide sufficient memory to store up to 300 samples for each variable required to be trended by the sequence of control.
g. Shall support the exporting of trend log data to any BACnet OWS that supports the read range BACnet service for trending.
h. Shall provide time schedule support for all of the devices on the field bus.
i. Shall support the editing of time schedule entries from any BACnet OWS that supports the BACnet service for writing of time schedule parameters.
j. Shall provide alarm message initiation for all alarms conditions from any of the field bus devices.
k. Shall deliver alarm messages to any BACnet OWS that supports the BACnet service for receiving alarm messages and is configured to be a recipient of the notification.
l. Shall support alarm acknowledgement from any BACnet OWS that supports the BACnet service for executing alarm/event acknowledgement.
m. Shall support the control of the out of service property and assignment of value or state to analog and binary objects from any BACnet OWS that supports writing to the out of service property and the value property of analog and binary objects.
n. Shall support the receipt and response to Time Synchronization commands from any device that supports the BACnet service for initiating time synchronization commands.
o. Shall support the “Who is?” and “I am.” BACnet service.
p. Shall support the “”Who has?” and “I have.” BACnet service.
q. Shall support Backup and Restore commands from any BACnet OWS that supports the initiation of Backup and Restore commands.
r. Shall be BTL certified.

F. Advance Application Controllers (B-AAC)
1. The key characteristics of a B-AAC are:
a. They have physical input and output circuits for the connection of analog input devices, binary input devices, pulse input devices, analog output devices, and binary output devices. The number and type of input and output devices supported will vary by model.
b. They may or may not provide support for additional input and output devices beyond the number of circuits that are provided on the basic circuit board. Support for additional I/O shall be provided by additional circuit boards that physically connect to the basic controller.
c. The application to be executed by a B-AAC is created by an application engineer using the vendor’s application programming tool.
d. If local time schedules are embedded, the B-AAC shall support the editing of time schedule entries from any BACnet OWS that supports the BACnet service for writing of time schedule parameters.

e. If local trend logging is embedded, the B-AAC shall support the exporting of trend log data to any BACnet OWS that supports the read range BACnet service for trending.
f. If local alarm message initiation is embedded, the B-AAC shall:
   1) Deliver alarm messages to any BACnet OWS that supports the BACnet service for receiving alarm messages and is configured to be a recipient off the alarm message.
   2) Support alarm acknowledgement from any BACnet OWS that supports the BACnet service for executing alarm/event acknowledgement,
g. Shall support the reading of analog and binary data from any BACnet OWS or Building Controller that supports the BACnet service for the reading of data.
h. Shall support the control of the out of service property and assignment of value or state to analog and binary objects from any BACnet OWS that supports writing to the out of service property and the value property of analog and binary objects.
i. Shall support the receipt and response to Time Synchronization commands from a BACnet Building Controller.
j. Shall support the "Who is" and "I am." BACnet services.
k. Shall support the "Who has" and "I have." BACnet services.

2. Analog Input Circuits
   a. The resolution of the A/D chip shall not be greater than 0.01 Volts per increment. For an A/D converter that has a measurement range of 0 to 10 VDC and is 10 bit, the resolution is 10/1024 or 0.00976 Volts per increment.
   b. For non-flow sensors, the control logic shall provide support for the use of a calibration offset such that the raw measured value is added to the (+/-) offset to create a calibration value to be used by the control logic and reported to the Operator Workstation (OWS).
   c. For flow sensors, the control logic shall provide support for the use of an adjustable gain and an adjustable offset such that a two point calibration concept can be executed (both a low range value and a high range value are adjusted to match values determined by a calibration instrument).
   d. For non-linear sensors such as thermistors and flow sensors the B-AAC shall provide software support for the linearization of the input signal.
3. Binary Input Circuits
   a. Dry contact sensors shall wire to the controller with two wires.
   b. An external power supply in the sensor circuit shall not be required.
4. Pulse Input Circuits
   a. Pulse input sensors shall wire to the controller with two wires.
   b. An external power supply in the sensor circuit shall not be required.
   c. The pulse input circuit shall be able to process up to 20 pulses per second.
5. True Analog Output Circuits
   a. The logical commands shall be processed by a digital to analog (D/A) converter chip. The 0% to 100% control signal shall be scalable to the full output range which shall be either 0 to 10 VDC, 4 to 20 milliamps or 0 to 20 milliamps or to ranges within the full output range (Example: 0 to 100% creates 3 to 6 VDC where the full output range is 0 to 10 VDC).
   b. The resolution of the D/A chip shall not be greater than 0.04 Volts per increment or 0.08 milliamps per increment.
6. Binary Output Circuits

a. Single pole, single throw or single pole, double throw relays with support for up to 230 VAC and a maximum current of 2 amps.
b. Voltage sourcing or externally powered triacs with support for up to 30 VAC and 0.5 amps at 24 VAC.

7. Program Execution
   a. Process control loops shall operate in parallel and not in sequence unless specifically required to operate in sequence by the sequence of control.
   b. The sample rate for a process control loop shall be adjustable and shall support a minimum sample rate of 1 second.
   c. The sample rate for process variables shall be adjustable and shall support a minimum sample rate of 1 second.
   d. The sample rate for algorithm updates shall be adjustable and shall support a minimum sample rate of 1 second.
   e. The application shall have the ability to determine if a power cycle to the controller has occurred and the application programmer shall be able to use the indication of a power cycle to modify the sequence of controller immediately following a power cycle.
8. Local Interface
   a. The controller shall support the connection of a portable interface device such as a laptop computer or vendor unique hand-held device. The ability to execute any tasks other than viewing data shall be password protected. Via this local interface, an operator shall be able to:
      1) Adjust application parameters.
      2) Execute manual control of input and output points.
      3) View dynamic data.

G. Application Specific Devices
1. Application specific devices shall have fixed function configurable applications.
2. If the application can be altered by the vendor's application programmable tool, the device is an advanced application controller and not an application specific device.
3. Application specific devices shall be BTL certified.

2.6 DDC SENSORS AND POINT HARDWARE

A. Temperature Sensors
1. Acceptable Manufacturers: Veris Industries
2. All temperature devices shall use precision thermistors accurate to +/- 1 degree F over a range of –30 to 230 degrees F. Space temperature sensors shall be accurate to +/- .5 degrees F over a range of 40 to 100 degrees F.
3. Room Sensor: Standard space sensors shall be available in an off white enclosure made of high impact ABS plastic for mounting on a standard electrical box. Basis of Design: Veris TW Series
   a. The sensor housing shall feature both an optional sliding mechanism for adjusting the space temperature setpoint, as well as a push button for selecting after hours operation.
   b. The sensor shall incorporate an LCD display for viewing the space temperature, setpoint and other operator selectable parameters. Using built in buttons, operators shall be able to adjust setpoints directly from the sensor.

4. Duct Probe Sensor: Sensing element shall be fully encapsulated in potting material within a stainless steel probe. Useable in air handling applications where the coil or duct area is less than 14 square feet. Basis of Design: Veris TD Series
5. Duct Averaging Sensor: Averaging sensors shall be employed in ducts which are larger than 14 square feet. The averaging sensor tube shall contain at least one thermistor for every 3 feet, with a minimum tube length of 6 feet. The averaging sensor shall be constructed of rigid or flexible copper tubing. Basis of Design: Veris TA Series
6. Pipe Immersion Sensor: Immersion sensors shall be employed for measurement of temperature in all chilled and hot water applications as well as refrigerant applications. Provide sensor probe length suitable for application. Provide each sensor with a corresponding pipe-mounted sensor well, unless indicated otherwise. Sensor wells shall be stainless steel for non-corrosive fluids below 250 degrees F and 300 series stainless steel for all other applications. Basis of Design: Veris TI Series
7. Outside Air Sensor: Provide the sensing element on the building's north side. Sensing element shall be fully encapsulated in potting material within a stainless steel probe. Probe shall be encased in PVC solar radiation shield and mounted in a weatherproof enclosure. Operating range -40 to 122 F, Basis of Design: Veris TO Series
8. A pneumatic signal shall not be allowed for sensing temperature.

B. Humidity Wall Transmitter
1. Acceptable Manufacturer: Veris Industries
2. Transmitters shall be accurate to +/- 1 % at full scale.
3. Transmitter shall have replaceable sensing element.
4. Sensor type shall be thin-film capacitive.
5. Sensor element shall contain multipoint calibration on-board in nonvolatile memory
6. Operating range shall be 0 - 100% RH noncondensing, 50 to 95 F
7. Output shall be field selectable 4-20 mA or 0-5/0-10 VDC.
8. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
9. Transmitter shall be available in an off white enclosure made of high impact ABS plastic for mounting on a standard electrical box.
10. Transmitter shall have LCD display
11. Transmitter shall be available with a certification of NIST calibration
12. Transmitter shall have integrated temperature sensor
13. Basis of Design: Veris HWL Series

C. Humidity Duct Transmitter
1. Acceptable Manufacturer: Veris Industries
2. Transmitters shall be accurate to +/- 1% at full scale.
3. Transmitter shall be fully encapsulated in potting material within a stainless steel probe.
4. Transmitter shall have replaceable sensing element.
5. Sensor type shall be thin-film capacitive.
6. Sensor element shall contain multipoint calibration on-board in nonvolatile memory
7. Operating range shall be 0 - 100% RH noncondensing, -40 to 122 F
8. Output shall be 4-20 mA or 0-5/0-10 VDC.
9. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
10. Transmitter shall be available with a certification of NIST calibration
11. Transmitter shall have integrated temperature sensor
12. Basis of Design: Veris HD Series

D. Humidity Outdoor Transmitter
   1. Acceptable Manufacturer: Veris Industries
   2. Transmitters shall be accurate to +/- 2% at full scale.
   3. Transmitter shall be fully encapsulated in potting material within a stainless steel probe. Probe shall be encased in PVC solar radiation shield and mounted in a weatherproof enclosure.
   4. Transmitter shall have replaceable sensing element.
   5. Sensor type shall be thin-film capacitive.
   6. Sensor element shall contain multipoint calibration on-board in nonvolatile memory
   7. Operating range shall be 0 - 100% RH noncondensing, -40 to 122 F
   8. Output shall be 4-20 mA or 0-5/0-10 VDC.
   9. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
   10. Transmitter shall be available with a certification of NIST calibration
   11. Basis of Design: Veris HO Series

E. Carbon Dioxide Wall Transmitter:
   1. Acceptable Manufacturer: Veris Industries
   2. Sensor type shall be Non-dispersive infrared (NDIR).
   3. Accuracy shall be ±30 ppm ±2% of measured value with annual drift of ±10 ppm. Minimum five year recommended calibration interval.
   4. Repeatability shall be ±20 ppm ±1% of measured value
   5. Response Time shall be <60 seconds for 90% step change
   6. Outputs shall be field selectable Analog: 4-20mA or 0-5/0-10VDC, Protocol: BACnet with SPDT Relay 1A@30VD
   7. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
   8. Temperature Range: [32° to 122°F (CO2 only)] [50° to 95°F (with humidity option)]
   9. Output range shall be programmable 0-2000 or 0-5000 ppm
   10. Transmitter shall be available in an [off white] [black] enclosure for mounting on a standard electrical box.
   11. Transmitter shall have LCD display for commissioning and provide additional faceplate to conceal LCD display where occupants may misinterpret CO2 readings.
   12. Transmitter shall have integrated humidity sensor and temperature sensor.
   13. Basis of Design: Veris CWL

F. Carbon Dioxide Duct Transmitter:
   1. Acceptable Manufacturer: Veris Industries
   2. Sensor type shall be Non-dispersive infrared (NDIR).
   3. Accuracy shall be ±30 ppm ±2% of measured value with annual drift of ±10 ppm. Minimum five year recommended calibration interval.
   4. Repeatability shall be ±20 ppm ±1% of measured value
   5. Response Time shall be <60 seconds for 90% step change
   6. Outputs shall be field selectable Analog: 4-20mA or 0-5/0-10VDC with SPDT Relay 1A@30VDC
   7. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
   8. Temperature Range: 32° to 122°F
   9. Output range shall be programmable 0-2000 or 0-5000 ppm
   10. Enclosure shall not require remote pickup tubes and make use of integrated H-beam probe to channel air flow to sensor.

11. Enclosure lid shall require no screws and make use of snap on features for attachment
12. Enclosure shall be made of high impact ABS plastic
13. Transmitter shall have LCD display
14. Basis of Design: Veris CDL

G. Air Pressure Transmitters.
1. Acceptable Manufacturers: Veris Industries
2. Sensor shall be microprocessor profiled ceramic capacitive sensing element
3. Transmitter shall have 14 selectable ranges from 0.1 – 10" WC
4. Transmitter shall be +/- 1% accurate in each selected range including linearity, repeatability, hysteresis, stability, and temperature compensation.
5. Transmitter shall be field configurable to mount on wall or duct with static probe
6. Transmitter shall be field selectable for Unidirectional or Bidirectional
7. Maximum operating pressure shall be 200% of design pressure.
8. Output shall be field selectable 4-20 mA or 0-5/0-10 VDC linear.
9. Transmitter shall accept 12-30 VDC or 24 VAC supply power
10. Response time shall be field selectable T95 in 20 sec or T95 in 2 sec
11. Transmitter shall have an LCD display
12. Units shall be field selectable for WC or PA
13. Transmitter shall have provision for zeroing by pushbutton or digital input.
14. Transmitter shall be available with a certification of NIST calibration
15. Basis of Design: Veris model PXU.

H. Liquid Differential Pressure Transmitters:
1. Acceptable Manufacturer: Veris Industries
2. Transmitter shall be microprocessor based
3. Transmitter shall use two independent gauge pressure sensors to measure and calculate differential pressure
4. Transmitter shall have 4 switch selectable ranges
5. Transmitter shall have test mode to produce full-scale output automatically.
6. Transmitter shall have provision for zeroing by pushbutton or digital input.
7. Transmitter shall have field selectable outputs of 0-5V, 0-10V, and 4-20mA.
8. Transmitter shall have field selectable electronic surge damping
9. Transmitter shall have an electronic port swap feature
10. Transmitter shall accept 12-30 VDC or 24 VAC supply power
11. Sensor shall be 17-4 PH stainless steel where it contacts the working fluid.
12. Performance:
    a. Accuracy shall be ±1% F.S. and ±2% F.S. for lowest selectable range
    b. Long term stability shall be ±0.25%
    c. Sensor temperature operating range shall be -4° to 185°F
    d. Operating environment shall be 14° to 131°F; 10-90% RH noncondensing
    e. Proof pressure shall be 2x max. F.S. range
    f. Burst pressure shall be 5x max. F.S. range
13. Transmitter shall be encased in a NEMA 4 enclosure
14. Enclosure shall be white powder-coated aluminum
15. Transmitter shall be available with a certification of NIST calibration
16. Basis of Design: Veris PW

I. Current Sensors
   1. Current status switches shall be used to monitor fans, pumps, motors and electrical loads. Current switches shall be available in split core models, and offer either a digital or an analog signal to the automation system. Acceptable manufacturer is Veris Industries

J. Current Status Switches for Constant Load Devices
   1. Acceptable Manufacturer: Veris Industries
   2. General: Factory programmed current sensor to detect motor undercurrent situations such as belt or coupling loss on constant loads. Sensor shall store motor current as operating parameter in non-volatile memory. Push-button to clear memory.
   3. Visual LED indicator for status.
   4. Split core sensor, induced powered from monitored load and isolated to 600 VAC rms. Sensor shall indicate status from 0.5 A to 175 A.
   5. Normally open current sensor output. 0.1A at 30 VAC/DC.
   6. Basis of Design: Veris Model H608.

K. Current Status Switches for Constant Load Devices (Auto Calibration)
   1. Acceptable Manufacturer: Veris Industries.
   2. General: Microprocessor based, self-learning, self-calibrating current switch. Calibration-free status for both under and overcurrent, LCD display, and slide-switch selectable trip point limits. At initial power-up automatically learns average current on the line with no action required by the installer
   3. Split core sensor, induced powered from monitored load and isolated to 600 VAC rms. Sensor shall indicate status from 2.5 A to 200 A.
   4. Display: Backlit LCD; illuminates when monitored current exceeds 4.5A
   5. Nominal Trip Point: ±40%, ±60%, or on/off (user selectable)
   6. Normally open current sensor output. 0.1A at 30 VAC/DC.
   7. Basis of Design: Veris Model H11D.

L. Current Status Switches for Variable Frequency Drive Application
   1. Acceptable Manufacturer: Veris Industries.
   2. General: Microprocessor controlled, self-learning, self-calibrating current sensor to detect motor undercurrent and overcurrent situations such as belt loss, coupling shear, and mechanical failure on variable loads. Sensor shall store motor current as operating parameter in non-volatile memory. Push-button to clear memory and relearn.
   3. Visual LED indicator for status.
   4. Alarm Limits: ±20% of learned current in every 5 Hz freq. band
   5. Split core sensor, induced powered from monitored load and isolated to 600 VAC rms. Sensor shall indicate status from 1.5 A to 150 A and from 12 to 115 Hz.
   6. Normally open current sensor output. 0.1A at 30 VAC/DC.
   7. Basis of Design: Veris Model H614.

M. Liquid Flow, Insertion Type Turbine Flowmeter:
   1. Acceptable Manufacturer: Veris Industries
   2. General: Turbine-type insertion flow meter designed for use in pipe sizes 1 1/2” and greater. Available in hot tap configuration with isolation valves and mounting hardware to install or remove the sensor from pipeline that is difficult to shut down or drain
   3. Performance:

a. Accuracy ±1% of rate over optimum flow range; ≥10 upstream and ≥5 downstream straight pipe diameters, uninterrupted flow
b. Repeatability ±0.5%
c. Velocity Range: 0.3 to 20 FPS
d. Pressure Drop 0.5 psi or less @ 10 ft/sec for all pipe sizes 1.5" dia and up
e. Pressure Rating: 1000 psi @ 70°F

4. Maximum Temperature Rating: 300°F
5. Materials: Stainless Steel or Brass body; Stainless steel impeller
6. Transmitter:
   a. Power Supply: 12 - 30VAC or 8 - 35VDC.
   b. Output: [Frequency] [4-20 mA] [Scaled Pulse]
   c. Temperature Range: 14° to 150°F
   d. Display: 8 character 3/8" LCD (Optional)
   e. Enclosure: NEMA 4, Polypropylene with Viton® sealed acrylic cover
7. Basis of Design: Veris SDI series

N. Liquid Flow/Energy Transmitter, Non-invasive Ultrasonic (Clamp-on):
1. Acceptable Manufacturer: Veris Industries
2. General: Clamp-on digital correlation transit-time ultrasonic flow meter designed for clean liquids or liquids containing small amounts of suspended solids or aeration. Optional temperature sensors for BTU calculations.
3. Liquid: water, brine, raw sewage, ethylene, glycol, glycerin, others. Contact manufacturer for other fluid compatibility
4. Pipe Surface Temperature: Pipe dia 1/2" to 2":-40-185°F; Pipe dia > 2": -40-250°F
5. Performance:
   a. Flow Accuracy:
      1) Pipe dia 1/2" to 3/4" 1% of full scale
      2) Pipe dia 1" to 2" 1% of reading from 4-40 FPS
      3) Pipe dia 2" to 100" 1% of reading from 1-40 FPS
   b. Flow Repeatability ±0.01% of reading
   c. Velocity Range: (Bidirectional flow)
      1) Pipe dia 1/2" to 2" 2 to 40 FPS
      2) Pipe dia 2" to 100" 1 to 40 FPS
   d. Flow Sensitivity 0.001 FPS
   e. Temperature Accuracy (energy): 32-212°F; Absolute 0.45°F; Difference 0.18°F
   f. Temperature Sensitivity: 0.05°F
   g. Temperature Repeatability: ±0.05% of reading
6. Transmitter:
   a. Power Supply: 95 to 264 VAC, 47 to 63 Hz or 10 to 28 VDC.
   b. Output: [RJ45] [Modbus TCP/IP] [Ethernet/IP] [BACnet/IP] [Pulse] [4-20 mA] [RS-485 Modbus RTU}
   c. Temperature Range: -40 to +185°F
   d. Display: 2 line backlit LCD with keypad
   e. Enclosure: NEMA 4, (IP65), Powder-coated aluminum, polycarbonate
7. Agency Rating: UL 1604, EN 60079-0/15, CSA C22.2, CSA Class 1 (Pipe > 2")
8. Basis of Design: Veris FST & FSR series

O. Analog Electric/Pneumatic Transducer:

1. Acceptable Manufacturer: Veris Industries
2. General: Micro-controlled poppet valve for high accuracy and with no air loss in the system. Field configurable for pressure sensing in multiple applications.
3. Power Supply: 22-30VDC, 20-30VAC
4. Control Input: 4-20mA, 0-10V, 0-5V; jumper selectable
5. Performance:
    a. Accuracy: 1% full scale; combined linearity, hysteresis, repeatability
    b. Compensated Temperature Range: 25° to 140°F
    c. Temp Coefficient: ±0.05%°C
    d. Operating Environment: 10-90% RH, non-condensing; 25° to 140°F
6. Supply Pressure: 45 psig max.
7. Manual Override: Jumper selectable mode, digital pushbutton adjust
8. Alarm Contact: 100mA@30VAC/DC (Optional)
9. Control Range 0-20 psig or 3-15 psig; jumper selectable
10. Pressure Differential 0.1 psig (supply to branch)
11. Pressure Indication Electronic, 3-1/2 digit LCD
12. Housing: Mounted on standard SnapTrack; Optional clear dust cover
13. Basis of Design: Veris EP Series

P. Control Valves
1. Provide automatic control valves suitable for the specified controlled media (water or glycol). Provide valves which mate and match the material of the connected piping. Equip control valves with the actuators of required input power type and control signal type to accurately position the flow control element and provide sufficient force to achieve required leakage specification.
2. Control valves shall meet the heating and cooling loads specified, and close off against the differential pressure conditions within the application. Valves should be sized to operate accurately and with stability from 10 to 100% of the maximum design flow.
3. Geothermal valves shall be two position, slow opening with full zone body full opening and end switches.
4. Trim material shall be stainless steel for steam and high differential pressure applications.

Q. Dampers
1. Automatic dampers, furnished by the Building Automation Contractor shall be single or multiple blade as required. Dampers are to be installed by the HVAC Contractor under the supervision of the BAS Contractor. All blank-off plates and conversions necessary to install smaller than duct size dampers are the responsibility of the Sheet Metal Contractor.
2. Damper frames are to be constructed of 13 gauge galvanized sheet steel mechanically joined with linkage concealed in the side channel to eliminate noise as friction. Compressible spring stainless steel side seals and acetyl or bronze bearings shall also be provided.
3. Damper blade width shall not exceed eight inches. Seals and 3/8 inch square steel zinc plated pins are required. Blade rotation is to be parallel or opposed as shown on the schedules.
4. For high performance applications, control dampers will meet or exceed the UL Class I leakage rating.
5. Control and smoke dampers shall be Ruskin, or approved equal.

6. Provide opposed blade dampers for modulating applications and parallel blade for two position control.

R. Damper Actuators
1. Damper actuators shall be electronic, and shall be direct coupled over the shaft, without the need for connecting linkage. The actuator shall have electronic overload circuitry to prevent damage. For power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing. Non-spring return actuators shall have an external manual gear release to allow positioning of the damper when the actuator is not powered.

S. Smoke Detectors
1. Air duct smoke detectors shall be by Air Products & Controls or approved equal. The detectors shall operate at air velocities from 300 feet per minute to 4000 feet per minute.
2. The smoke detector shall utilize a photoelectric detector head.
3. The housing shall permit mechanical installation without removal of the detector cover.
4. The detectors shall be listed by Underwriters Laboratories and meet the requirements of UL 268A.

T. Airflow Measuring Stations
1. Provide a thermal anemometer using instrument grade self-heated thermistor sensors with thermistor temperature sensors.
2. The flow station shall operate over a range of 0 to 5,000 feet/min with an accuracy of +/- 2% over 500 feet/min and +/- 10 ft/min for reading less than 500 feet/min.

2.7 ELECTRICAL POWER MEASUREMENT

A. Electrical Power Monitors, Single Point (Easy Install):
1. Acceptable Manufacturer: Veris Industries.
2. General: Consist of three split-core CTs, factory calibrated as a system, hinged at both axes with the electronics embedded inside the master CT. The transducer shall measure true (rms.RMS) power demand real power (kW) consumption (kWh). Conform to ANSI C12.1 metering accuracy standards.
3. Voltage Input: Load capacity as shown on drawings. 208-480 VAC, 60 Hz
4. Maximum Current Input: Up to 2400A
5. Performance:
   a. Accuracy: +/- 1% system from 10% to 100% of the rated current of the CT's
   b. Operating Temperature Range: 32-140°F, 122°F for 2400A.
6. Output: 4 to 20 mA, Pulse. or Modbus RTU
7. Ratings:
   a. Agency: UL508 or equivalent
   b. Transducer internally isolated to 2000 VAC.
   c. Case isolation shall be 600 VAC.
8. Basis of Design: Similar to Hawkeye Veris H80xx40 series
9. Accessories: BACnet communications gateway

B. Electrical Power Monitors, Single Point (High Accuracy):
1. Acceptable Manufacturer: Veris Industries.

2. General: Revenue grade meter. Measures voltage, amperage, real power (kW), consumption (kWh), and reactive power (kVARar), and power factor (PF) per phase and total load for a single load. Factory calibrated as a system using split core CT's. Neutral voltage connection is required.
3. Voltage Input: 208-480 VAC, 60 Hz
4. Current Input: Up to 2400A
5. Performance:
    a. Accuracy: +/- 1% system from 2% to 100% of the rated current of the CT's
    b. Operating Temperature Range: 32-122°F
6. Output: Pulse, BACnet, Modbus RTU
7. Display: Backlit LCD
8. Enclosure: NEMA 1
9. Agency Rating: UL508 or equivalent
10. Basis of Design: Veris Industries H81xx00 series.

C. Electrical Power Monitors, Single Point (High Accuracy/Versatility):
1. Acceptable Manufacturer: Veris Industries.
2. General: Revenue grade meter. Measures voltage, amperage, real power (kW), consumption (kWh), reactive power (kVAR), apparent power (kVA) and power factor (PF) per phase and total load for a single load. Available with data logging , Bi-directional (4-quadrant) metering, and pulse contact accumulator inputs.
3. Voltage Input: 90-600 VAC, 50/60 Hz, 125-300 VDC
4. Current Input: 5A – 32,000A, selectable 1/3V or 1V CT inputs
5. Performance:
    a. Accuracy shall be +/- 0.5% revenue grade
    b. Operating Temperature Range: -22 to 158°F
6. Output shall be Pulse or BACnet
7. Display: Backlit LCD
8. Enclosure: NEMA 4x optional
9. Agency Rating: UL508, ANSI C12.20
10. Basis of Design: Veris E5xxx series.

D. Electrical Power Monitors, Multiple Point (92 loads, High Accuracy):
1. Acceptable Manufacturer: Veris Industries.
2. General: Revenue grade meter. Measures volts, amps, power and energy for each circuit. 1/4 amp to 200 amp monitoring. 4 configurable alarm threshold registers
3. Voltage Input: 90-277 VAC, 60 Hz
4. Current Input: 5A – 32,000A, 1/3V CT inputs
5. Performance:
    a. Accuracy: +/- 0.5% meter (split core), +/- 1% system from 1/4-100A (solid core)
    b. Operating Temperature Range: 32-140°F
6. Output: Modbus RTU
7. Agency Rating: UL508, ANSI C12.10, IEC Class 1
8. Basis of Design: Veris E3xxx series.

2.8 ENERGY MONITORING

A. General

1. The energy monitoring system, Schneider Electric Building Analytics software, shall visually provide energy consumption, water consumption and other informational data on an easy to understand display using a web browser. Energy information to be shown shall be coordinated with the Owner.

B. The software shall include the following:
   1. Energy charting tools which allow users to view utility data, including where necessary electric, geothermal water, hot water, and water with the capability to do the following:
      a. Normalize by floor area
      b. Compare to other buildings
      c. View by building type
      d. Compare to degree day normalized data
      e. Compare to previous years consumption
      f. Compare to a statistical bin-based model of expected consumption
   2. Data visualization tools which allow users to plot utility and weather data, including the following capabilities:
      a. Time-series plots
      b. Scatter plots
      c. Tabular views
      d. Excel exports of data
      e. Annotated pdf outputs of graphs
      f. Saved views to share with other users

C. Integration is to be accomplished by hosting a software gateway locally to push utility meter data to a cloud-based long term storage solution. Data will be polled from local systems and pushed to the cloud via a secure, encrypted https post at 5 or 15 minute intervals. Polling shall be through common communication protocols, including any of the following:
   1. BACnet IP
   2. Modbus IP
   3. oBIX
   4. OPC
   5. Webservices

D. The ATC contractor shall include all required cloud subscription fees for a period of ten (10) years.

PART 3 - EXECUTION

3.1 CONTRACTOR RESPONSIBILITIES

A. GENERAL
   1. Installation of the building automation system shall be performed by the Contractor or a subcontractor. However, all installation shall be under the personal supervision of the Contractor. The Contractor shall certify all work as proper and complete. Under no

circumstances shall the design, scheduling, coordination, programming, training, and warranty requirements for the project be delegated to a subcontractor.

B. Access to Site
1. Unless notified otherwise, entrance to building is restricted. No one will be permitted to enter the building unless their names have been cleared with the Owner or the Owner's Representative.

C. Code Compliance
1. All wiring shall be installed in accordance with all applicable electrical codes and will comply with equipment manufacturer's recommendations. Should any discrepancy be found between wiring specifications in Division 17 and Division 16, wiring requirements of Division 17 will prevail for work specified in Division 17.

D. Cleanup
1. At the completion of the work, all equipment pertinent to this contract shall be checked and thoroughly cleaned, and all other areas shall be cleaned around equipment provided under this contract.

3.2 WIRING, CONDUIT, AND CABLE

A. ALL WIRE WILL BE COPPER AND MEET THE MINIMUM WIRE SIZE AND INSULATION CLASS LISTED BELOW:

Wire Class	Wire Size	Isolation Class
Power	12 Gauge	600 Volt
Class One	14 Gauge Std.	600 Volt
Class Two	18 Gauge Std.	300 Volt
Class Three	18 Gauge Std.	300 Volt
Communications	Per Mfr.	Per Mfr.

B. Power and Class One wiring may be run in the same conduit. Class Two and Three wiring and communications wiring may be run in the same conduit.

C. Where different wiring classes terminate within the same enclosure, maintain clearances and install barriers per the National Electric Code.

D. Where wiring is required to be installed in conduit, EMT shall be used. Conduit shall be minimum 1/2 inch galvanized EMT. Set screw fittings are acceptable for dry interior locations. Watertight compression fittings shall be used for exterior locations and interior locations subject to moisture. Provide conduit seal-off fitting where exterior conduits enter the building or between areas of high temperature/moisture differential.

E. Flexible metallic conduit (max. 3 feet) shall be used for connections to motors, actuators, controllers, and sensors mounted on vibration producing equipment. Liquid-tight flexible conduit shall be use in exterior locations and interior locations subject to moisture.

F. Junction boxes shall be provided at all cable splices, equipment termination, and transitions from EMT to flexible conduit. Interior dry location J-boxes shall be galvanized pressed steel, nominal four-inch square with blank cover. Exterior and damp location JH-boxes shall be cast alloy FS boxes with threaded hubs and gasketed covers.

G. Where the space above the ceiling is a supply or return air plenum, the wiring shall be plenum rated. Teflon wiring can be run without conduit above suspended ceilings. EXCEPTION: Any wire run in suspended ceilings that is used to control outside air dampers or to connect the system to the fire management system shall be in conduit.

H. Fiber optic cable shall include the following sizes; 50/125, 62.5/125 or 100/140.

I. Only glass fiber is acceptable, no plastic.

J. Fiber optic cable shall only be installed and terminated by an experienced contractor. The BAS contractor shall submit to the Engineer the name of the intended contractor of the fiber optic cable with his submittal documents.

3.3 HARDWARE INSTALLATION

A. INSTALLATION PRACTICES FOR WIRING

B. All controllers are to be mounted vertically and per the manufacturer's installation documentation.

C. 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.

D. A true earth ground must be available in the building. Do not use a corroded or galvanized pipe, or structural steel.

E. 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.

F. 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.

G. 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.

H. Wires are to be kept a minimum of three (3) inches from hot water, steam, or condensate piping.

I. Where sensor wires leave the conduit system, they are to be protected by a plastic insert.

J. Wire will not be allowed to run across telephone equipment areas.

3.4 INSTALLATION PRACTICES FOR FIELD DEVICES

A. Well-mounted sensors will include thermal conducting compound within the well to insure good heat transfer to the sensor.

B. 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.

C. Relay outputs will include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.

D. Water line mounted sensors shall be removable without shutting down the system in which they are installed.

E. 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.

F. 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.

3.5 ENCLOSURES

A. 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.

B. FIPs shall contain power supplies for sensors, interface relays and contactors, and safety circuits.

C. 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.

D. 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.

E. All outside mounted enclosures shall meet the NEMA-4 rating.

F. The wiring within all enclosures shall be run in plastic track. Wiring within controllers shall be wrapped and secured.

3.6 IDENTIFICATION

A. Identify all control wires with labeling tape or sleeves using words, letters, or numbers that can be exactly cross-referenced with as-built drawings.

B. 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.

C. Junction box covers will be marked to indicate that they are a part of the BAS system.

D. All I/O field devices (except space sensors) that are not mounted within FIP's shall be identified with name plates.

E. All I/O field devices inside FIP's shall be labeled.

3.7 LOCATION

A. The location of sensors is per mechanical and architectural drawings.

B. Space humidity or temperature sensors will be mounted away from machinery generating heat, direct light and diffuser air streams.

C. 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.

D. Field enclosures shall be located immediately adjacent to the controller panel(s) to which it is being interfaced.

3.8 SOFTWARE INSTALLATION

A. 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.

3.9 DATABASE CONFIGURATION.

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

3.10 COLOR GRAPHIC DISPLAYS.

A. 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.

3.11 REPORTS.

A. The Contractor will configure a minimum of 4 reports for the owner. These reports shall, at a minimum, be able to provide:

B. Trend comparison data

C. Alarm status and prevalence information

D. Energy Consumption data

E. System user data

3.12 DOCUMENTATION

A. 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
7. Commissioning and System Startup

3.13 POINT TO POINT CHECKOUT.

A. 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.

3.14 CONTROLLER AND WORKSTATION CHECKOUT.

A. 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.

3.15 SYSTEM ACCEPTANCE TESTING

A. General:
   1. The system installation shall be complete and tested for proper operation prior to acceptance testing for the Owner's authorized representative (Commissioning Agent). A letter shall be submitted to the Architect requesting system acceptance. This letter shall certify all controls are installed and the software programs have been completely exercised for proper equipment operation. Acceptance testing will commence at a mutually agreeable time within ten (10) calendar days of request.

B. All application software will be verified and compared against the sequences of operation.
   1. Roof Mounted Geothermal Heat Pump Control
   2. Air Terminal Units
   3. Cabinet Unit Heater
   4. Unit Heaters
   5. IT Room Air conditioning unit

C. 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.

D. 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 and the Owner’s authorized representative.

E. 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 and the Owner’s authorized representative.

END OF SECTION 230900

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section

1.2 SUMMARY

A. This Section includes control sequences for HVAC systems, subsystems, and equipment.

B. Related Sections include the following:

1. Section 230900 "Instrumentation and Control for HVAC" for control equipment and devices and for submittal requirements.

1.3 LEED BUILDING GENERAL REQUIREMENTS

A. The Contractor is required to implement practices and procedures to meet the project's environmental performance goals, which include achieving LEED Certification. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling; and implementation of indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the specification sections, are implemented to the fullest extent.

1.4 DEFINITIONS

A. DDC: Direct digital control.

B. VAV: Variable air volume.

1.5 GENERAL

A. Unless noted otherwise herein, all control functions described in this sequence of operation shall be accomplished by the Building Automation System (BAS), and all equipment shall be started, stopped and positioned (if a modulating device) by the BAS. All hardware necessary to accomplish the control functions shall be provided by the ATC contractor, unless noted otherwise. The BAS contractor shall coordinate the quantity of required final drive devices (damper motors, control valves, etc.) and sensors with the mechanical equipment vendor's products.

B. All setpoints described in this sequence of operation shall be fully adjustable throughout the entire range of the sensors being used to measure the variable being controlled. All controlled variables identified in the following sequence of operation shall be maintained at setpoint using proportional-integral control algorithms, in order to insure that no error exists between the controlled variable and its setpoint at steady-state conditions. Proportional-integral-derivative

algorithms shall be used if the process so warrants, at the discretion of the control software programmer.

C. Point Lists provided in the Sequence are a Minimum and should be used as a guideline. All points listed are required. Any additional points required to meet the sequence of operations or the specification or the intent of the specification will be included.

D. Alarms will be set up initially by the ATC contractor, as shown in the point list. The system will be capable of unlimited alarms, but the selected alarms will not be left for the customer to set. Any alarms that the customer requests to be set up will be done by the contractor at no additional charge.

1.6 GEOTHERMAL WATER LOOP SYSTEM

A. The ATC contractor will provide all requires sensors and controllers.

B. The geothermal water system will be enabled when any zone is occupied and when there's a call for heating and cooling during unoccupied mode.

C. All pumps will be provided with Hand-Off-Auto switches at the variable frequency drives. The BAS will control the system in the "Auto" mode.

D. Primary Geothermal loop Pump Operation: Two (2) pumps are piped in parallel and will run in lead/lag configuration.
   1. The lead primary geothermal water pump will start and modulate to maintain the desired water supply and return temperature differential setpoint of 10 deg F.
      a. When the water differential temperature increases, the speed of pump will increase.
      b. When the water differential temperature decreases, the speed of pump will decrease.
      c. When the water differential temperature is less than 2 deg F (adj), the pumps will shut down.
   2. If lead pump fails, the lag pump shall stage on and the failed pump shall be removed from operation. Provide alarm for pump failure.
   3. The VFDs minimum speed shall not drop below twenty percent (20%) (adj). All setpoints shall be field adjusted during the commissioning period to meet the requirements of actual field conditions.
   4. Pumps shall stage on and modulate to maintain setpoint as follows:
      a. The controller shall modulate the lead pump to maintain setpoint.
      b. If the lead pump cannot maintain setpoint and its speed rises above ninety percent (90%) (adj.) for a period of 10 minutes (adj), the lag pump shall stage on and modulate in unison with the lead pump.
      c. If both pumps are modulating at 40% (adj) for a period of 10 minutes (adj), the lag pump will stage off.
      d. The controller shall continue to modulate the lead pump to maintain setpoint.
   5. The following loop water conditions shall be monitored:
      a. Loop flow
      b. Supply Temperature
      c. Return Temperature
      d. Differential water temperature

6. The following are the minimum points list:
   - AI Loop Water Supply Temperature
   - AI Loop Water Return Temperature
   - AI Loop Water Supply Pressure
   - AI Loop Water Return Pressure
   - AI Loop Differential Water Temperature
   - AI Loop Water GPM
   - AO Loop Water Pump 1 VFD Speed
   - AO Loop Water Pump 2 VFD Speed
   - AO Loop Differential Water Temperature Setpoint
   - AO Loop Water Pressure Setpoint
   - DI Loop Water Pump 1 Flow Status
   - DI Loop Water Pump 2 Flow Status
   - DI Loop Water Pump 1 VFD Fault
   - DI Loop Water Pump 2 VFD Fault
   - DI Loop Water Pump 1 VFD Status
   - DI Loop Water Pump 2 VFD Status
   - DO Loop Water Pump 1 VFD Start/Stop
   - DO Loop Water Pump 2 VFD Start/Stop

7. The following alarms shall be generated:
   a. No Loop Flow
   b. High Loop Water Temperature Alarm: if supply water temperature reaches 90 deg F (adj).
   c. Low Loop water Temperature Alarm: if supply water temperature drops below 35 deg F.
   d. High Loop water temperature shutdown: if loop water supply temperature is greater than 95 deg F.
   e. Low Loop water temperature shutdown: if loop water supply temperature is less than 32 deg F.
   f. Loop Water Differential Temperature Alarm: if differential pressure is 4 degree F (adj) higher than setpoint
   g. Loop Water Pump 1 Failure
   h. Loop Water Pump 2 Failure
   i. Loop Water Pump1 Running in Hand
   j. Loop Water Pump 1 Runtime exceeded
   k. Loop Water Pump 2 Running in Hand
   l. Loop Water Pump 2 Runtime exceeded
   m. High Loop Water Pressure: if supply pressure exceeds the allowable pump operating pressure.

E. Secondary Geothermal Water Loop Pump Operation: Two (2) pumps are piped in parallel and will run in lead/lag configuration.
   1. The secondary geothermal loop will be provided with a normally open bypass valve at the end of the loop. The bypass valve will be sized at 20% of system flow.
   2. On a call for heating or cooling from any space, the lead pump will start and the associated geothermal control valve at each unit will open. Once fully opened as sensed by the end switch and proof of flow is established, a signal will be sent to the BAS to

start the heat pump. Alarms will be sent to the operator when no flow is detected and the control valve fails to open.

3. If lead pump fails, the lag pump shall stage on and the failed pump shall be removed from operation. Provide alarm for pump failure.
4. The VFDs minimum speed shall not drop below twenty percent (20%) (adj). All setpoints shall be field adjusted during the commissioning period to meet the requirements of actual field conditions.
5. The secondary geothermal loop pumps will be controlled by the differential pressure located near the end of the loop. Exact location will be coordinated in field.
6. The controller shall measure the secondary geothermal water loop differential pressure and modulate the geothermal water pump VFDs in sequence to maintain its geothermal water differential pressure setpoint. The VFDs minimum speed shall not drop below twenty percent (20%) (adj). All setpoints shall be field adjusted during the commissioning period to meet the requirements of actual field conditions.
7. Once the speed of the pump exceeded 30% , the bypass valve will close.
8. On a dropping geothermal water differential pressure, lag pump shall stage on and modulate to maintain setpoint as follows:
   a. The controller shall modulate the lead pump to maintain setpoint.
   b. If the lead pump cannot maintain setpoint and its speed rises above ninety percent (90%) (adj.) for a period of 10 minutes (adj), the lag pump shall stage on and modulate in unison with the lead pump.
   c. If both pumps are modulating at 40% (adj) for a period of 10 minutes (adj), the lag pump will stage off.
   d. The controller shall continue to modulate the lead pump to maintain setpoint.
9. On rising geothermal water differential pressure, the pumps shall stage off as follows:
   a. If the setpoint is maintained and the speed of the two (2) pumps had been modulating at 40% (adj) for a period of 10 minutes (adj), the lag pump will stage off.
   b. The controller shall continue to modulate the lead pump to maintain setpoint.
10. The following are the minimum points list

AI	Loop Water Supply Temperature
AI	Loop Water Return Temperature
AI	Differential Pressure
AI	Loop Water GPM
AO	Loop Water Supply Pressure
AO	Loop Water Pump 1 VFD Speed
AO	Loop Water Pump 2 VFD Speed
AO	Differential Pressure Setpoint
DI	Loop Water Pump 1 Flow Status
DI	Loop Water Pump 2 Flow Status
DI	Loop Water Pump 1 VFD Fault
DI	Loop Water Pump 2 VFD Fault
DI	Loop Water Pump 1 VFD Status
DI	Loop Water Pump 2 VFD Status
DI	Bypass Valve Status
DI	GSHP#1 Valve Open Status
DI	GSHP#2 Valve Open Status
DI	GSHP#3 Valve Open Status
DI	GSHP#4 Valve Open Status

DI	GSHP#1 Flow Status
DI	GSHP#2 Flow Status
DI	GSHP#3 Flow Status
DI	GSHP#4 Flow Status
DO	Loop Water Pump 1 VFD Start/Stop
DO	Loop Water Pump 2 VFD Start/Stop
DO	Bypass Valve Open/Close
DO	GSHP#1 Valve Open/Close
DO	GSHP#2 Valve Open/Close
DO	GSHP#3 Valve Open/Close
DO	GSHP#4 Valve Open/Close

11. The following alarms shall be generated:
    a. No Loop Flow.
    b. High Loop Water Temperature Alarm: if supply water temperature reaches 90 deg F (adj).
    c. Low Loop water Temperature Alarm: if supply water temperature drops below 35 deg F.
    d. High Loop water temperature shutdown: if loop water supply temperature is greater than 95 deg F.
    e. Low Loop water temperature shutdown: if loop water supply temperature is less than 32 deg F.
    f. Loop Water Differential pressure Alarm: if differential pressure is 3 psi (adj) higher than setpoint
    g. Loop Water Pump 1 Failure
    h. Loop Water Pump 2 Failure
    i. Loop Water Pump1 Running in Hand
    j. Loop Water Pump 1 Runtime exceeded
    k. Loop Water Pump 2 Running in Hand
    l. Loop Water Pump 2 Runtime exceeded
    m. High Loop Water Pressure: if supply pressure exceeds the allowable pump operating pressure.
    n. GSHP#1 Valve fails to open
    o. GSHP#2 Valve fails to open
    p. GSHP#3 Valve fails to open
    q. GSHP#4 Valve fails to open
    r. GSHP#1 no flow
    s. GSHP#2 no flow
    t. GSHP#3 no flow
    u. GSHP#4 no flow
    v. Bypass Valve fails to open

1.7 MECHANICAL ROOM TEMPERATURE AND VENTILATION CONTROL

A. The Automatic Temperature Control Contractor shall provide all controllers and sensors to perform the sequence of operation.

B. An exhaust fan with motorized damper, a low mounted outside air intake louver with modulating motorized damper and a roof mounted intake ventilator with modulating motorized

damper will be will be provided for ventilation of Mechanical Room. Two(2) unit heaters will be provided for heating.

C. On a rise in space temperature above 80 F (adj.) as sensed by a wall mounted temperature sensor, the outside air damper will modulate open to 50% , the exhaust air damper will open and the exhaust fan run at its minimum speed to maintain space temperature setpoint. On a continued rise in space temperature, the exhaust fan speed will increase and the outside air motorized damper will fully open. Once fan speed is more than 30%, the roof intake ventilator motorized damper will modulate open and will continue to modulate open as the exhaust fan speed increases. The reverse occurs when the setpoint is satisfied.

D. On a drop in temperature below 55 F (adj.), unit heater hot water control valves shall open and fan shall cycle. Fan speed shall be manually set to medium.

E. ATC Contractor shall provide all necessary sensors for monitoring and controlling the following conditions:

POINTS LIST:		TO BE SET UP BY ATC CONTRACTOR
AI	Mechanical Room Space Temperature	Alarm on + / - 10 deg.
AO	Mechanical Room Space Setpoint	
DI	Mechanical Room Outside Air Damper #1 Status	Alarm on Fail
DI	Mechanical Room Outside Air Damper #2 Status	Alarm on Fail
DI	Exhaust Fan EF-# run status	Alarm on Fail
DI	Exhaust Fan ECM Fault Status	
DI	Unit heater fan Status	
DO	Mechanical Room Exhaust fan Start/Stop	
DO	Mechanical Room Exhaust Fan EF- modulate	
DO	Unit heater valve open/Close	
DO	Mechanical Room Outside Air Damper #1 Open/Close (Roof mounted intake ventilator)	
DO	Mechanical Room Outside Air Damper #2 Open/Close (Low outside air intake damper)	

1.8 GLYCOL SYSTEM

A. The Automatic Temperature Control Contractor shall provide all controllers and sensors to perform the sequence of operation.

B. Glycol will be used in the geothermal water system.

C. ATC contractor and will monitor the low glycol level in the glycol tank.

D. When glycol level drops below setpoint, an alarm will be sent to BAS.

1.9 SINGLE ZONE VARIABLE AIR VOLUME GSHP with CO2 reset (GSHP-1)

A. General:

1. The ground source heat pump unit consist of two (2) modulating compressors and two (2) fixed capacity compressors.
2. The Automatic Temperature Control Contractor shall provide all controllers and sensors to perform the required sequence of operation.
3. All safety features and setpoints shall be coordinated with the manufacturer.
4. The Automatic Temperature Control Contractor shall provide space temperature, space mounted CO2 sensors and space mounted relative humidity sensors at three locations for averaging.

B. The GSHP shall be indexed for Occupied, Unoccupied or Optimum Start modes by the BAS.

C. The Outdoor air flow CFM will be monitored. Air flow measuring station shall be provided by ATC contractor.

D. The systems will operate providing the system safeties are satisfied. The fans shall not start until all smoke and fire/smoke dampers serving the ground source heat pump units are proven to be open.

E. Unoccupied Mode:
1. Heating: The heating space temperature set point will be initially set 10 degrees below the occupied setpoint (adj.). The outdoor air and exhaust air damper will remain closed. The return air damper will be open one hundred percent (100%). When space temperature drops below unoccupied setpoint, the supply fan will ramp slowly to fifty percent (50%) speed (adj) and the compressor will stage on until the space temperature is 4 deg F (adj) above unoccupied setpoint.
2. Cooling: The cooling space temperature set point will be initially set 10 degrees above the occupied setpoint (adj.). The outdoor air and exhaust air damper will remain closed. The return air damper will be open one hundred percent (100%). When space temperature rises above unoccupied setpoint, the supply fan will run at fifty percent (50%) speed (adj) and the compressor will stage on until the space temperature drops 2 deg F (adj) below unoccupied setpoint. When the space relative humidity rises above setpoint, the unit will enter dehumidification mode until the space relative humidity is 5% (adj) below setpoint.
3. A timed local override shall allow occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to schedule.

F. Morning Warm Up: Will be initiated by BAS. The unit will be on heating mode and the compressors will modulate to maintain setpoint. The supply fan will ramp slowly to a preset speed. The outdoor and exhaust dampers will remain closed, return air damper will remain one hundred percent (100%) open. The exhaust fan will be off. When the space reaches setpoint, the system will enter the occupied mode.

G. Dehumidification Mode: Coordinate all requirements to effectively operate the dehumidification cycle with the manufacturer.
1. Dehumidification is enabled when space humidity is above the space humidity setpoint.
2. In dehumidification mode, two(2) factory supplied suction pressure transducers shall be monitored by the BAS and the 2 lead and 2 on / off compressors shall be staged and modulated to maintain a 40 deg. F SST (adjustable).

3. Once in dehumidification mode, the unit will maintain the evaporator suction coil temperature setpoint by modulating the lead compressor via a 1.44-5 Vdc signal.
    a. If additional dehumidification is required, the fixed capacity compressor will stage on after the demand signal to the variable compressor demand signal is reduced to 50%. There shall be a 5 minute , adjustable, time delay between each stage and minimum five (5) minute (adjustable) run and off times programmed into the BAS sequence of operation. . Once fixed capacity compressors are staged on, the modulating compressor will be allowed to modulate down to 70% in order to maintain reheat capacity.
    b. To stage up additional compressor, the evaporator coil suction temperature needs to be above the evaporator coil suction temperature setpoint and the modulating compressor needs to be at 100% for a period of time equal to Stage Up Delay, five (5) minutes (adjustable). Once fixed capacity compressors are staged on, the modulating compressor will be allowed to modulate 50% and modulate up as needed.
    c. To stage down the extra compressor, the minimum run time of five (5) minutes (adjustable), must be met, the evaporator coil suction temperature needs to be below the evaporator suction temperature setpoint and the modulating compressor needs to be at 50% for a period of time equal to Stage Down Delay of 5 minutes (adjustable). Once the fixed compressor stages off, the modulating compressor will go to 100% and modulate down as needed to maintain coil temperature setpoint signal of 50 deg. F (adjustable) supplied through the suction pressure transducer. This will repeat as additional fixed capacity compressor stages off. The modulating compressor shall be the last compressor to be deactivated.
    d. Reheat shall be though modulating hot gas reheat. Reheat will be controlled to the appropriate supply air temperature setpoint.

H. Occupied Mode: Heating and Cooling- Two(2) modulating compressors and two (2) fixed capacity compressors:
1. The controller shall receive a signal from the secondary loop water source monitor indicating that there is water flow and that the water temperature is within the acceptable limits.
2. The supply fan shall be enabled, the outdoor air damper will modulate open based on minimum position at maximum occupancy, exhaust air damper will open and the return damper will modulate inversely to the outdoor air damper. The Exhaust Fan will track the outdoor air damper position. As the outdoor air damper open, the exhaust fan speed will increase.
3. When the space requires cooling and the return air enthalpy is higher than the outdoor air enthalpy, the dampers will modulate to maintain a mixed air temperature setpoint. The mixed air temperature setpoint will reset from 55 to 60 degrees (adj.) based on the discharge air temperature setpoint.
4. If cooling is required to maintain the discharge air temperature setpoint and the return air enthalpy is lower than the outdoor air enthalpy, the heat pump cooling mode will be enabled and the compressor will run as indicated below:
    a. The first modulating compressor will stage on and modulate to maintain the discharge air reset setpoint.
    b. Once the first compressor is enabled a Stage Up Delay Timer, five(5) minutes (adj) will begin. If after the Stage Up Delay Timer has been met and the first compressor is still at 100% capacity the demand signal to the lead compressor shall

be reset to 50% and the second compressor shall energize with a 50% demand signal. Both compressors will then modulate up together as needed.

c. If additional cooling is required, the fixed capacity compressor will stage on while the modulating compressors continues to modulate. The demand signal to the digital compressors shall be reduced to 75% before stage 3 or 4 are energized.

d. To stage additional compressor on, the discharge air temperature needs to be above the setpoint and the modulating compressor needs to be at 100% for a period of time equal to the stage up delay, five (5) minutes (adj). Once the fixed compressor is enabled, the modulating compressor will modulate down to 10% and modulate up as needed.

e. For compressors to stage on, Minimum Off Times, five(5) minutes (adj) must be satisfied as well as Stage Up Delays, five (5) minutes (adj).

f. If both modulating compressor modulates down to 30%, the Stage Down Delay Timer, five(5) minutes (adj) will begin. If the Stage Down Delay Timer, five (5) minutes (adj) has been met and the compressors are still at 30% and the discharge air temperature is still above the setpoint , the fixed compressor will stage off and the modulating compressors will modulate to 60% and will modulate as needed. This will repeat as additional fixed compressor stages off.

5. If cooling is required to maintain the reset discharge air setpoint based on the outside air temperature and the modulating compressors are running less than fifty percent (50%) for more than five (5) minutes, the supply fan speed will be reduced by ten percent (10%). If the compressors continues to run less than fifty percent (50%) for another five (5) minutes, the fan speed will be reduced another ten percent (10%) and continue in this cycle until the fan speed is at a preset minimum. If the space temperature is at setpoint and the space humidity rises above setpoint, the fan speed will be reduced to sixty-six percent (66%) for ten (10) minutes. If the space temperature is still satisfied and the space humidity is still above setpoint, the fan speed will be reduced to fifty percent (50%).

6. If heating is required, the heat pump heating mode will be enabled and the compressor will run as indicated below:

   a. The first modulating compressor will stage on and modulate to maintain the discharge air reset setpoint.

   b. If the first compressor modulates up to 60%, a Stage Up Delay Timer (adj) will begin. If after the Stage Up Delay Timer of five (5) minutes (adj) has been met and the first compressor is still at 60% or above, and the discharge air temperature is still below setpoint, the signal to the first compressor will be cut in half and the second modulating compressor will be enabled at the same capacity. Both compressors will then modulate up together as needed.

   c. If additional heating is required, the fixed capacity compressor will stage on while the modulating compressors continues to modulate.

   d. To stage additional compressor on, the discharge air temperature needs to be below the setpoint and the modulating compressor needs to be at 100% for a period of time equal to the stage up delay of five (5) minutes(adj). Once the fixed compressor is enabled, the modulating compressor will modulate down to 10% and modulate up as needed.

   e. For compressors to stage on, Minimum Off Times (adj) must be satisfied as well as Stage Up Delays (adj).

   f. If both modulating compressor modulates down to 30%, the Stage Down Delay Timer (adj) will begin. If the Stage Down Delay Timer has been met and the compressors are still at 30% and the discharge air temperature is still below the

setpoint , the fixed compressor will stage off and the modulating compressors will modulate to 60% and will modulate as needed. This will repeat as additional fixed compressor stages off.

7. If heating is required, the heat pump will be on heating mode and the compressors will modulate to maintain the reset discharge air temperature setpoint. If the modulating compressors are running at less than fifty percent (50%) for more than five (5) minutes, the supply fan speed will be set to eighty percent (80%) (adj.). If the compressor continues to be less than fifty percent (50%) for another five (5) minutes, the fan speed will be reduced another ten percent (10%) and continue in this cycle until the fan speed is at a preset minimum.

I. The discharge air temperature reset schedule will be displayed at the operator workstation and will be adjustable by an operator with the proper access level. In heating mode, discharge air to be reset from 95 F (adj.) to 75 F (adj.) when Outside air temperature varies linearly from 20 F. (adj.) to 65 F (adj.). In cooling mode, discharge air to be reset from 55 F (adj.) to 60 F (adj.) when outside temperature varies linearly from 95 F (adj.) to 70 F (adj.).

J. The averaging wall mounted CO2 transmitter provided by ATC contractor shall monitor the quality of air in the space. If CO2 detects a level of CO2 above setpoint, the BAS shall increase the amount of outside air brought into the space by modulating the outside air damper open. As the level of CO2 in the space decreases below setpoint, the BAS shall permit the outside air damper to modulate back to occupied minimum CFM setpoint.

K. The fan speed reduction rate will be displayed at the operator workstation and will be changeable by an operator with the proper access level.

L. The duct smoke detectors shall provide a signal to the BAS if products of combustion are present within the system or area served. The BAS will respond to this indication by shutting down the supply and exhaust fan VFDs and closing the outside air damper. An alarm will then be sent to the BAS operator workstation indicating a shutdown of the system has occurred due to the duct smoke detectors.

M. A high static pressure sensor shall monitor the supply duct static pressure. If the static pressure of the supply duct exceeds the setpoint of the sensor, the BAS will command both of the supply and return fan to stop. An alarm shall then be sent to the to the operator workstation indicating a shutdown of the system has occurred due to the duct high static pressure switch. A manual reset will be required in order to restart the system after a high duct static pressure safety shutdown.

N. A water detector will monitor the condensate pan for high water level. If the condensate level switch detects water, compressors will modulate off and fan will shut down. An alarm will be generated at the operator workstation.

O. Temperature Protection:
1. When supply air temperature rises above High Cutoff Temperature (Adj) or drops below the Low Cutoff Temperature (Adj), the unit shuts down until the mode is cancelled. An alarm will be sent to the BAS Operator Workstation.
2. This mode is cancelled when the Supply air Temperature drops 10 degrees F below the High Cutoff Temperature Setpoint or rises 10 degrees F above the Low Cutoff Temperature Setpoint or when the unit changes back into Occupied Operation.

P. Proof of Flow Interlock
   1. A proof of flow switch interlock shall be provided to prevent cooling and heating operation in the event of fan failure.

Q. Dirty Filter Status
   1. A differential pressure switch shall be provided for filter status indication.

R. The BAS system will monitor the space temperature sensor. The system will operate in unoccupied mode based on the coldest (heating) and warmest (cooling) monitored temperature.

S. ATC Contractor shall provide all necessary sensors for monitoring and controlling the following conditions:

AI	CO2 Level	Alarm on High (above 950 PPM)
AI	Outdoor Air CFM	
AI	Return Air Temperature	Alarm on high level
AI	Space Air Relative Humidity	Alarm on high level
AI	Space Air Temperature	
AI	Mixed Air Temperature	Alarm on Failure or +/- setpoint
AI	Compressor position feedback	
AI	Supply Air Temperature	Alarm on Failure or +/- setpoint
AI	Supply Fan Speed Feedback from VFD	
AI	Exhaust Fan Speed Feedback from VFD	
AI	Duct Static Pressure	
AI	Differential Pressure	
AI	0-10V signal from suction pressure transducer	
AO	Supply Fan Speed	
AO	Exhaust Fan Speed	
AO	Outdoor Air Damper Modulate	
AO	Return Air Dampen Open/Close	
AO	Geothermal Water Valve open/Close	
AO	Differential Pressure Setpoint	
AO	1.44- 5 Vdc stage 1 and 2 compressor modulation	
AO	0-10V Vdc economizer control	
AO	0-10Vdc Supply Fan control Signal	
DI	Supply Fan Status	Alarm on Fan Start Failure
DI	Supply Fan VFD Fault Status	Alarm on VFD Failure
DI	Exhaust Fan Status	Alarm on Fan Start Failure
DI	Exhaust Fan VFD Fault Status	Alarm on VFD Failure
DI	Hot Gas Reheat Status	
DI	Filter Status	Alarm on high differential pressure
DI	Low Limit Thermostat	Alarm on Low Temperature
DI	High Limit Thermostat	Alarm on High Temperature
DI	Duct pressure high limit	Alarm on high pressure
DI	Supply duct smoke detector	Alarm on smoke
DI	Condensate water detection	Alarm on high level
DI	Air Flow Status	Alarm on no flow
DI	Water flow status	
DI	Water valve status	
DO	Compressor 1 enable	

DO Compressor 2 enable
DO Compressor 3 enable
DO Compressor 4 enable
DO Heat Pump Reversing Valve
DO Supply Fan Start / Stop
DO Exhaust Fan Start/Stop
DO Outside Air Damper position
DO Return Air Damper position

1.10 MULTI- ZONE VARIABLE AIR VOLUME (GSHP-2 and GSHP-3)

A. General:
1. The ground source heat pump unit GSHP-2 consists of one (1) modulating compressor.
2. The ground source heat pump unit GSHP-3 consist of one (1) modulating compressor and one(1) fixed capacity compressor.
3. The Automatic Temperature Control Contractor shall provide all controllers and sensors to perform the required sequence of operation.
4. All safety features and setpoints shall be coordinated with the manufacturer.
5. The Automatic Temperature Control Contractor shall provide space temperature, CO2 sensors and relative humidity sensors for space monitoring.

B. The GSHP shall be indexed for Occupied, Unoccupied or Optimum Start modes by the BAS.

C. The Outdoor air flow CFM will be monitored. Air flow measuring station shall be provided by ATC contractor.

D. The systems will operate providing the system safeties are satisfied. The fans shall not start until all smoke and fire/smoke dampers serving the roof mounted ground source heat pump units are proven to be open.

E. Unoccupied Mode:
1. Heating: The heating space temperature set point will be initially set 10 degrees below the occupied setpoint (adj.). The outdoor air and exhaust air damper will remain closed. The return air damper will be open one hundred percent (100%). When space temperature drops below unoccupied setpoint, the supply fan will ramp slowly to fifty percent (50%) speed (adj) and the compressor will stage on until the space temperature is 4 deg F (adj) above unoccupied setpoint.
2. Cooling: The cooling space temperature set point will be initially set 10 degrees above the occupied setpoint (adj.). The outdoor air and exhaust air damper will remain closed. The return air damper will be open one hundred percent (100%). When space temperature rises above unoccupied setpoint, the supply fan will run at fifty percent (50%) speed (adj) and the compressor will stage on until the space temperature drops 2 deg F (adj) below unoccupied setpoint. When the space relative humidity rises above setpoint, the unit will enter dehumidification mode until the space relative humidity is 5% (adj) below setpoint.
3. A timed local override shall allow occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to schedule.

F. Morning Warm Up: Will be initiated by BAS. The unit will be on heating mode and the compressors will modulate to maintain setpoint. The supply fan will ramp slowly to a preset speed. The outdoor and exhaust dampers will remain closed, return air damper will remain one hundred percent (100%) open. The exhaust fan will be off. When the space reaches setpoint, the system will enter the occupied mode.

G. Dehumidification Mode: Coordinate all requirements to effectively operate the dehumidification cycle with the manufacturer.
   1. Dehumidification is enabled when space humidity is above the space humidity setpoint.
   2. In dehumidification mode, two(2) factory supplied suction pressure transducers shall be monitored by the BAS and the 2 lead and 2 on / off compressors shall be staged and modulated to maintain a 40 deg. F SST, (adjustable).
   3. Once in dehumidification mode, the unit will maintain the evaporator suction coil temperature setpoint by modulating the lead compressor via a 1.44 - 5 Vdc signal compressor.
      a. If additional dehumidification is required, the fixed capacity compressor will stage on after the demand signal to the variable compressor demand signal is reduced to 50%. There shall be a five (5) minute (adjustable), time delay between each stage and minimum five (5) minute (adjustable) run and off times programmed into the BAS sequence of operation. . Once fixed capacity compressors are staged on, the modulating compressor will be allowed to modulate down to 70% in order to maintain reheat capacity.
      b. To stage up additional compressor, the evaporator coil suction temperature needs to be above the evaporator coil suction temperature setpoint and the modulating compressor needs to be at 100% for a period of time equal to Stage Up Delay, 5 minutes adjustable. Once fixed capacity compressors are staged on, the modulating compressor will be allowed to modulate 50% and modulate up as needed.
      c. To stage down the extra compressor, the minimum run time of five (5) minutes (adjustable), must be met, the evaporator coil suction temperature needs to be below the evaporator suction temperature setpoint and the modulating compressor needs to be at 50% for a period of time equal to Stage Down Delay of five (5) minutes (adjustable). One the fixed compressor stages off, the modulating compressor will go to 100% and modulate down as needed to maintain coil temperature setpoint signal of 50 deg. F (adjustable) supplied through the suction pressure transducer. This will repeat as additional fixed capacity compressor stages off. The modulating compressor shall be the last compressor to be deactivated.
      d. Reheat shall be though modulating hot gas reheat. Reheat will be controlled to the appropriate supply air temperature setpoint.

H. Occupied Mode: Heating and Cooling
   1. The controller shall receive a signal from the secondary loop water source monitor indicating that there is water flow and that the water temperature is within the acceptable limits.
   2. The supply fan shall be enabled, the outdoor air damper will modulate open based on minimum position at maximum occupancy, exhaust air damper will open and the return damper will modulate inversely to the outdoor air damper. The Exhaust Fan will track the outdoor air damper position. As the outdoor air damper open, the exhaust fan speed will increase.

a. The Supply fan speed will modulate to maintain the duct static pressure setpoint. The duct static pressure setpoint will be reset to satisfy the variable air volume box "worst case scenario". Connected load VAV terminal units will dictate the minimum cfm, heating maximum and cooling maximum setpoints. On a reduced supply air fan speed, the outdoor air damper position will maintain its preset minimum CFM position at maximum occupancy.

b. Each associated zone will be monitored for CO2 levels.

3. When the space requires cooling and the return air enthalpy is higher than the outdoor air enthalpy, the dampers will modulate to maintain a mixed air temperature setpoint. The mixed air temperature setpoint will reset from 55 to 60 degrees (adj.) based on the discharge air temperature setpoint.

4. If cooling is required to maintain the discharge air temperature setpoint and the return air enthalpy is lower than the outdoor air enthalpy, the heat pump cooling mode will be enabled and the compressor will run as indicated below:
   a. For GSHP-2 with one (1) modulating compressor:
      1) The modulating compressor will stage on and modulate to maintain the discharge air setpoint.
      2) For the compressor to stage on, Minimum Off Times of five (5) minutes (adj) must be satisfied as well as Stage Up Delays (adj).
   b. For GSHP-3 with one (1) modulating compressor and one fixed capacity compressor :
      1) The first modulating compressor will stage on and modulate to maintain the discharge air setpoint.
      2) If additional cooling is required, the demand signal to the modulating compressor shall be reduced to 50% then the fixed capacity compressor can be staged on with a minimum five (5) minute (adj) run time while the modulating compressor continues to modulate.
      3) To stage the extra compressor on, the discharge air temperature needs to be above the setpoint and the modulating compressor needs to be at 100% for a period of time equal to the stage up delay of five (5) minutes (adj). Once the fixed compressor is enabled, the modulating compressor will modulate down or up from it's 50% setting to maintain discharge air temperature.
      4) For compressors to stage on, Minimum Off Times, 5 minutes (adj) must be satisfied as well as Stage Up Delays, five(5) minutes (adj).
      5) To stage down the extra compressor on, the discharge air temperature needs to be 2 degrees below the setpoint and the modulating compressor needs to be at 0% for a period of time equal to the stage down delay, five(5) minutes (adj). Once the fixed compressor stages off, the modulating compressor will modulate to 100% and modulate down as needed.
      6) For compressors to stage down, Minimum Run Times, five(5) minutes (adj) must be satisfied as well as Stage Down Delays, five(5) minutes (adj).

5. If heating is required, the heat pump heating mode will be enabled and the compressor will run as indicated below:
   a. For GSHP-2 with one (1) modulating compressor:
      1) The modulating compressor will stage on and modulate to maintain the discharge air setpoint.
      2) For the compressor to stage on, Minimum Off Times of five(5) minutes (adj) must be satisfied as well as Stage Up Delays of five(5) minutes (adj).

b. For GSHP-3 with one (1) modulating compressor and one fixed capacity compressor :
   1) The first modulating compressor will stage on and modulate to maintain the discharge air setpoint.
   2) If additional cooling is required, the demand signal to the modulating compressor shall be reduced to 50% then the fixed capacity compressor can be staged on with a minimum five(5) minute run time while the modulating
   3) To stage the extra compressor on, the discharge air temperature needs to be 2 degrees below the setpoint and the modulating compressor needs to be at 100% for a period of time equal to the stage up delay, of five(5) minutes (adj). Once the fixed compressor is enabled, the modulating compressor will modulate up and down as needed to maintain discharge air temperature.
   4) For compressors to stage on, Minimum Off Times, of five(5) minutes (adj) must be satisfied as well as Stage Up Delays of five(5) minutes (adj).
   5) To stage down the extra compressor on, the discharge air temperature needs to be above the setpoint by 2 deg. F and the modulating compressor needs to be at 0% for a period of time equal to the stage down delay five(5) minutes (adj). Once the fixed compressor stages off, the modulating compressor will modulate to 100% and modulate down as needed.
   6) For compressors to stage down, Minimum Run Times of five(5) minutes (adj) must be satisfied as well as Stage Down Delays of five(5) minutes (adj).

I. Wall mounted CO2 transmitters provided by ATC contractor shall monitor the quality of air in the space. If CO2 detects a level of CO2 above setpoint, the BAS shall increase the amount of outside air brought into the space by modulating the outside air damper open. As the level of CO2 in the space decreases below setpoint, the BAS shall permit the outside air damper to modulate back to occupied minimum CFM setpoint.

J. The fan speed reduction rate will be displayed at the operator workstation and will be changeable by an operator with the proper access level.

K. The duct smoke detectors shall provide a signal to the BAS if products of combustion are present within the system or area served. The BAS will respond to this indication by shutting down the supply and exhaust fan VFDs and closing the outside air damper. An alarm will then be sent to the BAS operator workstation indicating a shutdown of the system has occurred due to the duct smoke detectors.

L. A high static pressure sensor shall monitor the supply duct static pressure. If the static pressure of the supply duct exceeds the setpoint of the sensor, the BAS will command both of the supply and return fan to stop. An alarm shall then be sent to the to the operator workstation indicating a shutdown of the system has occurred due to the duct high static pressure switch. A manual reset will be required in order to restart the system after a high duct static pressure safety shutdown.

M. A water detector will monitor the condensate pan for high water level. If the condensate level switch detects water, compressors will modulate off and fan will shut down. An alarm will be generated at the operator workstation.

N. Temperature Protection:

1. When supply air temperature rises above High Cutoff Temperature (Adj) or drops below the Low Cutoff Temperature (Adj) , the unit shuts down until the mode is cancelled. An alarm will be sent to the BAS Operator Workstation.
2. This mode is cancelled when the Supply air Temperature drops 10 degrees F below the High Cutoff Temperature Setpoint or rises 10 degrees F above the Low Cutoff Temperature Setpoint or when the unit changes back into Occupied Operation.

O. Proof of Flow Interlock
1. A proof of flow switch interlock shall be provided to prevent cooling and heating operation in the event of fan failure.

P. Dirty Filter Status
1. A differential pressure switch shall be provided for filter status indication.

Q. The BAS system will monitor the space temperature sensor. The system will operate in unoccupied mode based on the coldest (heating) and warmest (cooling) monitored temperature.

R. ATC Contractor shall provide all necessary sensors for monitoring and controlling the following conditions (minimum):

S. ATC Contractor shall provide all necessary sensors, for each GSHP unit, for monitoring and controlling the following conditions:

AI	CO2 Level (Coordinate quantity d)	Alarm on High (above 950 PPM)
AI	Outdoor Air CFM	
AI	Return Air Temperature	Alarm on high level
AI	Space Air Relative Humidity	Alarm on high level
AI	Space Air Temperature	
AI	Mixed Air Temperature	Alarm on Failure or +/- setpoint
AI	Compressor position feedback	
AI	Supply Air Temperature	Alarm on Failure or +/- setpoint
AI	Supply Fan Speed Feedback from VFD	
AI	Exhaust Fan Speed Feedback from VFD	
AI	Duct Static Pressure	
AI	Differential Pressure	
AI	0-10V signal from suction pressure transducer	
AO	Supply Fan Speed	
AO	Exhaust Fan Speed	
AO	Outdoor Air Damper Modulate	
AO	Return Air Dampen Open/Close	
AO	Geothermal Water Valve open/Close	
AO	Differential Pressure Setpoint	
AO	1.44- 5 Vdc stage 1 compressor modulation	
AO	0-10V Vdc economizer control	
AO	0-10Vdc Supply Fan control Signal	
DI	Supply Fan Status	Alarm on Fan Start Failure
DI	Supply Fan VFD Fault Status	Alarm on VFD Failure
DI	Exhaust Fan Status	Alarm on Fan Start Failure
DI	Exhaust Fan VFD Fault Status	Alarm on VFD Failure
DI	Hot Gas Reheat Status	

DI	Filter Status	Alarm on high differential pressure
DI	Low Limit Thermostat	Alarm on Low Temperature
DI	High Limit Thermostat	Alarm on High Temperature
DI	Duct pressure high limit	Alarm on high pressure
DI	Supply duct smoke detector	Alarm on smoke
DI	Condensate water detection	Alarm on high level
DI	Air Flow Status	Alarm on No Flow
DI	Water flow status	
DI	Water valve status	
DO	Compressor 1 enable	
DO	Compressor 2 enable (for heat pump with two(2) compressors)	
DO	Heat Pump Reversing Valve	
DO	Supply Fan Start / Stop	
DO	Exhaust Fan Start/Stop	
DO	Outside Air Damper position	
DO	Return Air Damper position	

1.11 SINGLE ZONE VARIABLE AIR VOLUME GSHP (GSHP-4)

A. General:
1. The ground source heat pump unit consist of One (1) fixed capacity compressor.
2. The Automatic Temperature Control Contractor shall provide all controllers and sensors to perform the required sequence of operation.
3. All safety features and setpoints shall be coordinated with the manufacturer.
4. The Automatic Temperature Control Contractor shall provide space temperature.

B. The GSHP shall be indexed for Occupied, Unoccupied or Optimum Start modes by the BAS.

C. The Outdoor air flow CFM will be monitored though the outside air damper position.

D. The systems will operate providing the system safeties are satisfied. The fans shall not start until all smoke and fire/smoke dampers serving the roof mounted ground source heat pump units are proven to be open.

E. Unoccupied Mode:
1. Heating: The heating space temperature set point will be initially set 10 degrees below the occupied setpoint (adj.). The outdoor air and exhaust air damper will remain closed. The return air damper will be open one hundred percent (100%). When space temperature drops below unoccupied setpoint, the supply fan will ramp slowly to fifty percent (50%) speed (adj) and the compressor will stage on until the space temperature is 4 deg F (adj) above unoccupied setpoint.
2. Cooling: The cooling space temperature set point will be initially set 10 degrees above the occupied setpoint (adj.). The outdoor air and exhaust air damper will remain closed. The return air damper will be open one hundred percent (100%). When space temperature rises above unoccupied setpoint, the supply fan will run at fifty percent (50%) speed (adj) and the compressor will stage on until the space temperature drops 2 deg F (adj) below unoccupied setpoint.

3. A timed local override shall allow occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to schedule.

F. Morning Warm Up: Will be initiated by BAS. The unit will be on heating mode and the compressors will modulate to maintain setpoint. The supply fan will ramp slowly to a preset speed. The outdoor and exhaust dampers will remain closed, return air damper will remain one hundred percent (100%) open. When the space reaches setpoint, the system will enter the occupied mode.

G. Occupied Mode: Heating and Cooling- one (1) fixed capacity compressors:
1. The controller shall receive a signal from the secondary loop water source monitor indicating that there is water flow and that the water temperature is within the acceptable limits.
2. The supply fan shall be enabled, the outdoor air damper will modulate open based on minimum position at maximum occupancy, exhaust air damper will open and the return damper will modulate inversely to the outdoor air damper.
3. When the space requires cooling and the return air enthalpy is higher than the outdoor air enthalpy, the dampers will modulate to maintain a mixed air temperature setpoint. The mixed air temperature setpoint will reset from 55 to 60 degrees (adj.) based on the discharge air temperature setpoint.
4. If cooling is required to maintain the discharge air temperature setpoint and the return air enthalpy is lower than the outdoor air enthalpy, the outside air damper will modulated to minimum position, the heat pump cooling mode will be enabled and the compressor will stage on to maintain discharge air temperature setpoint.
    a. For compressors to stage on, Minimum Off Times of five(5) minutes (adj) must be satisfied as well as Stage Up Delays of five(5) minutes (adj).
5. If heating is required, the heat pump heating mode will be enabled and the compressor will stage on to maintain discharge air temperature setpoint.
        1) For compressors to stage on, Minimum Off Times (adj) must be satisfied as well as Stage Up Delays (adj).

H. The wall mounted CO2 transmitter provided by ATC contractor shall monitor the quality of air in the space. If CO2 detects a level of CO2 above setpoint, the BAS shall increase the amount of outside air brought into the space by modulating the outside air damper open. As the level of CO2 in the space decreases below setpoint, the BAS shall permit the outside air damper to modulate back to occupied minimum CFM setpoint.

I. A water detector will monitor the condensate pan for high water level. If the condensate level switch detects water, compressors will modulate off and fan will shut down. An alarm will be generated at the operator workstation.

J. Temperature Protection:
1. When supply air temperature rises above High Cutoff Temperature (Adj) or drops below the Low Cutoff Temperature (Adj) , the unit shuts down until the mode is cancelled.An alarm will be sent to the BAS Operator Workstation.
2. This mode is cancelled when the Supply air Temperature drops 10 degrees F below the High Cutoff Temperature Setpoint or rises 10 degrees F above the Low Cutoff Temperature Setpoint or when the unit changes back into Occupied Operation.

K. Proof of Flow Interlock
   1. A proof of flow switch interlock shall be provided to prevent cooling and heating operation in the event of fan failure.

L. Dirty Filter Status
   1. A differential pressure switch shall be provided for filter status indication.

M. The BAS system will monitor the space temperature sensor.

N. ATC Contractor shall provide all necessary sensors for monitoring and controlling the following conditions:

AI	CO2 Level	Alarm on High (above 950 PPM)
AI	Outdoor Air CFM	
AI	Space Air Relative Humidity	Alarm on high level
AI	Space Air Temperature	
AI	Mixed Air Temperature	Alarm on Failure or +/- setpoint
AI	Compressor position feedback	
AI	Supply Air Temperature	Alarm on Failure or +/- setpoint
AI	Supply Fan Speed Feedback from VFD	
AI	Duct Static Pressure	
AI	0-10V signal from suction pressure transducer	
AO	Supply Fan Speed	
AO	Outdoor Air Damper Modulate	
AO	Return Air Dampen Modulate	
AO	Geothermal Water Valve open/Close	
AO	Stage compressor	
AO	0-10V Vdc economizer control	
AO	0-10Vdc Supply Fan control Signal	
DI	Supply Fan Status	Alarm on Fan Start Failure
DI	Supply Fan VFD Fault Status	Alarm on VFD Failure
DI	Filter Status	Alarm on high differential pressure
DI	Low Limit Thermostat	Alarm on Low Temperature
DI	High Limit Thermostat	Alarm on High Temperature
DI	Duct pressure high limit	Alarm on high pressure
DI	Condensate water detection	Alarm on high level
DI	Air Flow Status	Alarm on No Flow
DI	Water flow status	
DI	Water valve status	
DO	Compressor 1 enable	
DO	Heat Pump Reversing Valve	
DO	Supply Fan Start / Stop	
DO	Outside Air Damper position	
DO	Return Air Damper position	

1.12 VARIABLE AIR VOLUME AIR TERMINAL UNIT

A. General:

1. The Automatic Temperature Control Contractor shall provide all controllers and sensors to perform the required sequence of operation.

B. Modes of operation are determined by a time schedule program in the BAS.

C. The space temperature sensor is monitored and temperature will be communicated to the VAV terminal unit controller.

D. The space CO2 will be monitored. If the CO2 level rises above setpoint, the VAV damper will open until CO2 is or below setpoint or until the VAV terminal unit reaches its maximum flow setpoint. It will then communicate with the associated GSHP unit.

E. The VAV terminal unit is controlled within user defined maximum and minimum supply air volume settings, refer to schedules.

F. When the zone temperature is between the occupied heating and cooling setpoints (inside of the bias), the primary air valve shall be at the minimum position.

G. Heating Occupied Mode:

1. The VAV terminal unit shall operate at first minimum CFM setpoint.
2. On a further drop in space temperature below setpoint, VAV terminal unit primary valve will modulate open to reach heating CFM position.

H. Cooling Occupied Mode:

1. The system monitors the room temperature and air velocity sensor and modulates the primary supply air damper to maintain the room temperature at set point.
2. As room temperature rises above setpoint, the VAV terminal unit primary air valve shall modulate open to increase the CFM to maintain space temperature setpoint.

I. Unoccupied Mode: When the air handling unit shuts down, VAV terminal unit controllers shall be indexed to unoccupied mode.

1. Unoccupied Cooling:

a. When the system is indexed to unoccupied mode, the air handling unit will stop. If the space temperature rises above the night setback setpoint, the VAV box damper will modulate open at minimum position. If any space temperature rises 5 degrees above the setback setpoint, the air handling unit will start and provide cooling to the zone until the zone reaches the night setback temperature setpoint.

2. Unoccupied Heating:

a. When the system is indexed to unoccupied mode, the air handling unit will stop. If the space temperature drops below the night setback setpoint, the VAV box damper will modulate open at minimum position. If any space temperature drops 5 degrees below the setback setpoint, the air handling unit will start and provide heating to the zone until the zone reaches the night setback temperature setpoint.

J. ATC Contractor shall provide all necessary sensors for monitoring and controlling the following conditions:

AI	CO2 Level	Alarm on High (above 950 PPM)
AI	Space Air Relative Humidity	Alarm on high level
AI	Space Air Temperature	
AI	Airflow monitor - CFM	
AO	VAV Damper	
AO	Space Temperature Setpoint	
DI	VAV Damper Status	
DO	VAV Damper Modulate	

1.13 CABINET UNIT HEATERS

A. The Automatic Temperature Control Contractor shall provide all controllers and sensors to perform the sequence of operation.

B. A wall mounted space temperature sensor will control the hot water valve. When the space temperature drops below the space temperature setpoint hot water control valve will modulate open and fan will run.

C. Points List:

AI	Space Air Temperature
DI	Fan Status
DI	Hot water Valve Status
DO	Hot water Valve modulate
DO	Fan enable

1.14 UNIT HEATERS (2 units)

A. The Automatic Temperature Control Contractor shall provide all controllers and sensors to perform the sequence of operation.

B. A wall mounted space temperature sensor will control the hot water valve. When the space temperature drops below the space temperature setpoint, the hot water control valve will modulate open and the fan will run.

C. Points List:

AI	Space Air Temperature	Alarm on -15 degrees F of setpoint
DI	Fan Status	
DI	Hot water Valve Status	
DO	Hot water Valve modulate	
DO	Supply fan enable	

1.15 SPLIT A/C SYSTEM (IT Room)

A. These systems will be provided from the factory with controls. Factory controls shall be interfaced/integrated to BAS. The ATC contractor provide interface, will mount and wire the provided space temperature sensors and provide the interlock wiring for the remote condensing units ATC Contractor to coordinate all required points.

B. The BAS will monitor the associated space temperature. If the space temperature rises above the setpoint by 4 degrees, an alarm will be generated and sent to BAS.

C. The BAS will monitor the associated zone relative humidity.

D. The BAS will monitor the condensate pan and condensate pump associated with the unit. If a high level of water is detected, an alarm will be generated and sent to BAS.

E. Points List:

AI	Space Air Temperature	Alarm on + 4 degrees F of setpoint
AI	Space Relative Humidity	
DO	Indoor and Outdoor unit Start/ Stop	
DI	Indoor and Outdoor Unit Status	Alarm on Failure
DI	Condensate Water Detection	
DI	Condensate Pump	

1.16 VENTILATION SYSTEM - (Break Room)

A. General:

1. The ATC contractor shall provide system enable and system status monitoring.
2. The ventilation system consists of supply and exhaust fans.
3. The ATC contractor shall provide the unit controller and all necessary sensors to operate the unit.

B. Run Conditions: Through wall mounted switch.

C. Points List:

DO	Fan Start/ Stop	
DI	Fan Status	Alarm on failure

1.17 RADON EXHAUST FANS (For quantity and locations refer to Plumbing Plans)

A. The Automatic Temperature Control Contractor shall provide all controllers and sensors to perform the sequence of operation.

B. The radon exhaust fans shall run continuously. Refer to plumbing drawings for more information.

C. The ATC contractor shall install and wire the pressure differential switch as provided by other Division. Coordinate exact location of differential switch in field.

D. Exhaust fan status shall be monitored by a current sensing switch. An alarm status shall be indicated at operator's work station in the event of fan failure.

E. The ATC contractor shall also provide a warning light with audible alarm device to indicate fan failure or pressure drop near the Principal Area. Coordinate location in field.

F. Points List:

DO	Fan Start/ Stop	
DI	Fan Status	Alarm on failure

1.18 MACHINE LAB AIR COMPRESSOR

A. The ATC contractor shall provide system enable and monitoring.

B. Air compressor run status shall be monitored by a current sensing switch.

1.19 VARIABLE FREQUENCY DRIVE INTERFACE

A. Variable Frequency Drive (VFD) Interface Monitor: BacNet as provided by VFD manufacturer. Refer to specification section 262923 for more information.

1. Current VFD status and operating conditions shall be monitored through its communications interface port. The interface shall monitor and trend the points.
   a. Motor Speed RPM
   b. Motor Frequency Hertz
   c. Motor Current Amps
   d. Motor Runtime
   e. VFD Status
   f. In fault Condition
   g. In Bypass

1.20 PLUMBING SUMP PUMP – Refer to plumbing plan for location

A. The ATC contractor shall provide system enable and monitoring.

B. Pump status shall be monitored by a current sensing switch. An Alarm status shall be indicated at the operator's work station in the event of pump failure.

C. POINTS LIST

DO	EP-1 Enable/Disable	
DI	EP-1 Run status	Alarm on Failure

1.21 ENERGY MONITORING

A. Geothermal Primary water loop meter
   1. The BMS shall monitor the geothermal primary water flow , via flowmeter, and the geothermal supply and return water temperature. The BMS will calculate the BTU usage.
   2. graphic display will show the current Geothermal Primary BTU usage level.
   3. The current BTU usage will be compared and displayed as a direct comparison to the previous days BTU usage for the same time period.
   4. The BTU Usage will be graphically displayed on a minute to minute basis. On the same graphic display, the previous day BTU usage will be displayed as a direct comparison.
   5. A separate graphic will display the weekly, monthly and yearly BTU usage as a direct comparison to the previous week, previous month and previous year.
   6. A monthly total will be generated from a daily accumulation. A report will be generated at the end of each month.

B. Geothermal Secondary Water Loop Meter
   1. The BMS shall monitor the geothermal secondary water flow , via flowmeter, and the geothermal supply and return water temperature. The BMS will calculate the BTU usage.
   2. A graphic display will show the current Geothermal Secondary BTU usage level.
   3. The current BTU usage will be compared and displayed as a direct comparison to the previous days BTU usage for the same time period.
   4. The BTU Usage will be graphically displayed on a minute to minute basis. On the same graphic display, the previous day BTU usage will be displayed as a direct comparison.
   5. A separate graphic will display the weekly, monthly and yearly BTU usage as a direct comparison to the previous week, previous month and previous year.
   6. A monthly total will be generated from a daily accumulation. A report will be generated at the end of each month.

C. Hot Water Btu Meter
   1. Provide a complete Btu measurement system, Onicon System-40, or equivalent , with BacNet MS/TP communications interface.
   2. The system shall include a pair of matched temperature sensor, integral inline ultrasonic flow sensor and remote/local display.
   3. The Btu measurement system shall be located before the first cabinet unit heater takeoff connection.
   4. The current BTU usage will be compared and displayed as a direct comparison to the previous days BTU usage for the same time period.
   5. The BTU Usage will be graphically displayed on a minute to minute basis. On the same graphic display, the previous day BTU usage will be displayed as a direct comparison.
   6. A separate graphic will display the weekly, monthly and yearly BTU usage as a direct comparison to the previous week, previous month and previous year.
   7. A monthly total will be generated from a daily accumulation. A report will be generated at the end of each month.

D. Power Monitoring (typical of 2)
   1. The electric meters as provided under Division26 will be interfaced with the BMS by ATC contractor . Coordinate requirements with Division 26. The Schneider Electric Analytic s software shall monitor the consumption on a continual basis. The current KWH and KW usage will be compared and displayed as a direct comparison to the previous days usage for the same time period.
   2. The KWH Usage will be graphically displayed on a minute to minute basis. On the same graphic display, the previous day KWH usage will be displayed as a direct comparison.
   3. A separate graphic will display the weekly, monthly and yearly KWH usage as a direct comparison to the previous week, previous month and previous year.
   4. A monthly total will be generated from a daily accumulation. A report will be generated at the end of each month.

E. Water Flow Meter (typical of 3)
   1. The water meters as provided by Division 22 will be interfaced with the BMS by ATC contractor . Interface requirement shall be coordinated with division 22. The Schneider Electric Analytics software shall monitor the consumption on a continual basis. The current water usage (cu ft or gal) will be compared and displayed as a direct comparison to the previous days usage for the same time period.
   2. The water Usage will be graphically displayed on a minute to minute basis. On the same graphic display, the previous day water usage will be displayed as a direct comparison.
   3. A separate graphic will display the weekly, monthly and yearly water usage as a direct comparison to the previous week, previous month and previous year.
   3. A monthly total will be generated from a daily accumulation. A report will be generated at the end of each month.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 230993

RFI’S

LaRosa
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Project No. BI-CTC-471 – QVCC – Manufacturing Center Addition – RFI List #1

1. Spec section 052100 1.6C "Shop Painting Applicators", states that the shop painting applicator shall be "Qualified according to AISC's sophisticated Paint Endorsement P2". However, the specs only call for a standard shop primer. This requirement would add unnecessary expense and there are no local fabricators who have this certification. Please advise if this requirement can be waived?

   Standard shop primer is acceptable.
   Paul J. Sheehan
   MHAI, 17JUl2015

Mike Garneau

From: Joe Corron <JCorron@ohdct.com>
Sent: Friday, July 17, 2015 8:20 AM
To: Joe Corron
Cc: Mark LePage; Holly Barrows
Subject: RFI Quinebaug Valley C.C. - Manufacturing Center

Good Afternoon,

After reviewing the drawings for the project noted above, I have the following questions.

1. Drawing A910- Door Type 5 calls for equal section heights. The section heights for the commercial doors are 24" and 21". With the door height of 10' 3" equal section heights are not possible.
   How is the door to be configured? SEE (1) BELOW
2. An exception will be taken for the 1" glass requirement. 1" glass is not available only ½" glass is available. ACCEPTED
3. Section 083613 2.7 K -Overhead Door Model "L" Electric Operators are no longer manufactured. An Overhead Door Model RHX will be estimated. ACCEPTED
4. Section 083613-2.6 C 1- Trolley Operation is not available on high lift doors. Side mount electric operation will be required. ACCEPTED
5. Section 083613-2.6 F 2- **Exception:** Four wire configured safety devices are not available, only two wire is available. ACCEPTED -
6. Section 083613-2.7 J- The glass sections panel configuration shown cannot be done. The maximum panel width allowed for non wind load doors is 48" and for wind load doors is 46"
   How is the glass section configuration to be done? SEE (6) BELOW
7. Section 083613-2.7 L 1- **Exception:** Baked-Enamel or Powder coat finish is not available on sectional doors.
   ACCEPTED - USE BAKED POLYESTER, WHICH IS AVAILABLE.

(1) We will accept a 10 foot high door with 24 inch panels. One half inch (½ inch) glass is acceptable if that is all the Manufacturer will provide.

(6) The large panels of glass that exceed 48 inches will be equally divided in half, and the layout will be reviewed during Shop Drawings submittals.

Mike Garneau

From: Jessica Docekal <jessica@stephenaroberts.com>
Sent: Thursday, July 16, 2015 8:10 AM
To: Mike Garneau
Subject: Manufacturing Facility @ Community College

Follow Up Flag: Follow up
Flag Status: Flagged

To Whom this may Concern,
I was looking over the plant list and estimating it and found that it says #5 Russian Sage, That is not supplied the largest I can find is a #2.
Is this a typo?
Thank you very much
Jessica Docekal

Stephen A Roberts Landscape Design & Construction
1160 Bay Street Springfield, MA 01109
Office Number: 413-214-6990
Fax Number: 413-214-6989
Website: www.stephenaroberts.com

The 2-gallon Russian Sage is sufficient in lieu of the 5-gallon Russian Sage.

7/21/15

Richard Abrahams
Will Walter

Mike Garneau

From: Kevin Michaud(kevin@actionairsystems.com) at CT - Action Air Systems <DoNotReply@isqftmail.com>
Sent: Monday, July 20, 2015 9:10 AM
To: Mike Garneau
Cc: Michaud, Kevin
Subject: Project Information Submission

iSqFt *Your Connection to Improved Profits*

1-800-364-2059
www.isqft.com

Hi, MIKE. There's a question and/or comment about your project.

Project Number: 5169904
Project Name: Manufacturing Center Addition Quinebaug Valley ...
Message: Mike: Can fixed spring roof curbs be used in lieu of adjustable spring curbs specified? The specification calls for adjustable spring curbs but the piping drops will conceal the spring so they could not be adjusted per the intent of the specifications. Sincerely Kevin Michaud Action Air Systems, Inc.

If you have questions or need additional information, you may contact the sender using the information below:

Name: Kevin Michaud
Company Name: CT - Action Air Systems
Email Address: kevin@actionairsystems.com
Phone Number: 8606458838

If you need technical assistance, we're here to help at 1-888-768-4569.

Please do not reply directly to this e-mail as we do not monitor this address for responses.

Thanks,
The iSqFt Team

From: Adee Gabriel
To: Dustin Lombardi
Cc: Richard Abrahams
Subject: RE: QVCC RFI #01, CTC-471
Date: Monday, July 20, 2015 12:07:45 PM

Fixed springs can be used in lieu of the adjustable springs.

Also, please issue below as well. What's the minimum number of manufacturer is e allowed in the specs? I would really like to to have only two (2) Cambridgeport and Mason – these are the well the well built curbs. But if three is minimum, then we can the thybar-thanks

Section 230548

2.11 RESTRAINED VIBRATION ISOLATION ROOF CURB

A. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

1. Cambridgeport
2. Mason Industries.
3. Thybar Corporation.

Adora M. Gabriel, PE , LEED AP BD+C
Mechanical Engineer

www.silverpetrucelli.com

SILVER / PETRUCELLI + ASSOCIATES
Architects/Engineers/Interior Designers

3190 Whitney Avenue Bldg 2
Hamden, Connecticut 06518
P: 203-230-9007 ext. 226
F: 203-230-8247
***S/P+A** is a member of the U.S. Green Building Council*

From: Dustin Lombardi
Sent: Monday, July 20, 2015 10:29 AM
To: Adee Gabriel
Cc: Richard Abrahams
Subject: FW: QVCC RFI #01, CTC-471

Take a look at page 3 of the attached RFI. There is a question about the adjustable spring curbs at QVCC. Please provide a response to the question for Richard to include in the addendum. Thank you.

Dustin Lombardi, AIA
Project Architect

RFI

LOCKHEED WINDOW CORP.
P. O. Box 166
Pascoag, RI 02859
Telephone: 401-568-3061 ext.
FAX: 401-568-7270

FACSIMILE

TO:	Silver Petrucelli & Associates	**DATE:**	July 21, 2015
ATTN:	Project Manager	**FAX:**	203 230 8247
FROM:	Stephen Del Rosso	**PAGES:**	(including cover)
RE:	Manufacturing Center Addition, Quinebaug Valley Community College		
C: CSD File			

☐ Urgent	☒ For Review	☐ Per Your Request	☒ Please Reply

Please respond to the following questions related to the specifications:

Drawing A550 Detail 6 (but not limited to):
Glass-mat sheathing is shown as a nailer for the exterior panel system. This product is typically not recommended as a nail base for exterior cladding. The panel system should have a more suitable substrate to fasten to.

Thank you

Stephen Del Rosso
sdelrosso@lockheedwindow.com

cc; Morganti 203 790-6138
Rob Dexter 860 713-7270

Drawing A550, Detail 6 to remain as is. Glass-mat sheathing is to be nailer for the exterior panel system.

7/21/15

Richard Abrahams
Bill Silver

.RFI

LOCKHEED WINDOW CORP.
P. O. Box 166
Pascoag, RI 02859
Telephone: 401-568-3061 ext.
FAX: 401-568-7270

FACSIMILE

TO:	Silver Petrucelli & Associates	**DATE:**	July 20, 2015
ATTN:	Project Manager	**FAX:**	203 230 8347 (8247)
FROM:	Stephen Del Rosso	**PAGES:**	(including cover)
RE:	Manufacturing Center Addition, Quinebaug Valley Community College		
C: CSD File			

☐ Urgent ☒ For Review ☐ Per Your Request ☒ Please Reply

Please respond to the following questions related to the specifications:

Section 085113 page 4, 2.2, I Windborne Debris – Is this a requirement for the project? The glass spec does not support this requirement. No, it is NOT.

Section 085113 page 3, 1.7.2c – Aluminum Finish Warranty 20 years. Not all manufacturers offer a 20 year warranty on their finish. Warranty requirements remain at 20 years.

Section 084413 page 7, 2.5, A.4a . One louver per unit. The detail drawings show a multi blade sunshade (Dtl. B1/A631). Please clarify. Six (6) louvers per unit.

Page 6, 2.1.K. Blast Resistance. Are the aluminum doors to be blast resistant? If so what kind of glass is to be used? NO. Blast resistance is NOT required.

Page 8, 2.5A.1 Door Construction 1-3/4".....Thermal doors are typically 2" deep. Please clarify the type and design of doors required. 2" Thermal doors required.

Thank you

Stephen Del Rosso
sdelrosso@lockheedwindow.com

cc; Morganti 203 790-6138
Rob Dexter 860 713-7270

The spec has the wrong fax # for S.P.

7/21/15

Richard Abrahams
Dustin Lombardi

Transmittal

the nutmeg companies inc.
1 Ohio Avenue
Norwich, CT 06360

Phone: (860) 589-4600
Fax: (860) 589-7474

SUBMITTED FOR:	Code
APPROVAL	1
REVIEW	2
YOUR INFORMATION	3
YOUR ACTION	4
YOUR QUOTATION	5
CONSTRUCTION	6
FABRICATION	7
CORRECTION	8
PER YOUR REQUEST	9
ACTION:	
APPROVED	A
APPROVED AS NOTED	B
NOT APPROVED	C
REVISE & RESUBMIT	D
	E

TO: Silver Petrucelli & Associates, Inc.
3190 Whitney Avenue
Hamden, CT 06518

DATE: July 21, 2015

ATTN: To whom it may concern

RE: QVCC Manufacturing Center Addition
Danielson, CT

DELIVERY: ☐ MAIL ☒ FAX ☐ Messenger ☐ 203.230.8347

We are transmitting 9 pages as described below, including this cover sheet.

QTY	SPEC No.	DATE or REVISION	DESCRIPTION	CODE
1		7/21/15	RFI #1, Vented Nail Board	2,4

Remarks: Please review and respond via an addendum.

copy: Rob Dexter; 860.713.7270

THE NUTMEG COMPANIES, INC.

Jonathan W. Adams
Senior Estimator

nutmeg companies inc.

REQUEST FOR INFORMATION No. 1: VENTED NAIL BOARD

Date: July 21, 2015

Project: QVCC Manufacturing Center Addition

To: Silver/Petrucelli & Associates, Inc.; Rob Dexter

From: Jonathan Adams

QUESTION:

SPECIFICATION REFERENCE: 061600 (Sheathing) **DRAWING REFERENCE:** A501

1. In reference to specification section 061600 (Sheathing), p 2.1 Screwable Vented Deck Assembly, it states that the total thickness of the product is to be 7 5/8". According to the product data sheets, attached, not one of the specified products meets that requirement. Please review and determine the product and thickness we should use.

Use whichever Manufacturer provides the greatest thickness.

RESPONSE: Provide the maximum thickness provided by the Manufacturer.

RESPONSE DATE: 7/21/15

Richard Abrahams
Dustin Lombardi

By:

.RFI

LOCKHEED WINDOW CORP.
P. O. Box 166
Pascoag, RI 02859
Telephone: 401-568-3061 ext.
FAX: 401-568-7270

FACSIMILE

TO:	Silver Petrucelli & Associates	**DATE:**	July 21, 2015
ATTN:	Project Manager	**FAX:**	203 230 8247
FROM:	Stephen Del Rosso	**PAGES:**	(including cover)
RE:	Manufacturing Center Addition, Quinebaug Valley Community College		
C: CSD File			

☐ Urgent ☒ For Review ☐ Per Your Request ☒ Please Reply

Please respond to the following questions related to the specifications:

Section 085000 page 8-9, 2.12 Insulating-Glass Types – The descriptions of glass types GI-12, GI-13 & GI-14 do not match the schedule listed on drawing A620. GI-12 and GI-13 have the same description in the specifications. Is GI-14 spandrel?

See Item No. 4 and Item No. 5, this Addendum.

Thank you

Stephen Del Rosso
sdelrosso@lockheedwindow.com

cc; Morganti 203 790-6138
Rob Dexter 860 713-7270

nutmeg companies inc.

REQUEST FOR INFORMATION No. 2: TOILET ACCESSORY LOCATIONS

Date: July 21, 2015

Project: QVCC Manufacturing Center Addition

To: Silver/Petrucelli & Associates, Inc.; Rob Dexter

From: Jonathan Adams

QUESTION:

SPECIFICATION REFERENCE: 102800 (Toilet Accessories) **DRAWING REFERENCE:** N/A

1. In reference to specification section 102800 (Toilet Accessories), please review and determine the quantities and/or locations of the specified products we should use.

RESPONSE: See Revised Dwg. A-720, Attached to this Addendum.

RESPONSE DATE: 7/21/15

By: Richard Abrahams + Katherine Berger

nutmeg companies inc.

REQUEST FOR INFORMATION No. 3: FIRE EXTINGUISHER LOCATIONS

Date: July 21, 2015

Project: QVCC Manufacturing Center Addition

To: Silver/Petrucelli & Associates, Inc.; Rob Dexter

From: Jonathan Adams

QUESTION:

SPECIFICATION REFERENCE: 104413 / 104416 (Fire Extinguishers & Cabinets) **DRAWING REFERENCE:** N/A

1. In reference to specification sections 104413 (Fire Protection Cabinets) and 104416 (Fire Extinguishers), please review and determine the quantities and/or locations of the specified products we should use.

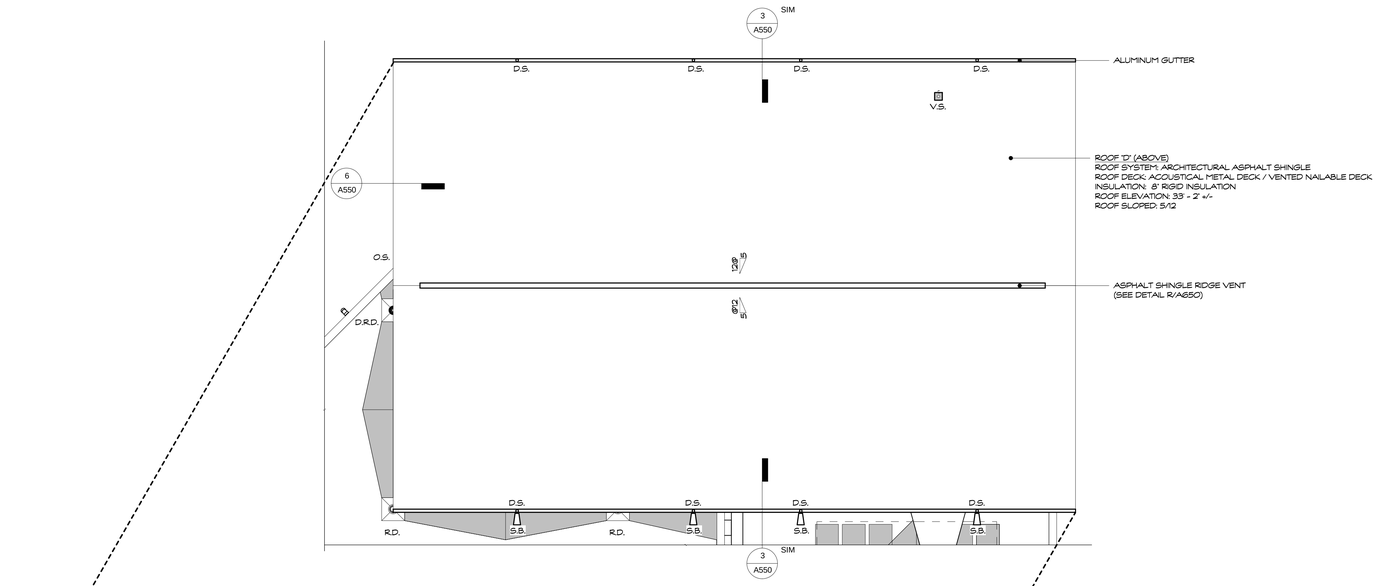
RESPONSE: 5 FIRE EXTINGUISHERS AND CABINETS TOTAL IN FOLLOWING SPACES: 2 IN MACHINE LAB ROOM 112 AND ONE (1) EACH IN MECHATRONICS 106, METROLOGY 107, MECH. 108. LOCATIONS TO BE DETERMINED IN FIELD.

RESPONSE DATE: ~~7/21/15~~ 7/21/15

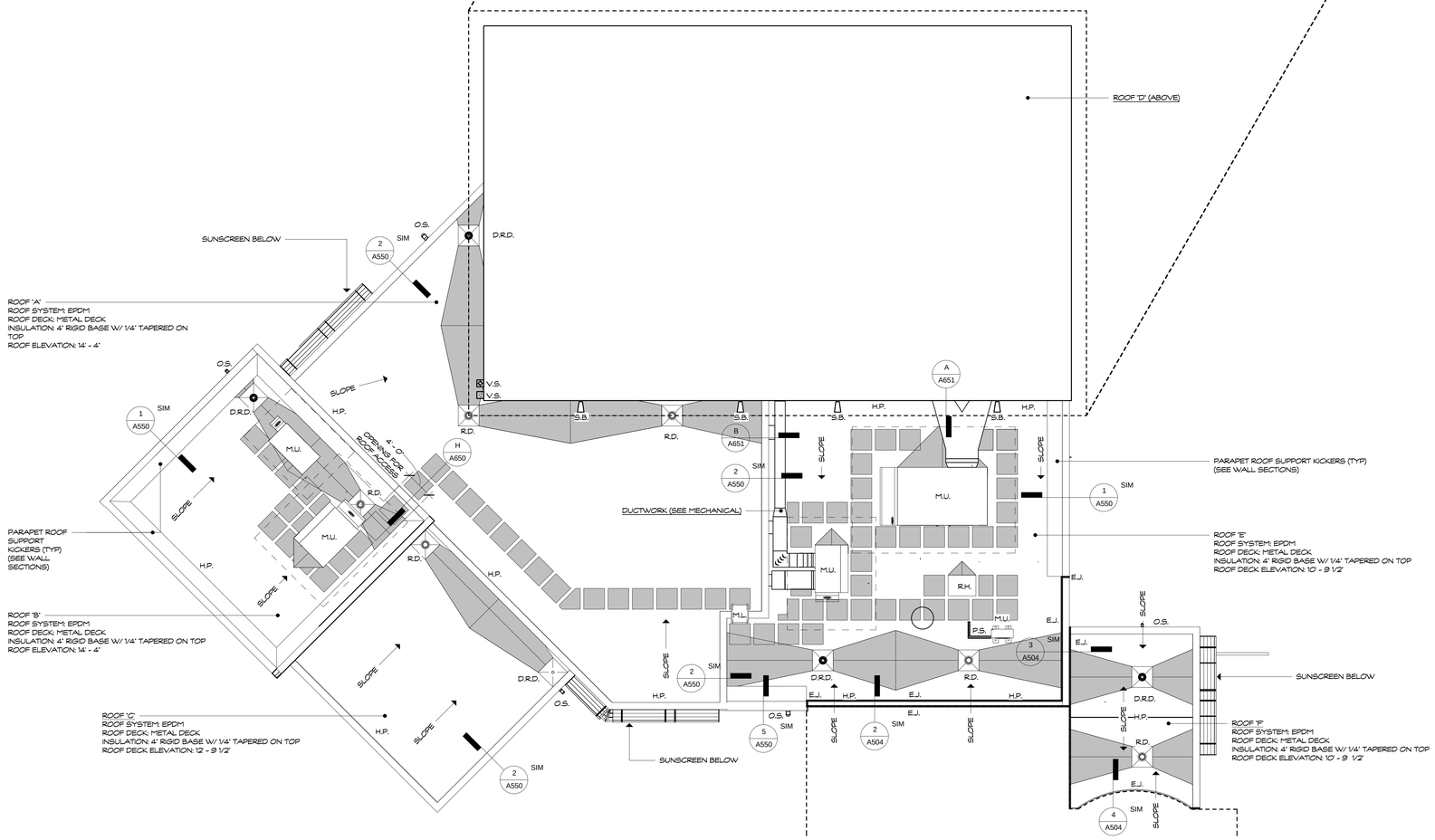
By: Richard Abrahams / Dustin Lombardi

1 Ohio Avenue, Norwich, CT 06360 * (860) 823-1780 * Fax (860) 885-1421 * http://www.nutmegcompanies.com

S1-0303617 P1-203699 F1-10466



UPPER ROOF PLAN
SCALE: 1/8" = 1'-0"
NORTH
2
A130



LOWER ROOF PLAN
SCALE: 1/8" = 1'-0"
NORTH
1
A130

SYMBOL LEGEND

- (X) - PLAN, SECTION, DETAIL OR ELEVATION NUMBER- SHEET NUMBER
- ---- - EXISTING OUTLINE OF BUILDING
- SLOPE - INDICATES SLOPE DIRECTION OF TAPERED INSULATION @ 1/4" 1'-0"
- H.P. - INDICATES HIGH POINT OF INSULATION.
- R.D. - ROOF DRAIN & SUMP TO BE INSTALLED. - SEE DETAIL A/A650
- O.S. - OVERFLOW SCUPPER SEE DETAIL- N/A650
- D.S. - METAL DOWNSPOUT.
- S.B. - CONCRETE SPLASH BLOCK.
- - TAPERED INSULATION CRICKET SLOPED AT 1" PER FT
- V.S. - VENT STACK. SEE DETAIL- F/A650 & K/A 650
- M.U. - MECHANICAL UNIT. -SEE DETAIL- G/A650 & L/A650
- P.P. - PITCH POCKET. -SEE DETAIL-C/A650
- - WALK WAY PADS. -(CONTRASTING COLOR OF ROOF)
- E.J. - EXPANSION JOINT.
- M.L. - NEW METAL LADDER. -SEE DETAIL P/A650
- R.H. -ROOF HATCH - SEE DETAIL D/A650 (SEE PROJECT MAN. FOR GAURD RAILS AND ACCESSORIES)
- D.R.D. - DUAL ROOF DRAIN & SUMP - SEE DETAIL E/A650

GENERAL NOTES

1. ALL FLAT ROOFS TO RECEIVE 1/4" SLOPE
2. ALL MATERIALS ARE NEW UNLESS OTHERWISE NOTED 'EXISTING'.
3. ALL WOOD BLOCKING, PLYWOOD & NAILERS FIRE TREATED (F.R.T)
4. ALL MEMBRANE FLASHING INDICATED IS TO EXTEND A MINIMUM OF 8" (VERTICAL OR HORIZONTAL).
5. CONTRACTOR TO INSPECT THE UNDERSIDE OF ALL ROOFS PRIOR TO ROOFING OPERATIONS TO INSURE THAT NO INTERIOR MATERIALS, EQUIPMENT FINISHES OR OBJECTS WILL BE DAMAGED.
6. CONTRACTOR ASSUMES ALL RESPONSIBILITY DURING PROJECT & WILL REPLACE ANY & ALL DAMAGED EQUIPMENT AT NO ADDITIONAL COST TO THE OWNER.
7. SITE AREAS DISTURBED SHALL BE CLEANED & RE-LEVELED, W/ LAWN AREAS MAGNETICALLY RAKED TO REMOVE ANY METAL DEBRIS & RE-SEEDED AS REQUIRED TO MATCH ADJACENT CONDITIONS.
8. CONTRACTOR ASSUMES ALL RESPONSIBILITY FOR CLEAN UP OF ROOFING MATERIALS & DEBRIS THAT PENETRATE THE INTERIOR ENVELOPE OF THE BUILDING W/ NO ADDITIONAL COST TO THE OWNER.
9. ALL CRICKETS ARE TO BE A MINIMUM OF 1" PER FOOT & COORDINATE CRICKETS AROUND HVAC UNITS AS REQUIRED TO AVOID PONDING.
10. EXACT ROUTE OF DRAIN PIPING IS TO BE DETERMINED IN THE FIELD, MAKE MINOR ADJUSTMENTS TO THE ROUTE AT NO ADDITIONAL COST TO THE OWNER.
11. NEW INSULATION TO BE A MINIMUM 4" BASE LAYER RIGID INSULATION BENEATH ALL TAPERED INSULATION.
12. ELEVATION MEASUREMENTS TAKEN FROM TOP OF DECK.
13. ALL ROOFING INSULATION IS RIGID TAPERED WITH PROTECTION BOARD, UNLESS NOTED OTHERWISE

ROOF AREAS

ROOF 'A'	2,235 SF
ROOF 'B'	1,025 SF
ROOF 'C'	795 SF
ROOF 'D'	5,625 SF
ROOF 'E'	445 SF
ROOF 'F'	1,955 SF
TOTAL:	12,080 SF

THIS AREA IS APPROXIMATE

ROOF 'D'

OUTSIDE AIR	0.17
ASPHALT SHINGLE	2.20
WOOD DECK	1.23
8" RIGID INSULATION	44.8
METAL DECK	0.0
INSIDE AIR	0.61
R TOTAL:	49.01

ROOF 'A', 'B', 'C', 'E', & 'F'

OUTSIDE AIR	0.17
EPDM	0.33
COVER BOARD	2.20
4" RIGID INSULATION	22.4
AVG 4" TAPERED INSULATION	22.4
METAL DECK	0.0
INSIDE AIR	0.61
R TOTAL:	48.11

ENERGY CONSERVATION

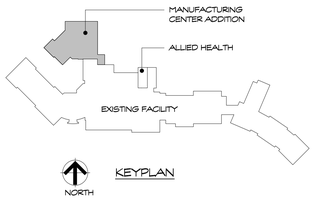
IBC CODE REQUIREMENT R-VALUE TOTAL
CONNECTICUT ZONE 5A
CBSC REQUIREMENT: R24 = U .042 OR LESS

CODE INFORMATION

USE GROUP: B
CONSTRUCTION CLASS: 2B
BASIC WIND SPEED: 105 MPH
SURFACE ROUGHNESS EXPOSURE: C
IMPORTANCE FACTOR: 1.15

FACTORY MUTUAL ENGINEERINGE RESEARCH CORPORATION (FM): ROOF ASSEMBLY CLASSIFICATION OF NON-COMBUSTIBLE CONSTRUCTION, WIND UPLIFT REQUIREMENTS IN ACCORDANCE WITH FM PROPERTY LOSS PREVENTION DATA SHEETS 1-28 (SEE CHART BELOW)

ROOF AREA	FIELD (PSF)	PERIMETER (PSF)	CORNERS (PSF)	PERIMETER	CORNER
A	60	90	135	3FT	3FT X 3FT
B	60	90	135	3FT	3FT X 3FT
C	60	90	135	3FT	3FT X 3FT
D	60	105	150	6FT	6FT X 6FT
E	60	90	135	4FT	4FT X 4FT
F	60	90	135	3FT	3FT X 3FT



KEYPLAN

drawing title: ROOF PLAN

REVISIONS

mark	date	description
1	7/16/15	ADDENDUM # 3

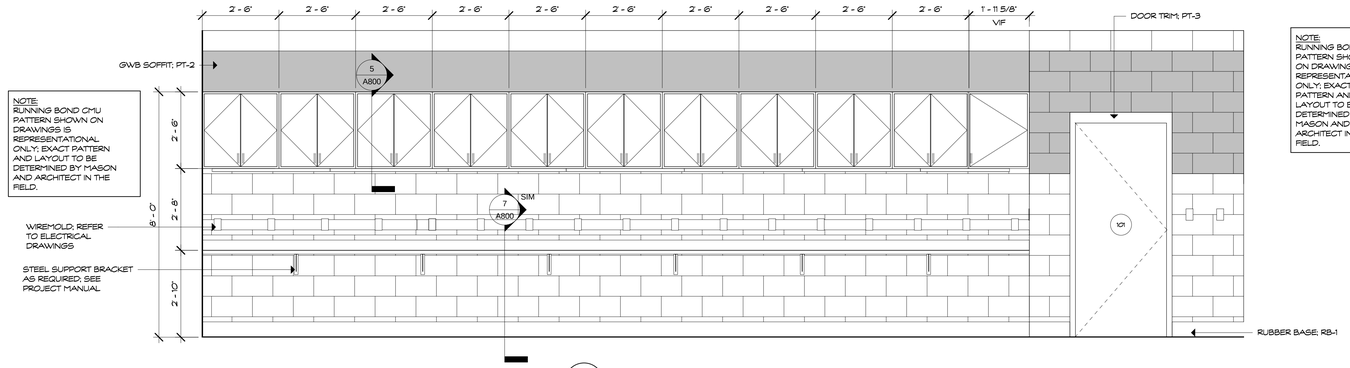
STATE OF CONNECTICUT
DEPARTMENT OF ADMINISTRATIVE SERVICES

DRAWING PREPARED BY
Silver/Petrucelli + Associates
3190 Whitney Avenue
Hamden, CT 06518

project
Quinebaug ValleyCommunity College
Manufacturing Center
DANIELSON, CONNECTICUT

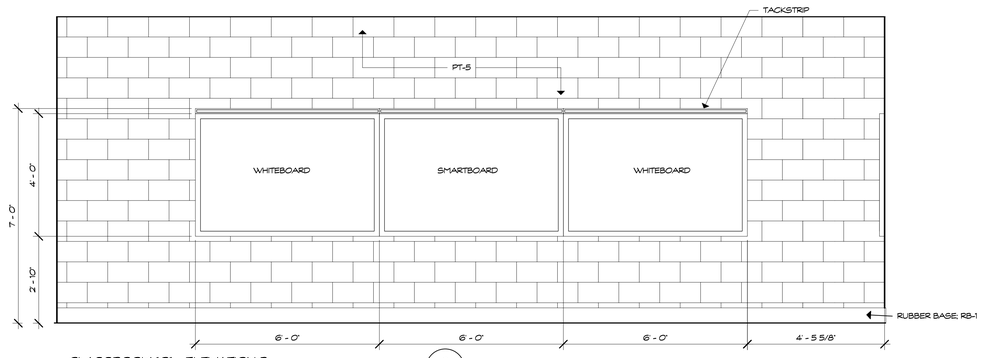
CAD no.
project no. BI-CTC-471

date 5.08.2015
scale AS NOTED
drawn by DML
approved by
drawing no. A130

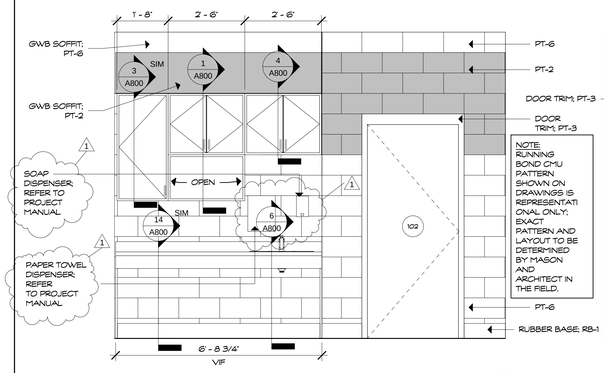


CLASSROOM 101 - ELEVATION A
SCALE: 1/2" = 1'-0"
1 A720

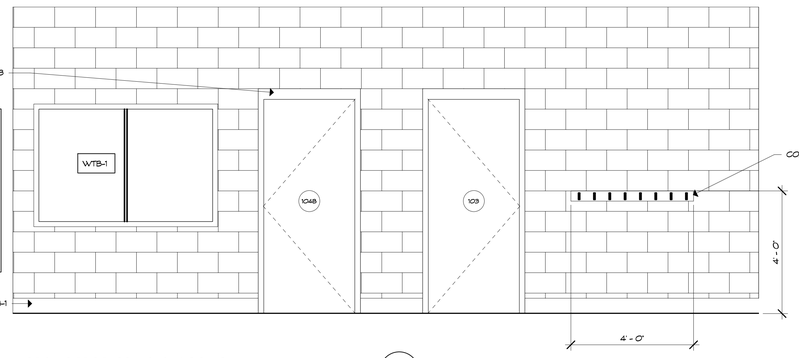
NOTE: RUNNING BOND CMU PATTERN SHOWN ON DRAWINGS IS REPRESENTATIONAL ONLY; EXACT PATTERN AND LAYOUT TO BE DETERMINED BY MASON AND ARCHITECT IN THE FIELD.



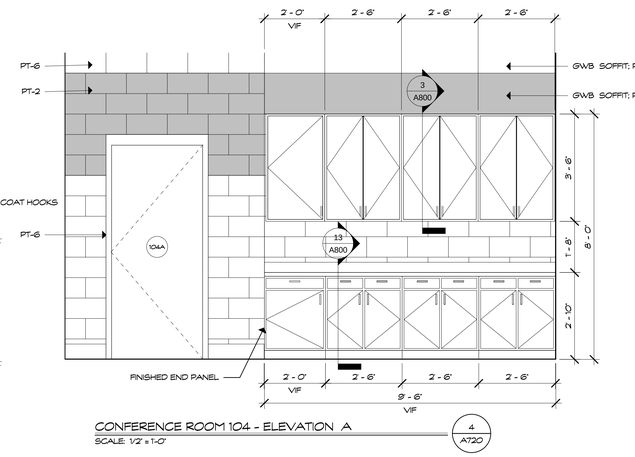
CLASSROOM 101 - ELEVATION B
SCALE: 1/2" = 1'-0"
2 A720



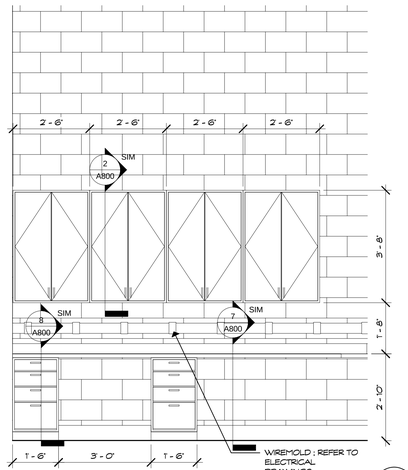
OPEN OFFICE 102 - ELEVATION A
SCALE: 1/2" = 1'-0"
3 A720



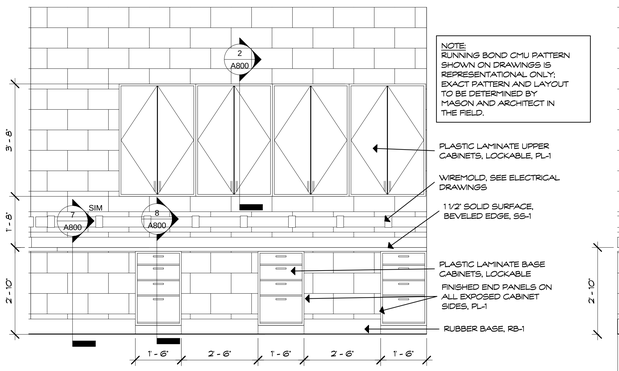
OPEN OFFICE 102 - ELEVATION B
SCALE: 1/2" = 1'-0"
8 A720



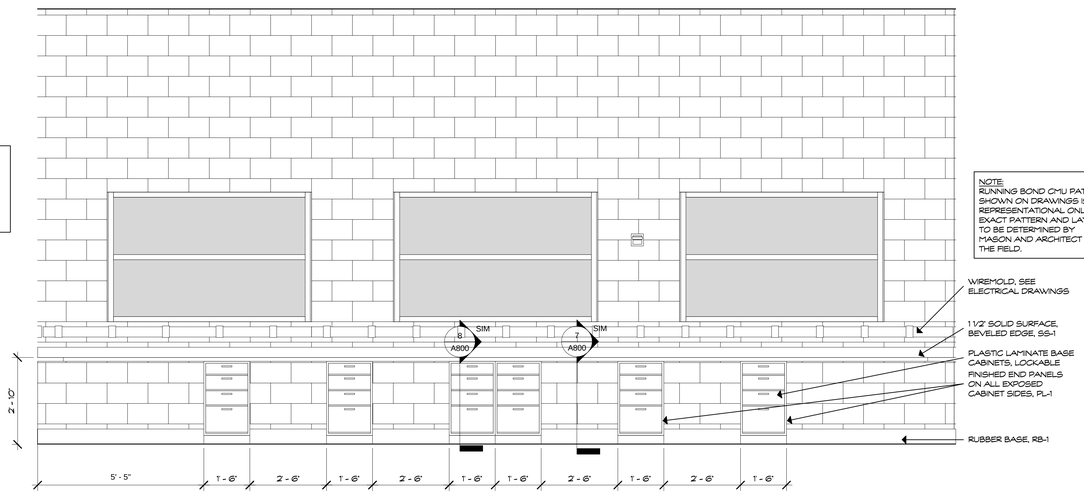
CONFERENCE ROOM 104 - ELEVATION A
SCALE: 1/2" = 1'-0"
4 A720



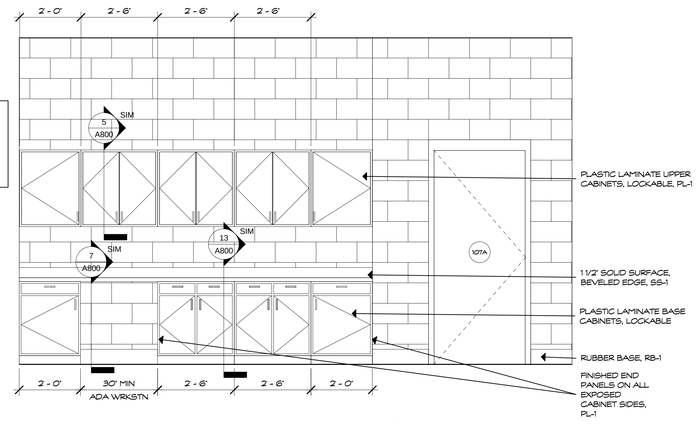
MECHATRONICS 106 - ELEVATION C
SCALE: 1/2" = 1'-0"
7 A720



MECHATRONICS 106 - ELEVATION A
SCALE: 1/2" = 1'-0"
5 A720



MECHATRONICS 106 - ELEVATION B
SCALE: 1/2" = 1'-0"
6 A720



METROLOGY 107 - ELEVATION C
SCALE: 1/2" = 1'-0"
9 A720

drawing title
INTERIOR ELEVATIONS

REVISIONS

mark	date	description
1	7/16/15	ADDENDUM # 3

STATE OF CONNECTICUT
DEPARTMENT OF ADMINISTRATIVE SERVICES

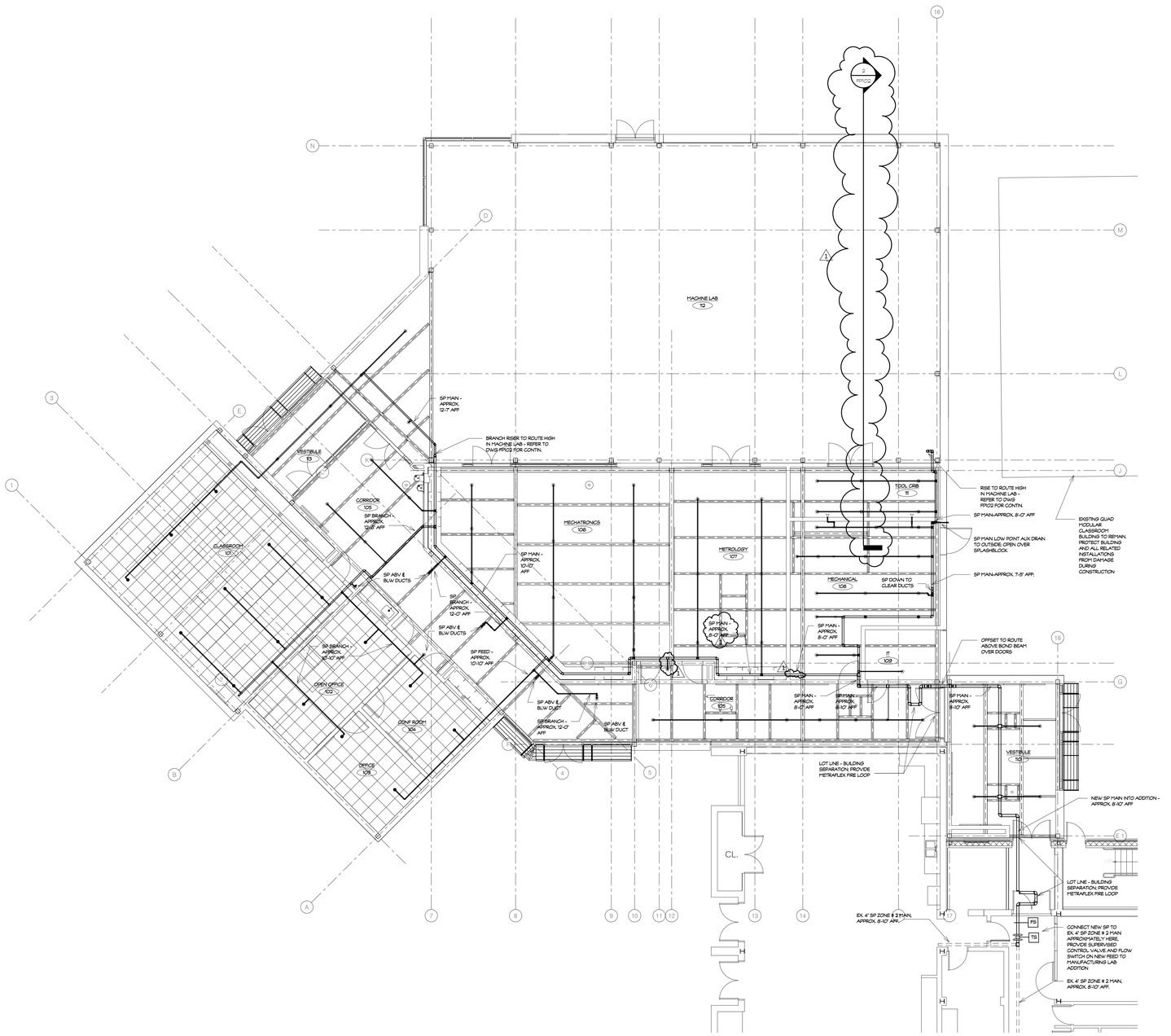
DRAWING PREPARED BY
Silver/Petrucelli + Associates
3190 Whitney Avenue
Hamden, CT 06518

date 5.08.2015
scale AS NOTED
drawn by KC
approved by

project
Quinebaug ValleyCommunity College
Manufacturing Center
DANIELSON, CONNECTICUT

CAD no.
project no. BI-CTC-471

drawing no. A720

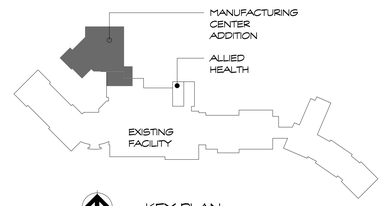


NORTH

MAIN LEVEL FIRE PROTECTION PLAN

SCALE: 1/8" = 1'-0"

1 / FP101



NORTH

KEY PLAN

drawing title
ADDITION-MAIN LEVEL FIRE PROTECTION PLAN

REVISIONS

mark	date	description
1	7/15/15	ADDENDUM #3

STATE OF CONNECTICUT
DEPARTMENT OF ADMINISTRATIVE SERVICES

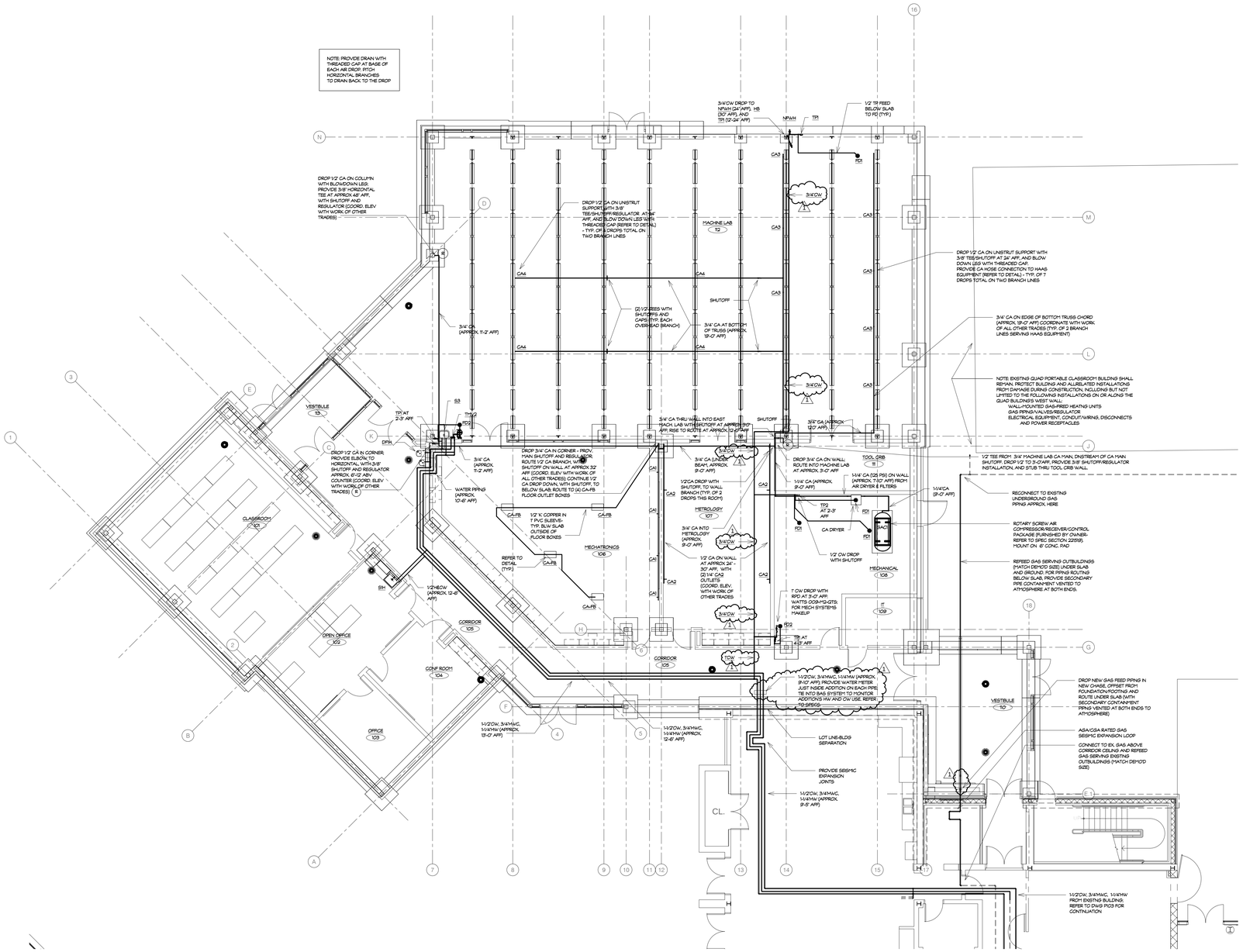
DRAWING PREPARED BY
Silver/Petrucelli + Associates
3190 Whitney Avenue
Hamden, CT 06518

project
Quinebaug Valley Community College
Manufacturing Center
DANIELSON, CONNECTICUT

CAD no.

project no.
BI-CTC-471

date 5.08.2015
scale 1/8" = 1'-0"
drawn by MBQ
approved by KJS
drawing no. FP101



NORTH

ADDITION PLUMBING PLAN - SUPPLY

SCALE: 1/8" = 1'-0"

1 / P101

drawing title			
ADDITION PLUMBING PLAN - SUPPLY			
REVISIONS			
mark	date	description	
1	7/15/15	ADDENDUM #3	

STATE OF CONNECTICUT
DEPARTMENT OF ADMINISTRATIVE SERVICES

DRAWING PREPARED BY
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project
Quinebaug Valley Community College
Manufacturing Center
DANIELSON, CONNECTICUT

date	scale	drawn by	approved by	drawing no.
5.08.2015	1/8" = 1'-0"	MBQ	KJS	P101

CAD no. | project no. BI-CTC-471