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March 6, 2025

BID ADDENDUM No. 1

Re: Bedford UFSD
Phase 2 – Bond Improvements at
Fox Lane High School, Fox Lane Middle
School, Administration Building
BBS File No. 23-131a-c

This addendum contains changes to the requirements of the contract drawings and/or project manual. Such changes shall be incorporated into the contract documents and shall apply to the work with the same meaning and force as if they had been included in the original documents. Wherever this addendum modifies a portion of a paragraph of project manual or any portion of the drawing, the remainder of the paragraph or drawing affected shall remain in force.

The conditions of the basic project manual shall govern all work described in this addendum. Wherever the conditions of work and the quality or quantity of materials or workmanship are not fully described in this addendum, the conditions of work, etc. included in the basic project manual for similar items of work shall apply to the work described in this addendum.

The "Conditions of the Contract" apply to all work described in this addendum.

The following changes shall be and are hereby made:

PROJECT MANUAL MODIFICATIONS

1. 012600.1 – Request for Information

- a. The specification section attached shall be added to the Project Manual.

2. 230923 – Sequence of Operations

- a. The specification section attached shall be added to the Project Manual.

3. 230923 – Direct Digital Control System for HVAC

- a. The specification section attached shall be added to the Project Manual.

CONSTRUCTION DOCUMENT MODIFICATIONS

- 1. 23-131B M0.01 – General Notes, Legends, Etc.**
 - a. The attached drawing shall be added to the Construction Documents.
- 2. 23-131B M1.01 – Demolition Plans**
 - a. The attached drawing shall be added to the Construction Documents.
- 3. 23-131B M2.01 – Proposed First and Second Floor Plans**
 - a. The attached drawing shall be added to the Construction Documents.
- 4. 23-131B M2.02 – Proposed First and Second Floor Plans**
 - a. The attached drawing shall be added to the Construction Documents.
- 5. 23-131B M2.03 – Proposed Third Floor and Second Floor Plans**
 - a. The attached drawing shall be added to the Construction Documents.
- 6. 23-131B M6.01 – Schedules and Details**
 - a. The attached drawing shall be added to the Construction Documents.
- 7. 23-131B M6.02 – Schedules and Details**
 - a. The attached drawing shall be added to the Construction Documents.
- 8. 23-131B M6.03 – Schedules and Details**
 - a. The attached drawing shall be added to the Construction Documents.
- 9. 23-131B M6.04 – Schedules and Details**
 - a. The attached drawing shall be added to the Construction Documents.
- 10. 23-131B M6.05 – Schedules and Details**
 - a. The attached drawing shall be added to the Construction Documents.

END OF ADDENDUM

REQUEST FOR INFORMATION

RFI No.:

Date:

Project:

BBS Project No.:

Location:

To The Attention of :

Company:

Requested BY:

Trade:

Phone:

Fax:

Date Information Required By:

Description:

Spec Section/ Dwg:

Reply:

BY:

FIRM:

BBS Architects, Landscape Architects & Engineers, P.C.

DATE:

If a "Request for Information" is deemed relevant and appropriate by the Architect, the Architect's response to such requests shall be made in writing within any time limits agreed upon or otherwise with reasonable promptness. Upon evaluation of the Prime Contractor's request and if deemed necessary, the Architect's response may include supplemental drawings and specifications.

DIVISION 23 - MECHANICAL

SECTION 23 09 23 - DIRECT DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Scope: Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, configuration and installation for complete building automation system (also identified as BMS, Direct Digital Control System For HVAC) including all necessary hardware and all operating and applications software as required for the complete performance of the Work, as shown on the Drawings, as specified herein. There is an existing "Andover / Schneider General BMS at this building that is to be modified / amended to include the new / existing HVAC equipment added under this contract.
- B. Related Sections: Related sections include, but shall not be limited to, the following:
 - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
 - 2. Applicable general requirements for electrical Work specified within Divisions 23, Specification Sections for all equipment within division 22 and 23 apply to this Section.
- C. Network level components of the system - workstations, servers, etc. shall communicate using the BACnet protocol, as defined by ASHRAE Standard 135-2004. No gateways shall be used for communication to controllers furnished under this section.
- D. At a minimum, provide controls for the following:
 - 1. Air Handling Units
 - 2. Fin Tube Radiators
 - 3. Cabinet unit heaters
 - 4. Exhaust and Supply Fans
 - 5. Unit Ventilators
 - 6. DX / VRF air conditioning systems
 - 7. Energy Recovery Units
- E. Except as otherwise noted, the control system shall consist of all necessary Ethernet Network Controllers, Standalone Digital Control Units, Room Controllers, workstations, software, sensors, transducers, relays, valves, dampers, damper operators, control panels, and other accessory equipment, along with a complete system

of electrical interlocking wiring to fill the intent of the specification and provide for a complete and operable system. Line voltage wiring necessary for temperature controls / temperature control power supplies is to be included under this contract. 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.

- F. The BAS system supplier 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.
- G. All interlocking wiring, wiring and installation of control devices associated with the equipment listed below shall be provided under this Contract. When the BAS system is fully installed and operational, the BAS system supplier 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 system supplier shall demonstrate the operation of the system and prove that it complies with the intent of the drawings and specifications.
- H. Provide services and manpower necessary for commissioning of the system in coordination with the HVAC Contractor, Balancing Contractor and Owner's representative.
- I. 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.
- J. Related Sections
 - 1. This Section includes the Building Management System (BMS) control equipment 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, 26, & 28.
 - 2. Additional related sections and sub-sections can apply.
 - a. 25 00 10 Intelligent Building Management System (iBMS)
 - b. 25 01 00 Operation and Maintenance of Integrated Automation
 - c. 25 08 00 Commissioning of Integrated Automation
 - d. 25 09 93 Sequence of Operations for HVAC Controls
 - e. 25 11 00 Integrated Automation Network Devices

- f. 25 13 00 Integrated Automation Control and Monitoring Network
- g. 26 09 13 Embedded Power and Energy Management Software
- h. 26 09 23.01 Metering and Switchboard Instruments
- i. 26 09 23.02 Lighting Control Devices - Photoelectric
- j. 26 09 23.03 Lighting Control Devices - Incandescent Dimming
- k. 26 09 23.04 Lighting Control Devices - Fluorescent Dimming
- l. 26 09 24 Lighting Control Devices - Low Voltage

1.2 REFERENCES

- A. General, Code Compliance: The code listed below form a part of this Specification to the extent referenced. The codes are referred to in the text by the basic designation only. The edition/revision of the referenced code shall be the latest date as of the date of the Contract Documents, unless otherwise specified.
 - 1. Provide BAS components and ancillary equipment, which are UL-916 listed and labeled.
 - 2. All equipment or piping used in conditioned air streams, spaces or return air plenums shall comply with NFPA 90A Flame/Smoke/Fuel contribution rating of 25/50/0 and all applicable building codes or requirements.
 - 3. All wiring shall conform to the National Electrical Code.
 - 4. All smoke dampers shall be rated in accordance with UL 555S.
 - 5. Comply with FCC rules, Part 15 regarding Class A radiation for computing devices and low power communication equipment operating in commercial environments.
 - 6. Comply with FCC, Part 68 rules for telephone modems and data sets.

1.3 DEFINITIONS

- A. Unless specifically defined within the Contract Documents, the words or acronyms contained within this specification shall be as defined within, or by the references listed within this specification, the Contract Documents, or, if not listed by either, by common industry practice.
 - 1. Standard
 - a. ASHRAE: American Society Heating, Refrigeration, Air Conditioning Engineers
 - b. AHU: Air Handling Unit
 - c. BACnet: Building Automation Controls Network
 - d. BMS: Building Management System
 - e. DDC: Direct Digital Control
 - f. EIA: Electronic Industries Alliance
 - g. GUI: Graphical User Interface

- h. HVAC: Heating, Ventilation, and Air Conditioning
 - i. IEEE: Institute Electrical Electronic Engineers
 - j. MER: Mechanical Equipment Room
 - k. PID: Proportional, Integral, Derivative
 - l. VAV: Variable Air Volume Box
2. Communications and protocols
- a. ARP: Address Resolution Protocol
 - b. BACnet: Building Automation and Control Networks
 - c. CORBA: Common Object Request Broker Architecture
 - d. CSMA/CD: Carrier Sense Multiple Access/Collision Detect
 - e. DDE: Dynamic Data Exchange
 - f. FTP: File Transfer Protocol
 - g. FTT: Free Topology Transceivers
 - h. HTTP: Hyper Text Transfer Protocol
 - i. IIOP: Internet Inter-ORB Protocol
 - j. IP: Internet Protocol
 - k. LAN: Local Area Network
 - l. LON: Echelon Communication - Local Operating Network
 - m. MS/TP: Master Slave Token Passing
 - n. OBIX: Open Building Information Exchange
 - o. ODBC: Open Database Connectivity
 - p. ORB: Object Request Broker
 - q. SNVT: Standard Network Variables Types
 - r. SQL: Structured Query Language
 - s. UDP: User Datagram Protocol
 - t. XML: eXtensible Markup Language
3. Controllers
- a. ASD: Application Specific Device
 - b. AAC: Advanced Application Controller
 - c. ASC: Application Specific Controller
 - d. CAC: Custom Application Controller
 - e. DCU: Distributed Control Unit
 - f. HRC: Hotel Room Controller
 - g. LCM: Local Control Module
 - h. MC: MicroControllers
 - i. MPC: Multi-purpose Controller
 - j. NSC: Network Server Controller
 - k. PEM: Package Equipment Module
 - l. PPC: Programmable Process Controller
 - m. RC: Room controller
 - n. RPC: Room Purpose Controller
 - o. SDCU: Standalone Digital Control Units
 - p. SLC: Supervisory Logic Controller
 - q. UEC: Unitary Equipment Controller

- r. VAVDDC: Variable Air Volume Direct Digital Controller
- 4. Tools and Software
 - a. AFDD: Automated Fault Detection and Diagnostic
 - b. APEO: Automated Predictive Energy Optimization
 - c. DR: Demand Response
 - d. CCDDT: Configuration, Commissioning and Diagnostic Tool
 - e. BPES: BACnet Portable Engineering Station
 - f. LPES: LON Portable Engineering Station
 - g. POT: Portable Operator's Terminal
 - h. PEMS: Power and Energy Management Software
 - i. MTBF: Mean Time Between Failure

1.4 SYSTEM DESCRIPTION

- A. In accordance with 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.
- B. For this project, the system shall consist of the following components:
 - 1. Administration and Programming Workstation(s): The BAS system supplier shall include Operation software and architecture 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 system supplier 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 system supplier shall furnish needed quantity of 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 BACnet Building Controllers (B-BC).

4. Standalone Digital Control Units (SDCUs): Provide the necessary quantity and types of SDCUs to meet the requirements of the project for mechanical equipment control including air handlers, central plant control, and terminal unit control. Each SDCU will operate completely standalone, containing all of the I/O and programs to control its associated equipment. Each 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 BACnet Advanced Application Controllers (B-AAC).
- C. The Local Area Network (LAN) shall be either a 10 or 100 Mbps Ethernet network supporting BACnet, Modbus, XML and HTTP 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.
 - D. 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.
 - E. The system shall enable an open architecture that utilizes EIA standard 709.1, the LonTalk™ protocol and/or ANSI / ASHRAE™ Standard 135-2004, BACnet functionality to assure interoperability between all system components. Native support for the LonTalk™ protocol and the ANSI / ASHRAE™ Standard 135-2004, 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.
 - F. The system shall enable an architecture that utilizes a MS/TP selectable 9.6-76.8 Kbaud protocol, as a common communication protocol between controllers and integral ANSI / ASHRAE™ Standard 135-2004, 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 135-2004, 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.
 - G. LonTalk™ packets may be encapsulated into TCP/IP messages to take advantage of existing infrastructure or to increase network bandwidth where necessary or desired.
 1. Any such encapsulation of the LonTalk™ protocol into IP datagrams shall conform to existing LonMark™ guide functionality lines for such encapsulation and shall be based on industry standard protocols.

2. The products used in constructing the BMS shall be LonMark™ compliant.
 3. In those instances, in which Lon-Mark™ devices are not available, the BMS system supplier shall provide device resource files and external interface definitions for LonMark devices.
- H. The software tools required for network management of the LonTalk™ protocol and the ANSI / ASHRAE™ Standard 135-2004, 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. BACnet clients shall comply with the BACnet Operator Workstation (B-OWS) device profile; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet IP or MS/TP. Physical connection of LonWorks devices shall be via Ethernet IP or FTT-10A.
- I. The system shall provide support for Modbus TCP and RTU protocols natively, and not require the use of gateways.
- J. 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 HTML5 enabled browsers without requiring proprietary operator interface and configuration programs. The system shall not require JAVA to be enabled in the browser.
 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.
- K. 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.

- L. 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.

1.5 SUBMITTALS

- A. General: Submittals shall be in accordance with the requirements of Section 01 33 00 Submittals and Section 23 00 10 Mechanical, in addition to those specified herein.
 - 1. 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.
 - 2. Shop drawings shall include a riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also included shall be individual schematics of each mechanical system showing all connected points with reference to their associated controller. Typical's will be allowed where appropriate.
 - 3. 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.
 - 4. 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.
 - 5. 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.
 - 6. 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.
 - 7. 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".

- a. System architecture drawing.
 - b. Layout drawing for each control panel
 - c. Wiring diagram for individual components
 - d. System flow diagram for each controlled system
 - e. Instrumentation list for each controlled system
 - f. Sequence of control
 - g. Binding map
 - h. A matrix sheet detailing all system addresses and communication settings for the following:
 - 1) All IP network addresses & settings
 - 2) All BMS device addresses & communication settings
 - i. Operation and Maintenance Manuals
8. Information common to the entire system shall be provided. This shall include but not be limited to the following.
- a. Product manuals for the key software tasks.
 - b. Operating the system.
 - c. Administering the system.
 - d. Engineering the operator workstation.
 - e. Application programming.
 - f. Engineering the network.
 - g. Setting up the web server.
 - h. Report creation.
 - i. Graphics creation.
 - j. All other engineering tasks.
 - k. System Architecture Diagram.
 - l. List of recommended maintenance tasks associated with the system servers, operator workstations, data servers, web servers and web clients.
 - m. Define the task.
 - n. Recommend a frequency for the task.
 - o. Reference the product manual that includes instructions on executing the task.
 - p. Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
 - q. Licenses, guarantees, and warranty documents for equipment and systems.
 - r. Submit one copy for each building, plus two extra copies.
9. Information common to the systems in a single building shall be provided.
- a. System architecture diagram for components within the building annotated with specific location information.
 - b. As-built drawing for each control panel.
 - c. As-built wiring design diagram for all components.
 - d. Installation design details for each I/O device.
 - e. As-built system flow diagram for each system.
 - f. Sequence of control for each system.

- g. Binding map for the building.
 - h. Product data sheet for each component.
 - i. Installation data sheet for each component.
 - j. Submit two copies for each building and two extra copies.
10. Software shall be provided:
- a. Submit a copy of all software installed on the servers and workstations.
 - b. Submit all licensing information for all software installed on the servers and workstations.
 - c. Submit a copy of all software used to execute the project even if the software was not installed on the servers and workstations.
 - d. Submit all licensing information for all of the software used to execute the project.
 - e. All software revisions shall be as installed at the time of the system acceptance.
 - f. Firmware Files
 - g. Submit a copy of all firmware files that were downloaded to or pre-installed on any devices installed as part of this project.
 - h. 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.
 - i. Submit a copy of all application files that were created during the execution of the project.
 - j. Submit a copy of all graphic page files created during the execution of the project.

1.6 QUALITY ASSURANCE

- A. All bidders must be building automation contractors in the business of installing direct digital control building automation systems for a minimum of 5 years.
- 1. The Building Management 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.
 - 2. 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.

- B. All bidders must be authorized distributors or branch offices of the manufacturers specified.
- C. The following bidders have been pre-qualified:
 - 1. Schneider Electric by Automated Control Logic - Tie into Existing Campus BMS Network
 - 2. Or as approved by owners.
- D. 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.
- E. 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.
- F. 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.
- G. The BAS system supplier shall commission and set in operating condition all major equipment and systems, such as the chilled water, DX / VRF, 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. If the vendor is providing an AFDD/CC system, use of the analytics shall be used to help commission the system.
- H. 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.
- I. 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).
- J. 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.
- K. A Startup Testing Report and a Performance Verification Testing Report shall be provided upon test completion.

1.7 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. Supply conditioned electrical circuits for control units, panels, devices, etc..
- 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 NSC's, Ethernet communication cabling and TCP/IP addresses.

1.8 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 of 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
 - 12. System database / memory stick backup of same.

1.9 WORK BY OTHERS

- A. The BAS system supplier shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others' work.
- B. The BAS system supplier shall furnish all Airflow Stations, Control Dampers, Control Valves, Flow Meters, Flow Switches for installation by the Mechanical Contractor and/or others.
- C. The BAS system supplier 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 120VAC power wiring to motors, heat trace. Power / junction boxes for power to BAS panels shall be by the temperature control contractor.
 - b. Furnish smoke detectors and wire to the building fire alarm system. HVAC Contractor to mount devices. BAS system supplier 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 system supplier to coordinate this with the electrical contractor.

- D. Prior to delivery to the Project site, ensure that suitable storage space is available to store materials in a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, and corrosive atmospheres. Materials shall be protected during delivery and storage and shall not exceed the manufacturer stated storage requirements. As a minimum, store indoors in clean, dry space with uniform temperature to prevent condensation. In addition, protect electronics from all forms of electrical and magnetic energy that could reasonably cause damage.
- E. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and equipment tag number or service name as identified within the Contract Documents.
- F. Inspect and report any concealed damage or violation of delivery storage, and handling requirements to the Engineer.

1.10 WARRANTY

- A. All components, system software, and parts furnished and installed by the BMS system supplier shall be guaranteed against defects in materials and workmanship for 2 years of substantial completion. Labor to repair, reprogram, or replace these components shall be furnished by the BMS system supplier at no charge during normal working hours during the warranty period. Materials furnished but not installed by the BMS system supplier 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design Product: 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 Field Controller Devices:
 - a. Schneider Electric EcoStruxure Building MPX BACnet series, b3 BACnet series, MNB BACnet installed by

approved manufacturer's local field office or authorized distributor.

b. Or approved equal.

2.2 SYSTEM ARCHITECTURE

- A. 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 SQL 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, LonWorks IP, and/or Modbus TCP protocol.
- B. Modbus RTU/ASCII (and J-bus), Modbus TCP, BACnet MS/TP, BACnet IP, LonTalk FTT-10A, 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.
- C. A sub-network of SDCUs using the BACnet IP, BACnet MS/TP protocol shall connect the local, stand-alone controllers with Ethernet-level Network Server Controllers/IP Routers.
- D. 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.
- E. The fieldbus layer shall support all of the following types of SDCUs:
 - 1. BACnet IP SDCU requirements: The system shall consist of one or more BACnet/IP field buses managed by the Network Server Controller. The field bus layer shall consist of up to 50 IP SDCUs in daisy chain topology, or 39 if using RSTP, per layer, with a max of 5 sub networks in daisy chain for a total of 250 SDCUs or 6 sub networks in RSTP for a total of 234 SDCUs.

2. BACnet MS/TP 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 135-2004. The NSCs shall be capable of at least two BACnet MS/TP field buses for a total capability of 254 SDCUs per NSC.
- F. 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.
- G. 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.
- H. 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.
 3. The system shall be capable of using graphical and/or line application programming language for the Network Server Controllers.
- I. All Network Server Controllers must natively support the BACnet IP, BACnet MS/TP, LonWorks FTT-10, Modbus TCP, Modbus RTU (RS-485 and RS-232

2.3 OPERATOR WORKSTATION REQUIREMENTS

- A. 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 5 concurrent operator users and/or 1 concurrent engineering user 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. Web-based workstations (webstations) shall have a minimum of 10 concurrent operator users.
4. 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.
5. A minimum of 0 physical Workstations 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, and Enterprise Central Requirements

1. The Enterprise Central shall consist of the following:
 - a. Processor
 - 1) Minimum: Intel Core i5 @ 3.0 GHz or equivalent
 - 2) Recommended: Intel Core i5 @ 4.0 GHz or better
 - b. Memory
 - 1) Minimum: 6GB
 - 2) Recommended: 12GB or higher
 - c. Operating systems:
 - 1) Microsoft Windows 8.1 64-bit
 - 2) Microsoft Windows 10 64-bit
 - 3) Microsoft Windows Server 2008 R2 64-bit
 - 4) Microsoft Windows Server 2012 64-bit
 - 5) Microsoft Windows Server 2012 R2 64-bit
 - 6) Microsoft Windows Server 2016 R2 64-bit
 - d. 10/100MBPS Ethernet NIC
 - e. Storage
 - 1) Minimum: 1TB
 - 2) Recommended: 4TB
 - 3) Solid State Drive recommended
 - f. Required additional software:
 - 1) Microsoft .Net 4.7
 - g. License agreement for all applicable software
2. The workstation shall consist of the following:
 - a. Processor
 - 1) Minimum: 2.0 GHz
 - 2) Recommended: 3.0 GHz or higher
 - b. Memory
 - 1) Minimum: 4GB
 - 2) Recommended: 8GB or higher
 - c. Operating systems:
 - 1) Microsoft Windows 7 64-bit
 - 2) Microsoft Windows 8.1 64-bit

- 3) Microsoft Windows 10 64-bit
- 4) Microsoft Windows Server 2008 R2 64-bit
- 5) Microsoft Windows Server 2012 64-bit
- 6) Microsoft Windows Server 2012 R2 64-bit
- 7) Microsoft Windows Server 2016
- 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 4.7
- 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. Minimum:
 - 1) Google Chrome 61 or higher
 - 2) Mozilla Firefox 60 or higher
 - 3) Microsoft Edge (EdgeHTML) 16 or higher
 - 4) Safari 11.1 or higher
 - b. Recommended:
 - 1) Google Chrome 71 or higher
 - 2) Mozilla Firefox 64 or higher
 - 3) Microsoft Edge (EdgeHTML) 17 or higher
 - 4) Safari 11.4 or higher

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, Italian, Finnish, Portuguese, Swedish, Russian, and traditional and simplified Chinese. The multiple languages shall not require additional add on software from the standard workstation installer and shall be selectable within said workstation.
4. Webstations shall have the capability to automatically redirect to an HTTPS connection to ensure more secure communications.
5. Personalized layouts and panels within workstations shall be extended to webstations to ensure consistent user experiences between the two user interfaces.
6. Webstations shall give the user the same capabilities within the graphics pages as are given within the workstation but shall be mobile responsive for use on smaller devices.
7. Servers and clients shall have the ability to be located in different time zones, which are then synchronized via the NTP server.
8. Workstation shall indicate at all times the communication status between it and the 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.

2. Additional requirements include mandatory change of passwords:
 - a. At first logon with default credentials
 - b. Of admin passwords before deploying
3. No general accounts, one account per user
4. Capability to integrate and use Windows Active Directory for user log on credentials
5. Include a timed auto log off feature
6. Use TLS 1.2 encryption or higher
7. Capability to use blacklisted and whitelisted IPs/MAC addresses to gate access
8. All devices and software that support HTTP shall allow disabling the HTTP access and require access via HTTPS.
9. All devices that have web portals for the configuration of IP addresses and other configuration attributes shall have the ability, through commands issued, to disable this service upon completion. A direct connection method with ASCII commands shall enable this service again if changes need to be applied. Loss of power or cycling the device shall not reverse this command. Disabling this web portal eliminates the security risk and the need for updating security patches.
10. All devices shall support SNMP V3 monitoring of network performance and stack statistics for the purpose of managing denial of service attacks
11. The Integrated Control Platform shall support the feature to alarm on a predetermined period of time until the default password for each device is changed from the default factory setting.
12. The Integrated Control Platform shall support encrypted password authentication for all web services whether serving or consuming.

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 from 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. The system shall support HTML5 enabled graphics.
 - c. It shall be possible for the user to use JavaScript to customize the behavior of each graphic.
 - d. The editor shall use Scalable Vector Graphics (SVG) technology.
 - e. A built-in library of animated objects such as dampers, fans, pumps, buttons, knobs, gauges, and 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.
 - f. Support for high DPI icons shall be included and automatically chosen if viewing on a high definition display such as Retina or 4K displays.
 - g. Using the mouse, operators shall be able to adjust setpoints, start or stop equipment, modify PID loop parameters, or change schedules.
 - h. 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.
 - i. 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.
 - j. It shall be possible to create and save graphical components and JavaScript code in reusable and transferrable, customized libraries.

- k. Graphics should rescale based on whatever monitor or viewing device is being used.
 - l. Be able to create graphics on varying layers that can be moved and repeated.
 - m. 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.
 - n. The ability to create re-usable cascading menus.
 - o. The ability to have multiple instances of a graphic and edit one instance to change all.
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 EcoBuilding Business in the creation of graphic pages shall be saved to a library file for use by the owner.

- I. 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 at the NSC, workstation, and webstation levels. At the Enterprise level the minimum number of active and viewable alarms shall be 10,000. 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 using Simple Mail Transfer Protocol (SMTP) with support for secure email using Simple Mail Transfer Protocol Secure (SMTPS) No special software interfaces shall be required and no email client software must be running in order for email to be distributed. The email notification shall be able to be sent to an individual user or a user group.
 - 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. The alarm viewer can be configured to auto hide alarms when triggered.
- l. An operator shall have the capability to assign an alarm to another user of the system.
- m. Time schedules shall be able to be used to set control notifications to users.
- n. An operator shall have the capability to save and apply alarm favorites.
- o. Alarm notifications must support multiple distribution methods within one notification.

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. 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 7 32-bit (Professional)
 - 2) Microsoft Windows 7 64-bit (Professional)
 - 3) Microsoft Windows 8.1 32-bit (Pro or Enterprise)
 - 4) Microsoft Windows 8.1 64-bit (Pro or Enterprise)
 - 5) Microsoft Windows 10 64-bit (Pro or Enterprise)
 - 6) Microsoft Windows Server 2008 R2 64-bit (Standard, Enterprise, Datacenter, Web, or Itanium)
 - 7) Microsoft Windows Server 2012 64-bit (Standard)
 - 8) Microsoft Windows Server 2012 R2 64-bit (Standard, Datacenter)
 - b. SQL Versions:
 - 1) Microsoft SQL Server 2008 R2 64-bit SP2 (Standard and Express with Advanced Services)

- 2) Microsoft SQL Server 2012 64-bit (Standard and Express with Advanced Services)
- 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. Both languages will have debugging capabilities in their editors.

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. The system shall be capable of creating 'custom types'. These types can be created within the programming environment, graphics, or as full controller 'templates' that can be pushed to any other variable pertaining to it to allow for singular reference to multiple objects. This allows easing of updating/changes allowing the use to make a singular change and push to all connected instances.
7. It shall be possible to view graphical programming live and real-time from the Workstation.
8. The system shall be capable of creating 'binding templates' allowing the user to bind multiple points to multiple objects all at once.
9. Key terms should appear when typing (IntelliType).
10. Applications should be able to be assigned different priorities and cycle times for a prioritized execution of different function.
11. 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. The Enterprise server shall be able to store up to 5 million events.
4. The event view shall support viewing of up to 100,000 events.
5. It shall be possible to save custom filtered views of event information that are viewable and configurable in Workstation.
6. 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-based 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.
 - c. System shall have out-of-the-box dashboards that enable customizable views of live data which can be public to all users or capable to make them specific to a user based on log in credentials.
 - d. The user shall have the ability to create custom dashboards.
 - e. The dashboards shall have a kiosk mode which allows for occupant level data display on monitors or tablets throughout the building.
 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

2.4 NETWORK SERVER CONTROLLERS (NSC)

- A. Network Server 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. The NSCs shall be capable of whitelisting IPs to restrict access to a pre-defined list of hosts or devices.
- E. Whitelisting of file extensions for documents shall be capable.
- F. Encrypted and authenticated communication shall be configurable for non-open protocol communications using TLS 1.2.
- G. The NSCs shall support Simple Network Management Protocol version 3 (SNMPv3) for monitoring of the NSCs using a Network Management Tool.

- H. The NSCs shall support remote system logging for used by System Information and Event Monitoring (SIEM) software.
- I. They shall also be responsible for monitoring and controlling their own HVAC equipment such as an AHU or boiler.
- J. 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.
- K. 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 LonWorks controller data and Modbus controller data or BACnet controller data and Modbus controller data
 - 7. Network Management functions for all LonWorks based devices
- L. 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. Two 10/100b Ethernet for communication to Workstations, other NRCs, IP field bus controllers, other SDCUs, and onto the internet.
 - 1) The two Ethernet ports shall support active switch and BACnet/IP communication protocols.
 - 2) Support IPv4 addressing
 - 3) Ethernet port 1 shall support static or DHCP client configuration for communication to Workstation or other NSCs
 - 4) Ethernet port 2 shall support switch mode or DHCP server to set addressing of DHCP client devices
 - 5) It shall be possible to disable Ethernet port 2
 - 6) In DHCP server mode, the Ethernet port 2 shall support 50 BACnet/IP field controllers in daisy chain configuration directly from the port
 - 7) Each NSC shall be able to support a total of 250 IP SDCUs in daisy chain configuration (5 sub networks via switch)

- 8) If using RSTP (Rapid Spanning Tree Protocol) with a managed switch (with IEEE 802.1W or IEEE 802.1Q-2014 support), Ethernet port 2 shall support up to 39 devices
- 9) Each NSC shall be able to support a total of 234 IP SDCUs in RSTP configuration (6 sub networks via managed switch)
- 10) Where a switch is needed, use a Cisco 9000 Catalyst or IE switch, EtherWAN EX63402-01B, or other equal and approved equivalent.
- b. Two RS-485 ports for communication to BACnet MSTP bus or serial Modbus (software configurable)
- c. One TP/FT port for communication to LonWorks devices.
- d. One device USB port
- e. One host USB port
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).

M. 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.

N. 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.

O. 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)
- P. 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.
- Q. Real Time Clock (RTC):
- 1. Each NSC shall include a 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.
 - 2. The RTC date and time shall also be accurate, up to 30 days, when the NSC is powerless.
 - 3. No batteries may be used to for the backup of the RTC.
- R. 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.
- S. 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.
- T. Data Retention:
- 1. During a power failure, the NSC shall retain all programs, configuration data, historical data, and all other data that is configured to be retained. There shall be no time restriction for this retention and it must not use batteries to achieve it.

U. 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.

V. 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.

W. 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

X. 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.

Y. 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

Z. 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.
6. Tooltips shall be present, magnetic, and visible based on users preference.
7. Comments shall be visible whenever viewing the trend log list.
8. System shall give indication of memory usage and be able to alert the user if too many logs are allocated.

AA. 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.

BB. 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. The NSC shall be configurable to logging all Embedded Web Server access attempts
3. The NSC shall have the option to redirect HTTP based Embedded Web Server connections to secure, HTTPS connections.
4. The NSC shall authenticate and authorize all users connecting to the Embedded Web Server
5. The NSC shall provide to ability to configure an automatic logoff for Embedded Web Server users that have not had any activity for an adjustable time period.

2.5 BACNET IP FIELDBUS CONTROLLERS

A. Controllers - BACnet/IP Protocol

1. All BACnet/IP Fieldbus controllers shall be BACnet Testing Laboratory listed (v12 or later) as specified BACnet Advanced Application Controller (B-AAC)
2. All BACnet/IP Fieldbus controllers shall use the following communication specifications and achieve performance as specified herein:
 - a. All controllers shall be able to communicate peer-to-peer without the need for a NSC

- b. Any BACnet/IP Fieldbus controllers on the Ethernet Data Link/Physical layer shall be able to act as a Master to allow for the exchange and sharing of data variables and messages with any other controller connected on the same communication cabling. Slave controllers are not acceptable.
- B. The BACnet/IP Fieldbus controllers shall be equipped with 2x 10/100bT Ethernet communication ports with active switch and will support BACnet/IP communication protocols with the following configurations:
 - 1. Supporting IPv4 addressing
 - 2. Supporting Static IP setting, DHCP client and Auto-IP address acquisition
 - 3. It shall be possible to disable Ethernet port 2
- C. Topologies
 - 1. BACnet/IP Fieldbus controllers shall support daisy chain topology of up to 50 controllers. In case of any disruption to the communication, a system alarm shall notify the NSC/BMS of the point disruption has occurred.
 - 2. BACnet/IP Fieldbus Controllers shall support RSTP loop whereby up to 39 controllers are supported.
 - a. In case of any disruption there shall be no communication interruption
 - b. In case of any disruption there shall be system alarms that will inform the operator of the disruption
- D. Performance
 - 1. Each BACnet/IP Fieldbus Controllers shall have a 32-bit microprocessor operating at 500 MHz and support a BACnet protocol stack in accordance with the ANSI/ASHRAE Standard 135-2008 and the BACnet Device Profile supported.
 - 2. They shall be multi-tasking, real-time digital control processors consisting of communication controllers, controls processing, power supplies with built-in inputs and outputs.
- E. Programmability
 - 1. The BACnet/IP Fieldbus controllers shall support both script programming language and graphical that will be consistent with the NSC.
 - 2. The control program will reside within the same enclosure as the input/output circuitry, that reads inputs and controls outputs
 - 3. All control sequences programmed into the BACnet/IP Fieldbus Controllers shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.
 - 4. BACnet/IP Fieldbus controllers shall communicate with the Network Server Controller (NSC) via a BACnet/IP connection at a baud rate of not less than 100 Mbps
 - 5. BACnet/IP Fieldbus controllers shall support a dedicated communications port for connecting and supplying power to a matching room temperature and/or humidity sensor and/or CO2

and/or presence detector that does not utilize any of the I/O points of the controller.

6. BACnet/IP Fieldbus controllers (Excluding VAV) shall support an add-on display to supply and provide access in real-time for monitoring inputs and overriding of outputs
7. The override functionality must be supported by a dedicated processor to assure reliable operation (overriding of output)
8. Each BACnet/IP Fieldbus controller shall have sufficient memory, to support its own operating system and databases, including:
 - a. Control processes
 - b. Energy management applications
 - c. Alarm management
 - d. Historical/trend data
 - e. Maintenance support applications
 - f. Custom processes
 - g. Manual override monitoring
9. Each BACnet/IP Fieldbus controller shall support local trend data up to 2x the built-in I/O and at a minimum be capable of holding 5 days @ 15 min intervals locally.
10. The BACnet/IP Fieldbus controller analog or universal input shall use a 16 bit A/D converter.
11. The BACnet/IP Fieldbus controller analog or universal output shall use a 10 bit D/A converter.
12. Built-in I/O: each BACnet/IP Fieldbus controllers shall support:
 - a. At minimum 8 and up to 20 configurable IO channels to monitor and to control the following types of inputs and outputs without the addition of equipment inside or outside the DDC Controller cabinet.
 - 1) Universal Inputs - 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)
 - k) PT100 (Siemens)
 - l) PT1000 (Sauter)
 - m) Ni1000 (Danfoss)
 - 2) Analog inputs
 - a) Current Input - 0-20 mA
 - b) Voltage Input 0-10 Vdc
 - 3) Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
 - 4) Digital outputs
 - 5) Analog outputs of 4-20 mA and/or 0-10 Vdc

13. Real Time Clock (RTC):
 - a. Each BACnet/IP Fieldbus controller shall include a real time clock, accurate to +/-1 minute per month. The RTC shall provide the following: time of day, day, month, year, and day of week.
 - b. The RTC date and time shall also be accurate, up to 7 days, when the BACnet/IP Fieldbus controller is powerless.
 - c. No batteries may be used to for the backup of the RTC.
14. The BACnet/IP Fieldbus controller for Variable Air Volume (VAV) applications
 - a. The BACnet/IP Fieldbus controller for VAV applications shall include a built-in 'flow thru' differential pressure transducer
 - b. The VAV differential pressure transducer shall have a measurement range of 0 to 1 in. W.C. and measurement accuracy of $\pm 5\%$ at 0.001 to 1 in. W.C. and a minimum resolution of 0.001 in. W.C., insuring primary air flow conditions shall be controlled and maintained to within $\pm 5\%$ of setpoint at the specified minimum and maximum air flow parameters
 - c. The BACnet/IP FieldBus controller for VAV applications shall support a dedicated commissioning tool for air flow balancing
 - d. The BACnet/IP Fieldbus controller for VAV applications shall require no programing for air balancing algorithm
 - e. All balancing parameters shall be synchronized in NSC
15. The BACnet/IP Fieldbus controller for connected room solutions
 - a. In addition, if applicable, the system shall include a BACnet/IP fieldbus controller that integrates control for HVAC, Lighting, Blind Control, BTL, and Zigbee wireless communication in a singular unit.
 - 1) HVAC IO as described above
 - 2) Lighting bus, with at minimum, DALI capabilities
 - 3) Bus for blind control applications
 - 4) BTL (Bluetooth) wireless capabilities to allow for use of apps, such as commissioning tools and occupant apps for control of space
 - 5) Zigbee wireless for connection to wireless sensors within the room space, such as occ sensors, door contacts, and smart third party devices, such as trashbins, coffee makers, etc.
 - b. The controller shall work with any 3rd party BMS system and can be brought into the host system through the auto discovery mechanism.
16. The BACnet/IP Fieldbus controller for remote IO
 - a. The system shall have available a BACnet/IP fieldbus controller to support inclusion of IO that is remote from the controller(s) that may need it.

- b. As the controller is just an IO 'station' handling data to other controllers it still shall:
 - 1) Support local alarms and local trends
 - 2) No impact firmware update capabilities
 - 3) User defined fallback for outputs in case of network disruption
- 17. The BACnet/IP Fieldbus room controller
 - a. For connected room solutions that do not require integrated lighting and blind busses built into a singular unit, the system shall include a BACnet/IP enabled controller specifically designed for room control.
 - b. The controller shall communicate via BACnet/IP via Wifi.
 - c. The controller shall be capable of controlling fan coil units, cooling VVT zones with reheat, fin-tube radiators, cabinet heaters, radiant panel heaters, electric re-heat zones, terminal reheats, rooftop units (1H1C, 2H2C, 3H2C, MH2C), or heat pumps, if necessary.
 - d. The controller shall house an onboard temperature sensor, and options for onboard humidity and occupancy sensor.
 - e. The controller shall utilize a touch screen interface and have multiple options for casings and fascias. The screen shall be a TFT transmissive LED backlit LCD touchscreen with at least 5 color options.
 - f. Controller will have password protection to prevent unauthorized access to the configuration menu parameters.
 - g. The controller will have integrated Zigbee wireless communications with predefined profiles for Zigbee door and window switches, occupancy sensors, water leakage detectors, CO2 sensors, and additional temperature and humidity sensors.
 - h. The controller will be capable of hosting at least 10 Zigbee sub devices.
 - i. The controller will be capable of being programmed with customizable scripts via the open programming language Lua. It shall be equipped with at least 256KB of SRAM with 80KB configurable/reserved for Lua scripting purposes.
- 18. Each BACnet/IP Fieldbus controller shall have a minimum of 10% spare capacity for each point type represented on the controller for future point connection
- 19. Power Requirements.: 24VDC (21 to 33 VDC) and 24 VAC +/-20% with local transformer power
- F. Commissioning Tool - The BACnet/IP Fieldbus controller shall be supported via a dedicate mobile based commissioning tool for configuration, programming, air balancing and I/O checkout

1. The Commissioning Tool shall be supported across: iOS, Android and Windows 10 platforms
 2. The Commissioning Tool shall be available for download on App Store, Google Store and Windows Store
 3. Commissioning Tool Interface to BACnet/IP Fieldbus controllers shall be via a Bluetooth adapter interface through the Intelligent Space Sensor or via a Wi-Fi access point on the LAN
 4. Functionality
 - a. Device Configuration - the Commissioning Tool shall be able to set or edit all Network configurations associated with the BACnet/IP Fieldbus controller.
 - b. Programming - The Commissioning Tool shall be able to load offline engineered applications directly into the controller directly.
 - c. Air Balancing
 - 1) The Commissioning Tool shall allow the air balancer to manually control the action of the actuator including the following function: open VAV damper, close VAV damper, open all VAV dampers, and close all VAV dampers.
 - 2) The Commissioning Tool shall be able to generate Air Balancing report
 - d. IO Checkout
 - 1) The Commissioning Tool shall be able to support overriding of the outputs and reading value of inputs live
 - 2) The Commissioning Tool shall be able to support generation of I/O checkout report
 - e. There shall be no limit to the number of Commissioning Tools that can be used on a network segment, however, one connection per controller is recommended
- G. Intelligent Space Sensors - The BACnet/IP Fieldbus controller shall support a dedicated RJ45 communication port to communicate and power up to 4 intelligent wall mount sensors without the use of on board inputs or outputs
1. The Intelligent Space Sensor shall communicate with the BACnet/IP Fieldbus controller through the sensor port and via category 5 or category 6 cable
 2. The Intelligent Space Sensor shall provide 2 RJ45 communication ports that will allow communication with parent BACnet/IP Field controller upstream and additional Intelligent Space Sensors downstream
 3. The Intelligent Space Sensor shall provide ambient space condition sensing without the use of hardware I/O
- H. Each Intelligent Space Sensor shall provide a color touch display with:
1. Minimum 61 mm (2.4") by 61 mm (2.4") display
 2. Backlit

- I. The Intelligent Space Sensor shall be capable of displaying measured space temperature from 0 to 50 °C (32 to 122 °F) with accuracy of ± 0.2 °C (± 0.4 °F) selectable for 0.1 or 1 degree display resolution of °F or °C
 1. Sensing Element: 10k Type 3 Thermistor
 2. Accuracy of ± 0.2 °C (± 0.4 °F)
 3. Resolution: 0.1 or 1 degree display resolution
 4. Range: 0 to 50 °C (32 to 122 °F)
- J. The Intelligent Space Sensor shall have the option for humidity sensor support sensing humidity from 0 % RH to 100 % RH Digital humidity indication (selectable for 0.1 or 1% RH with selectable display resolution of 0.1 or 1 % RH
 1. Accuracy: ± 2 % RH
 2. Resolution: 0.1 or 1 % RH
 3. Range: 0 % RH to 100 % RH
- K. The Intelligent Space Sensor shall have the option for support of CO2 sensor with display resolution with 0 to 2000 ppm resolution
 1. Accuracy: ± 30 ppm $\pm 2\%$ of measured value
 2. Range: 0 to 2,000 ppm
 3. Operating elevation: 0 to 16,000 ft.
 4. Temperature dependence: 0.11% FS per °F
 5. Stability: <2% of FS over life of sensor (15 years)
 6. Sensing method: Non-dispersive infrared (NDIR), diffusion sampling
- L. The Intelligent Space Sensor shall have the option for motion sensor
- M. Display options: The Intelligent Space Sensor shall be capable of displaying the following elements:
 1. Space temperature
 2. Cooling space temperature set point
 3. Heating space temperature set point
 4. Current heating or cooling mode
 5. Current occupancy mode
 6. Fan speed
 7. Current time

2.6 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. 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

- OVS 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 OVS that supports the BACnet service for receiving alarm messages and is configured to be a recipient of the alarm message.
 - 2) Support alarm acknowledgement from any BACnet OVS that supports the BACnet service for executing alarm/event acknowledgement,
 - g. Shall support the reading of analog and binary data from any BACnet OVS 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 OVS 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 (OVS).
 - 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.

F. 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.

G. Room controllers

1. For connected room solutions that do not require integrated lighting and blind busses built into a singular unit, the system shall include a BACnet MS-TP enabled controller specifically designed for room control.
2. The controller shall communicate via BACnet MS-TP. It should also be capable of MODBUS RTU communication.
3. The controller shall be capable of controlling fan coil units, cooling VVT zones with reheat, fin-tube radiators, cabinet heaters, radiant panel heaters, electric re-heat zones, terminal reheats, rooftop units (1H1C, 2H2C, 3H2C, MH2C), or heat pumps, if necessary.
4. The controller shall house an onboard temperature sensor, and options for onboard humidity and occupancy sensor.
5. The controller shall utilize a touch screen interface and have multiple options for casings and fascias. The screen shall be a TFT transmissive LED backlit LCD touchscreen with at least 5 color options.
6. Controller will have password protection to prevent unauthorized access to the configuration menu parameters.
7. The controller will have integrated Zigbee wireless communications with predefined profiles for Zigbee door and window switches, occupancy sensors, water leakage detectors, CO2 sensors, and additional temperature and humidity sensors.
8. The controller will be capable of hosting at least 10 Zigbee sub devices.
9. The controller will be capable of being programmed with customizable scripts via the open programming language Lua. It shall be equipped with at least 256KB of SRAM with 80KB configurable/reserved for Lua scripting purposes.

2.7 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][black] enclosure made of high impact ABS plastic for mounting on a standard electrical box. Basis of Design: Veris TW Series
 - a. Where manual overrides are required, 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. Where a local display is specified, 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 +/- 2 % at full scale.
 - 3. Transmitter shall have replaceable sensing element.
 - 4. Sensor types 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 option of having an LCD display
 - 11. Transmitter shall have option of being NIST certified
 - 12. Transmitter shall have option of an 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 $\pm 2\%$ 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 have option of being NIST certified
11. Transmitter shall have option of an 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 $\pm 2\%$ 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 have option of being NIST certified
11. Transmitter shall have option of an integrated temperature sensor
12. 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 $\pm 2\%$ of measured value with annual drift of ± 10 ppm. Minimum five year recommended calibration interval.
4. Repeatability shall be ± 20 ppm $\pm 1\%$ 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: Modbus or BACnet] with [SPDT Relay 1A@30VDC][temperature setpoint slider]
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 enclosure for mounting on a standard electrical box.
11. Transmitter shall have an option of an LCD display for commissioning and provide additional faceplate to conceal LCD display where occupants may misinterpret CO2 readings.
12. Transmitter shall have option of an integrated temperature sensor and/or humidity 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 $\pm 2\%$ of measured value with annual drift of ± 10 ppm. Minimum five year recommended calibration interval.
4. Repeatability shall be ± 20 ppm $\pm 1\%$ 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 option of an LCD display
14. Transmitter shall have option of an integrated temperature sensor and/or humidity sensor
15. 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 $\pm 1\%$ 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 $\pm 1\%$ F.S. and $\pm 2\%$ F.S. for lowest selectable range
 - b. Long term stability shall be $\pm 0.25\%$
 - 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. Transmitter shall be preinstalled on a bypass valve manifold

17. 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: $\pm 40\%$, $\pm 60\%$, 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: $\pm 20\%$ 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 $\pm 1\%$ of rate over optimum flow range; ≥ 10 upstream and ≥ 5 downstream straight pipe diameters, uninterrupted flow
 - b. Repeatability $\pm 0.5\%$
 - 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.
 - 1) Output: [Frequency][4-20 mA][Scaled Pulse]
 - b. Temperature Range: 14° to 150°F
 - c. Display: 8 character 3/8" LCD (Optional)
 - d. 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 $\pm 0.01\%$ 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: $\pm 0.05\%$ 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: $\pm 0.05\%^\circ\text{C}$
 - 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. Pressure Independent Control Valves

1. Note: When selecting pressure independent valves the specifier should also revise spec to NOT include balancing valves and also modify to NOT require the individual balancing of each coil/valve combination.
2. NPS 2 and Smaller: PN 16, stainless steel components.
3. NPS 2½ through 10: Class 125 cast iron body per ASME B16.1-2010, Material class B per ASTM A 126-04 (2014), stainless steel components.
4. Accuracy NPS ¾" and Smaller: The control valves shall accurately control the flow from 0...100% rated flow with a differential pressure range of 2.32...58 psi for low and standard flow units, 5...58 psi for high flow units within 5% of set flow value.
5. Accuracy NPS 1 through 1¼": The control valves shall accurately control the flow from 0...100% rated flow with a differential pressure range of 2.9...58 psi for standard flow units, 5...58 psi for high flow units within 5% of set flow value.
6. Accuracy NPS 1½ through 4: The control valves shall accurately control the flow from 0...100% rated flow with a differential pressure range of 4.35...58 psi within 5% of set flow value.
7. Accuracy NPS 5 through 10: The control valves shall accurately control the flow from 0...100% rated flow with a differential pressure range of 5.8...58 psi for standard flow units, 8.7...58 psi for high flow units within 5% of set flow value.
8. Flow Characteristics: Linear Control, selectable to equal percentage at the proportional valve actuator.
9. Field adjustable flow by means of a percentage of rated valve flow.
10. Position feedback output signal integrated into all proportional actuators.
11. 100% authority with modulating below 1% regardless of flow settings.
12. No cartridges requiring replacement or maintenance.
13. Close ratings shall be 232 psi for all valve sizes.
14. Basis of Design: Schneider Electric SmartX PICV, or approved equal.

Q. Control Valve Actuators

1. ½" to ¾" Ball Valve Actuators
 - a. Size for torque required for valve close-off pressure for system design.
 - b. Coupling: Direct coupled to valve body without use of external devices/tools
 - c. Auxiliary End Switch (optional) to be SPST 24 Vac/Vdc, 101 mA to 5 mA maximum on selected two-position models.
 - d. Controller Signal Two-position, Floating or Proportional (0...5 Vdc, 0...10 Vdc, 5...10 Vdc, or 4...20 mA dc). Design allows for change via DIP switches without removal of cover.
 - e. Manual operating lever and position indicator must be standard.

- f. Power Requirements: 24 Vac for floating, proportional, and 110...230 Vac for two position multi-voltage types
 - g. Actuators must be available with either Spring Return (SR) or Non-Spring Return (NSR) models.
 - h. Operating Temperature Limit Floating is to be 32...140°F (0...60°C) Proportional 32...140°F (0...60°C) Two-Position 32...169°F (0...76°C)
 - i. Wiring (depending on model) Removable Terminal Block, 10 ft. (3.05 m) Plenum Cable, 18 in. (45 cm) Appliance Wire
 - j. Locations must be rated NEMA 2, IEC IP31. (Indoor Use Only.) Actuators with terminal block or plenum cable leads are plenum rated per UL file number E9429.
 - k. Agency Listings: ISO 9001, cULus, and CE.
 - l. Basis of Design: Schneider Electric VBB/VBS, or approved equal.
2. ½" to 3" 2-way and ½" to 2" 3-way Ball Valves Actuators
- a. Size for torque required for valve close-off pressure for system design.
 - b. Actuators are to be available in spring return (SR) and non-spring return (NSR) models. Spring Return (SR) actuators are to provide a choice to return direction.
 - c. Actuators are to be available in models for two-position, floating and proportional control.
 - d. All actuator models are to be equipped with pigtail leads, manual override, and auxiliary switch(es)
 - e. Operating temperatures' Floating Non-Spring Return (NSR) with 33 lb.-in. of torque must be -25 to 130 °F (-32 to 55°C). All other actuators are to -22 to 140 °F (-30 to 60 °C)
 - f. Actuators must be NEMA 2 rated.
 - g. Agency Listings: ISO 9001, cULus, and CE.
 - h. Basis of Design: Schneider Electric VB-2000, or approved equal.
3. ½" to 2" Bronze, Linear Globe Valve Actuators/67 or 78 lbs. force
- a. Actuator must have bi-color LED status indication for motion indication, auto calibration and alarm notification.
 - b. When the actuator is properly mounted must have a minimum of a NEMA 2 (IP53) rating.
 - c. Actuators are to be non-spring return.
 - d. Actuators are to be floating (used for two-position) or proportional models.
 - e. Proportional models will have optional models with a position output signal with field selectable 2...10 Vdc and 0...10 Vdc input signals and selectable input signal direct or reverse acting.
 - f. Actuator must have auto calibration which provides precise control by scaling the input signal to match the exact travel of the valve stem

- g. Actuators must come in models with Pulse Width Modulated (PWM) with field selectable 0.59 to 2.93 sec and 0.1 to 25.5 sec input signal ranges with a position output signal
 - h. Actuators must have manual override with automatic release.
 - i. Models with position feedback output signal include field selectable 2...10 Vdc or 0...5 Vdc output signal
 - j. Removable wiring screw terminal with ½" conduit opening.
 - k. Actuator operating temperature ranges:
 - 1) When controlling fluid up to 266°F (130°C) = ambient air temperature is to be 23...131°F (-5...55°C)
 - 2) Fluid up to 281°F (138°C) = 23...127°F (-5...53°C)
 - 3) Fluid up to 340°F (171°C) = 23...115°F (-5...46°C)
 - 4) Fluid up to 400°F (204°C) = 23...102°F (-5...39°C)
 - l. Actuator agency Listings: cUL-us LISTED mark, NEMA 2, NEC class 2 FCC part-15 class B, Canadian ICES-003, ESA registered, Plenum rated per UL 20430
 - m. Basis of Design: Schneider Electric MG350V, or approved equal.
4. ½" to 2" Bronze, Linear Globe Valve Actuators/105 lbs. force
- a. Actuators must have Two- Position, Floating, and Proportional models.
 - b. Proportional models will a controller input signal of either a 0...10 Vdc, 2...10 Vdc, 4...20 mAdc, 0...3 Vdc, or 6...9 Vdc. Control function direct/reverse action is switch selectable on most models.
 - c. Actuator force is to be 105 lb. (467 newton) with ½" (13 mm) nominal linear stroke
 - d. Power requirements 24 Vac, 120 Vac or 230 Vac depending on model.
 - e. Actuator housings rated for up to NEMA 2/ IP54.
 - f. Actuator is to have overload protection throughout stroke.
 - g. Actuator Operating temperature -22...140°F (-30...60°C) up to a maximum valve fluid temperature of 366°F (186°C).
 - h. Actuator must automatically set input span to match valve travel.
 - i. Actuator must have manual override to allow positioning of valve and preload.
 - j. Actuator is to be spring return.
 - k. Actuator is to mount directly to valves without separate linkage.
 - l. Actuator agency Listings: UL 873, CUL: UL
 - m. Basis of Design: Schneider Electric SmartX Mx51-7103, or approved equal
5. ½" to 2" Bronze, Linear Globe Valve Actuators/220 lbs. force
- a. Actuators must have Two- Position for a SPST controller, Floating for a SPST controller, and Proportional models will a controller input signal of either a 0...10 Vdc,

- 2...10 Vdc, 4...20 mA_{dc}, or 6...9 Vdc. Control function direct/reverse action is jumper selectable
- b. Actuator is to be spring return.
 - c. Actuator will have 220 lb. force (979 newton) with ½" (13 mm) or 1" (25 mm) nominal linear stroke
 - d. Feedback on proportional model with 2...10 Vdc (max. 0.5 mA) output signal or to operate up to four like additional slave actuators.
 - e. Actuator operating temperature is 0...140°F (-18...60°C) up to a maximum valve fluid temperature of 281°F (138°C), 0...120°F (-18...49°C) up to a maximum valve fluid temperature of 300°F (149°C), 0...100°F (-18...38°C) up to a maximum valve fluid temperature of 340°F (171°C), 0...90°F (-18...32°C) up to a maximum valve fluid temperature of 366°F (186°C).
 - f. Actuator must automatically set input span to match valve travel
 - g. Actuator is to have a 24 Vac power supply on Two-position and Proportional models and 120 Vac on Two-position models.
 - h. Actuator housings rated for up to NEMA 2/ IP54
 - i. Actuator must have manual override to allow positioning of valve and preload
 - j. Actuator is to mount directly to vales without separate linkage.
 - k. Actuator agency Listings: UL 873, CUL: UL
 - l. Basis of Design: Schneider Electric SmartX Mx51-720x, or approved equal.
6. ½" to 2" Bronze, Linear Globe Valve Actuators with linkage SR
- a. Actuators with 35, 60, 133, or 150 lb.-in of force depending on model.
 - b. Actuator housings rated for up to NEMA 2/ IP54 with a 150 lb.-in. rated a NEMA 4.
 - c. Actuators are to be spring return.
 - d. Actuators are to have Two-position, Floating and Proportional models.
 - e. Actuators must have overload protection throughout rotation.
 - f. Actuator have an optional built-in auxiliary switch to provide for interfacing or signaling on selected models.
 - g. Actuator agency listings: UL-873, C22-2 No.24-83, CUL0
 - h. Basis of Design: Schneider Electric SmartX, or approved equal.
7. ½" to 2" Bronze Body, Linear Globe Valve Actuators with linkage SR & NSR
- a. Actuators are to be either floating SPDT control or proportional control 0...10, 2...10 Vdc or 4...20 mA with a 500-ohm resistor included.
 - b. Actuators are to be direct/reverse with selectable DIP switches.

- c. Actuators are to have 90 lb. (400N), 180 lb. (800N), or 337 lb. (1500N) of force on Non-Spring Return (NSR) 157 lb. of force on the Spring Return model. Note: Not every actuator is for every valve.
 - d. Actuators are to be powered with 24 Vac or 24 Vdc.
 - e. All Non-Spring Return (NSR) actuators are to be NEMA 2, vertical mount only. Spring Return (SR) actuators are to have NEMA 4 models.
 - f. Actuators must have manual override to allow positioning of the valve.
 - g. Actuators must have selectable valve sequencing and flow curves of either equal percentage or linear.
 - h. Actuators must have feedback.
 - i. Actuators must have internal torque protection throughout stroke.
 - j. Actuator operating temperature is 14...122°F (-10...50°C) for chilled water applications, 14...113°F (-10...45°C) up to a maximum valve fluid temperature of 281°F (138°C), 14...107°F (-10...42°C) up to a maximum valve fluid temperature of 300°F (149°C), 14...100°F (-10...38°C) up to a maximum valve fluid temperature of 340°F (171°C), 14...90°F (-10...32°C) up to a maximum valve fluid temperature of 366°F (186°C).
 - k. Actuator agency listings (North America) UL873, cULus, RCM, CE
 - l. Basis of Design: Schneider Electric Forta M400A-VB, M800A-VB, M900A and M1500x-VB screw mounted on Venta VB7000s, or approved equal.
8. 2 ½" to 6" Cast Iron Flanged Globe Valve Linear Actuators with linkage
- a. Actuators are to be either floating SPDT control or proportional control 0...10, 2...10 Vdc or 4...20 mA with a 500-ohm resistor included.
 - b. Actuators are to direct/reverse acting with selectable DIP switch.
 - c. Actuators are to have 180 lb. (800N) or 337 lb. (1500N) of force.
 - d. Actuators will need a 24 Vac or Vdc power supply.
 - e. Actuators are to be rated NEMA 2, vertical mount only.
 - f. Actuators must have manual override to allow positioning of the valve.
 - g. Actuators must have selectable valve sequencing and flow curves of either equal percentage to linear. A 2...10 Vac feedback.
 - h. Actuators must have Internal torque protection throughout stroke.
 - i. Actuator operating temperature is 14...122°F (-10...50°C) for chilled water applications, 14...113°F (-10...45°C) up to a maximum valve fluid temperature of 281°F (138°C), 14...107°F (-10...42°C) up to a maximum valve fluid temperature of 300°F (149°C).

- j. Actuator agency listings (North America) UL873, cULus, RCM, CE
 - k. Basis of Design: Schneider Electric Forta M800A and M1500A, or approved equal.
9. 2-½" to 6" Cast Iron Flanged Globe Valve Actuators/220 lbs. force.
- a. Actuators must have Two- Position for a SPST controller, Floating for a SPST controller, and Proportional models will a controller input signal of either a 0...10 Vdc, 2...10 Vdc, 4...20 mAdc, or 6...9 Vdc. Control function direct/reverse action is jumper selectable.
 - b. Actuator is to be spring return.
 - c. Actuator will have 220 lb. force (979 newton) with ½" (13 mm) or 1" (25 mm) nominal linear stroke.
 - d. Feedback on proportional model with 2...10 Vdc (max. 0.5 mA) output signal or to operate up to four like additional slave actuators.
 - e. Actuator must automatically set input span to match valve travel.
 - f. Actuator Operating temperature 0...140°F (-18...60°C) up to a maximum valve fluid temperature of 300°F (149°C).
 - g. Actuator is to have a 24 Vac power supply on Two-position and Proportional models and 120 Vac on Two-position models.
 - h. Actuator housings rated for up to NEMA 2/IP54.
 - i. Actuator must have manual override to allow positioning of valve and preload.
 - j. Actuator is to mount directly to vales without separate linkage.
 - k. Actuator agency Listings: UL 873, CUL: UL.
 - l. Basis of Design: Schneider Electric SmartX Mx61-720x, or approved equal.
10. 2-½" to 6" Cast Iron Flanged Globe Valve Actuators with linkage SR.
- a. Actuators with 60, 133, or 150 lb.-in of force depending on model.
 - b. Actuator housings rated for up to NEMA 2/ IP54 with a 150 lb.-in. rated a NEMA 4.
 - c. Actuators are to be spring return.
 - d. Actuators are to have Two-position, Floating and Proportional models.
 - e. Actuators must have overload protection throughout rotation.
 - f. Actuator have an optional built-in auxiliary switch to provide for interfacing or signaling on selected models.

- g. Actuator agency listings: UL-873, C22-2 No.24-83, CUL0.
 - h. Basis of Design: Schneider Electric SmartX, or approved equal.
11. 2" to 18" 2-Way and 2" to 16" 3-Way Linear Butterfly Valve Actuator with linkage NSR
- a. The butterfly valve actuators are to be Non-Spring Return (NSR) two-position and proportional taking 0...10 Vdc or 4...20 mA models. All Actuators are to be NEMA 4, manual override (hand wheel) two auxiliary switches, and built-in heater.
 - b. Actuator close-offs and CVs must be appropriate for the valve size in a typical HVAC application.
 - c. Actuators must be available in 24 Vac and 120 Vac models.
 - d. Actuators must have Internal wiring isolation for parallel wiring multiple units that eliminates the risk of feedback from one actuator to another.
 - e. Proportional models must have feedback of 0...10 Vdc or 4...20 mA.
 - f. Actuator operating temperature shall be -40...150°F (-40...60°C).
 - g. Actuator agency listings (North America) UL, CSA and CE
 - h. Basis of Design: Schneider Electric S70, or approved equal.
12. 2" to 4" 2-Way and 3-Way Butterfly Valve Actuators SR
- a. The butterfly valve actuators are to be Spring Return (SR) two-position and proportional taking 2...10 Vdc or 4...20 mA models. All Actuators are to be NEMA 2.
 - b. Actuator close-offs and CVs must be appropriate for the valve size in a typical HVAC application.
 - c. Actuators must be available in 24 Vac models.
 - d. Actuators shall have two SPDT auxiliary switch models.
 - e. Actuators must have [Internal wiring isolation for parallel wiring multiple units that eliminates the risk of feedback from one actuator to another.
 - f. Proportional models must have feedback of 2...10 Vdc or 4...20 mA.
 - g. Actuator operating temperature shall be -22...140°F (-12...60°C).
 - h. Actuator agency listings (North America) UL, CSA and CE
 - i. Basis of Design: Schneider Electric SmartX Mx-41-7153, or approved equal.
13. 2" to 6" 2-Way and 3-Way Butterfly Valve Actuators NSR
- a. The butterfly valve actuators are to be Non-Spring Return (NSR) two-position and proportional taking 0...10 Vdc or 4...20 mA models. All Actuators are to be NEMA 2.
 - b. Actuator close-offs and CVs must be appropriate for the valve size in a typical HVAC application.
 - c. Actuators must be available in 24 Vac models.
 - d. Actuators shall have two SPDT auxiliary switch models.

- e. Actuators must have [Internal wiring isolation for parallel wiring multiple units that eliminates the risk of feedback from one actuator to another.
- f. Proportional models must have feedback of 2...10 Vdc or 4...20 mA.
- g. Actuator operating temperature shall be -4...122°F (-2...50°C).
- h. Actuator agency listings (North America) UL, CSA and CE
- i. Basis of Design: Schneider Electric SmartX NR-22xx-5xx, or approved equal.

R. 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 system supplier. 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.

S. Damper Actuators

- 1. Direct-coupled type non-hydraulic designed for minimum 100,000 full-stroke cycles at rated torque.
- 2. Direct-coupled damper actuators must have a five-year warrantee.
- 3. Size for torque required for damper seal at maximum design conditions and valve close-off pressure for system design.
- 4. Direct-coupled damper actuators should accommodate 3/8", 1/2" 1.05" round or 3/8"...1/2" and 3/4" square damper shafts.
- 5. Actuator operating temperature minimum requirements: 44, 88 and 133 lb.-in. are -25°F...130°F (-32°C...55°C). The 30, 35, 60, 150 and 300 lb.-in. are -25°F...140°F (-30°C... 60 °C). The 270 are -22°F...122°F (-30°C... 50 °C).
- 6. Overload protected electronically throughout rotation except for selected Floating actuators the have a mechanical clutch.
- 7. Spring Return Actuators: Mechanical fail safe shall incorporate a spring-return mechanism.

8. Non-Spring Return Actuators shall stay in the position last commanded by the controller with an external manual gear release to allow positioning when not powered.
9. Power Requirements: 24Vac/dc [120Vac][230Vac]
10. Proportional Actuators controller input range from 0...10 Vdc, 2...10 Vdc or 4...20 mA models.
11. Housing: Minimum requirement NEMA type 2 with NEMA type 4 available for applications requiring higher ratings.
12. Actuators with a microprocessor should not be able to be modified by an outside source (cracked or hacked).
13. Actuators of 133 and 270 lb.-in. of torque or more should be able to be tandem mount or "gang" mount.
14. Agency Listings: ISO 9001, cULus, CE and CSA
15. Basis of Design: Schneider Electric SmartX Actuators, or approved equal.

T. 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.

U. 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.

2.8 ELECTRICAL POWER MEASUREMENT

A. Electrical Power Monitors, Single Point (Easy Install):

1. Acceptable Manufacturer: Schneider Electric, 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 Enercept H80xx Series, E23 Series
 - 9. Accessories: Current transducers (CTs): split-core (E681/H681/U004) series, solid-core (E682/U004 series) and Rogowski Coils - rope style (E683 series); Communications gateways: Modbus to Ethernet (EGX150)
- B. Electrical Power Monitors, Single Point (High Accuracy):
 - 1. Acceptable Manufacturer: Schneider Electric, 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.
 - 11. Accessories: Current transducers (CTs): split-core (E681/H681/U004) series, solid-core (E682/U004 series)
- C. Electrical Power Monitors, Single Point (High Accuracy/Versatility):
 - 1. Acceptable Manufacturer: Schneider Electric, 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 +/- [0.2%][0.5%] revenue grade
 - b. Operating Temperature Range: -22-158°F

6. Output shall be [Pulse][BACnet][Modbus RTU][LON][Modbus TCP][BACnet/IP][Modbus RTU/TCP][SNMP]
 7. Display: Backlit LCD
 8. Enclosure: NEMA 4x optional
 9. Agency Rating: UL508, ANSI C12.20
 10. Basis of Design: Veris E50 series, Veris E60 Series or Schneider Electric PM5000 Series
 11. Accessories: Current transducers (CTs): split-core (E681/H681/U004) series, solid-core (E682/U004 series) and Rogowski Coils - rope style (E683 series)
- D. Electrical Power Monitors, Multiple Point (92 loads, High Accuracy):
1. Acceptable Manufacturer: Schneider Electric, 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: [BACnet][Modbus RTU][ModbusTCP][BACnet/IP][Modbus RTU/TCP][SNMP]
 7. Agency Rating: UL508, ANSI C12.10, IEC Class 1
 8. Basis of Design: Veris E3xxx series.

PART 3 - EXECUTION

3.1 GENERAL

- A. In addition to the requirements specified herein, execution shall be in accordance with the requirements of Specification Section 23 00 00 and Drawings.
- B. Examine equipment exterior and interior prior to installation. Report any damage and do not install any equipment that is structurally, moisture, or mildew damaged.
- C. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Engineer, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.
- D. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

- E. Install equipment in accordance with reviewed product data, final shop drawings, manufacturer's written instructions and recommendations, and as indicated on the Drawings.
- F. Provide final protection and maintain conditions in a manner acceptable to the manufacturer that shall help ensure that the equipment is without damage at time of Substantial Completion.
- G. Demolition
 - 1. Remove controls which do not remain as part of the building automation system, all associated abandoned wiring and conduit, and all associated pneumatic tubing. The Owner will inform the Contractor of any equipment which is to be removed that will remain the property of the Owner. All other equipment which is removed will be disposed of by the Contractor.
- H. 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.
- I. 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.
- J. 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 SYSTEM ACCEPTANCE TESTING

- A. All application software will be verified and compared against the sequences of operation.
- B. 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.
- C. 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.

- D. 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.
- E. Perform an operational test of each third party interface that has been included as part of the automation system. Verify that all points are properly polled, that alarms have been configured, and that any associated graphics and reports have been completed. If the interface involves a file transfer over Ethernet, test any logic that controls the transmission of the file, and verify the content of the specified information.

3.3 INSTALLATION

- A. Hardware Installation Practices for Wiring
 - 1. All controllers are to be mounted vertically and per the manufacturer's installation documentation.
 - 2. The 120VAC power wiring to each Ethernet or Remote Site controller shall be a dedicated run, with a separate breaker. Each run will include a separate hot, neutral and ground wire. The ground wire will terminate at the breaker panel ground. This circuit will not feed any other circuit or device.
 - 3. A true earth ground must be available in the building. Do not use a corroded or galvanized pipe, or structural steel.
 - 4. Wires are to be attached to the building proper at regular intervals such that wiring does not droop. Wires are not to be affixed to or supported by pipes, conduit, etc.
 - 5. Conduit in finished areas will be concealed in ceiling cavity spaces, plenums, furred spaces and wall construction. Exception; metallic surface raceway may be used in finished areas on masonry walls. All surface raceway in finished areas must be color matched to the existing finish within the limitations of standard manufactured colors.
 - 6. Conduit, in non-finished areas where possible, will be concealed in ceiling cavity spaces, plenums, furred spaces, and wall construction. Exposed conduit will run parallel to or at right angles to the building structure.
 - 7. Wires are to be kept a minimum of three (3) inches from hot water, steam, or condensate piping.
 - 8. Where sensor wires leave the conduit system, they are to be protected by a plastic insert.
 - 9. Wire will not be allowed to run across telephone equipment areas.
 - 10. Provide fire caulking at all rated penetrations.
- B. Installation Practices for Field Devices
 - 1. Well-mounted sensors will include thermal conducting compound within the well to insure good heat transfer to the sensor.
 - 2. Actuators will be firmly mounted to give positive movement and linkage will be adjusted to give smooth continuous movement throughout 100 percent of the stroke.

3. Relay outputs will include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.
4. Water line mounted sensors shall be removable without shutting down the system in which they are installed.
5. For duct static pressure sensors, the high pressure port shall be connected to a metal static pressure probe inserted into the duct pointing upstream. The low pressure port shall be left open to the plenum area at the point that the high pressure port is tapped into the ductwork.
6. For building static pressure sensors, the high pressure port shall be inserted into the space via a metal tube. Pipe the low pressure port to the outside of the building.

C. Wiring, Conduit, and Cable

1. All wire will be copper and meet the minimum wire size and insulation class listed below:
 - a. Power - 12 Gauge - 600 Volt
 - b. Class One - 14 Gauge Std. - 600 Volt
 - c. Class Two - 18 Gauge Std. - 300 Volt
 - d. Class Three - 18 Gauge Std. - 300 Volt
 - e. Communications - Per Mfr.
2. 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.
3. Where different wiring classes terminate within the same enclosure, maintain clearances and install barriers per the National Electric Code.
4. 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.
5. 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.
6. 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.
7. 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.

8. Fiber optic cable shall include the following sizes; 50/125, 62.5/125 or 100/140.
9. Only glass fiber is acceptable, no plastic.
10. Fiber optic cable shall only be installed and terminated by an experienced contractor. The BAS system supplier shall submit to the Engineer the name of the intended contractor of the fiber optic cable with his submittal documents.

D. Enclosures

1. For all I/O requiring field interface devices, these devices where practical will be mounted in a field interface panel (FIP). The Contractor shall provide an enclosure which protects the device(s) from dust, moisture, conceals integral wiring and moving parts.
2. FIPs shall contain power supplies for sensors, interface relays and contactors, and safety circuits.
3. The FIP enclosure shall be of steel construction with baked enamel finish; NEMA 1 rated with a hinged door and keyed lock. The enclosure will be sized for twenty percent spare mounting space. All locks will be keyed identically.
4. All wiring to and from the FIP will be to screw type terminals. Analog or communications wiring may use the FIP as a raceway without terminating. The use of wire nuts within the FIP is prohibited.
5. All outside mounted enclosures shall meet the NEMA-4 rating.
6. The wiring within all enclosures shall be run in plastic track. Wiring within controllers shall be wrapped and secured.

E. Identification

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

F. Existing Controls.

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

G. Location

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

H. Software Installation

1. 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.

3.4 TRAINING

- A. The BAS system supplier 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 (20) 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
- C. C.Factory, classroom training will include a minimum of (2) training reservations for a 3 day course with material covering workstation operation tuition free with travel expense responsibility of the owner. The option for 2-3 weeks of system engineering and controller programming shall be possible if necessary and desired.

3.5 CONTROL SYSTEM SWITCH-OVER

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

3.6 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.

3.7 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.

3.8 REPORTS.

- A. The Contractor will configure a minimum of 4 reports for the owner. These reports shall, at a minimum, be able to provide:
 - 1. Trend comparison data
 - 2. Alarm status and prevalence information
 - 3. Energy Consumption data
 - 4. System user data

3.9 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.
- B. In case of wireless devices, the signal strength recorded during checkout shall be reported.

3.10 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.

3.11 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
 - 8. An electronic copy of all databases, configuration files, or any type of files created specifically for each system.

END OF SECTION 23 09 23

DIVISION 23 - MECHANICAL

SECTION 23 09 93 – SEQUENCE OF OPERATIONSGENERAL

A. Unit Ventilators (Occupancy based DCV)

- a. The units shall be controlled by Schneider Electric room mounted sensors to maintain occupied and unoccupied space temperature set points. The sensor will have no adjustment – all setpoint adjustments will be made at the DDC front-end. A discharge air sensor (8' averaging capillary), mixed air temperature sensor and controller are to be installed for each unit. A Schneider Electric Advanced application controller shall be provided for control of these units.
- b. The DDC front-end will index the unit between occupied and unoccupied cycles. Whenever the unit's supply fan is off, the outside air damper shall be fully closed.
- c. The units shall be tied into the building's DDC control system for occupied/unoccupied cycle operation. All setpoints will be adjustable from the front-end.
- d. Optimal Start: An adaptive optimal start algorithm shall be used to enable the unit with the outside air damper closed and heating enabled to warm-up the space prior to occupancy time, necessary to achieve zone occupied temperature setpoints by the start of scheduled occupied period. The learning adaptive algorithm shall compare the zone temperature to its setpoint at beginning of scheduled occupied period and shall automatically adapt the heating response time for the next unoccupied period. The maximum warm-up start time will be adjustable at the DDC front-end. At no later than the scheduled occupancy time, the unit will transition to occupied mode sequence as indicated below, with the outside air damper modulating open to 20% of minimum code required ventilation position to provide minimum required DCV volumetric flow of outside air (adjustable).
- e. Pre-Occupancy Purge: Thirty minutes prior to the scheduled occupancy time of the unit, the unit will be indexed to a pre-occupancy cycle. This cycle shall run the unit supply / exhaust fans for 30 minutes with the outdoor air / return air / spill air dampers positioned as required to allow for the code required ventilation rate at maximum occupancy. Once the fan is proven running, the outdoor air damper will modulate open, the heating valve will be under the control of the low limit discharge sensor, maintaining discharge air at 60 deg. (adjustable).
- f. Post Occupancy Purge: When the unit is indexed into the unoccupied mode as dictated by the occupancy schedule programmed into the BMS, the unit will run in a post occupancy flush cycle. The outdoor air, return air & exhaust / spill air dampers shall be positioned to provide 100% quantity of outdoor air required for full occupancy of the space, with all fans running until the space CO2 levels reach outdoor air ambient conditions. When indoor air CO2 levels are equal to outdoor air CO2 levels, the unit will shut down, entering the unoccupied cycle.
- g. Freezestat: A freezestat shall be provided, draped across the full face of the coils in order to detect a freezing condition. Upon an initial trip at T1 = 40 deg. F., the heating valve will open fully & the outdoor air damper will close. An alarm will be sent to the BMS front end. This action will automatically reset once the internal unit temperature has risen. Upon a hard trip at T2 = 38 deg. F., the unit fans will be shut down, the heating valve will open fully

and the outdoor air damper will close. This will be a manual reset condition. An alarm will be sent to the BMS front end.

- h. Damper Control: The unit economizer dampers will be controlled to maintain CO2 levels based upon a room occupancy sensor for demand controlled ventilation. Once the supply fan has been proven running, the outdoor air damper will move to 20% of the minimum code required ventilation rate. When the space occupancy sensor detects room occupancy, the unit ventilator outdoor air damper will open to at least the minimum code required ventilation position. The outdoor air damper will be allowed to modulate open beyond that required for demand controlled ventilation if free cooling is available, and required to maintain indoor temperature setpoint.
- i. Occupied Period: During the occupied period, the supply fan will run continuously and indicate to the DDC controller via a current relay wired to a binary input of the controller that the fan is running. Once the fan is proven running, the outside air damper shall modulate to 20% of minimum code required ventilation rate. Whenever occupancy is sensed, outdoor air damper will modulate to the full minimum code required ventilation rate / damper position. Whenever the space temperature is below the space set point of 68°F (adjustable), the heating valve(s) will be cycled to maintain the discharge air temperature at the discharge heating setpoint. The discharge air setpoint shall reset automatically between the discharge high limit of 100°F (adjustable) and low limit of 60°F (adjustable) reset based on deviation of the space temperature from the space heating setpoint. As the space temperature rises above the space set point (adjustable), the outside air damper shall modulate open beyond their minimum position, up to 100% to maintain the cooling space setpoint. The controller's program will maintain a minimum discharge and mixed air temperature of 60°F (adjustable) by enabling the heating and modulating the outside air damper, beyond the minimum position, in sequence without overlap).
- j. Occupied Period – Cooling Mode: The front-end will determine the heating and cooling modes of the unit based on the outdoor air temperature/free cooling availability. If the space is on a call for cooling and there is no free cooling available and the supply fan is proven running, the outdoor air damper will move to 20% of the minimum open position (no occupancy) or the minimum outdoor air position (occupancy, adjustable from the front-end) and the DDC controller will cycle the stages of DX cooling / cycle the chilled water valve to maintain the space cooling set point. If the economizer dampers fail to satisfy the cooling demand and the space temperature is above setpoint, the economizer dampers will modulate to minimum position as previously described and the stages of mechanical cooling / cycling of chilled water valve will be enabled to maintain cooling temperature setpoint.
- l. During the unoccupied cycle, the unit's supply fan shall be cycled to maintain space setback temperature set point of 55 deg. F. (adjustable). The heating valve will be modulated to maintain the night heating setpoint. The outside air dampers shall be closed.
- m. All outside air dampers shall fail in the closed position.

A. New Face & Bypass Unit Ventilators, Hot Water / DX Cooling

- a. The units shall be controlled by Andover room mounted sensors to maintain occupied and unoccupied space temperature set points. A discharge air sensor (8' averaging capillary), space temperature sensor and unitary controller are to be installed for each unit.
- b. The units will be provided with a factory installed freeze-stat. This is to be left in place to shut the fan off when a freezing condition occurs. Whenever the fan is off, the outside air damper will be closed. As an added feature, the DDC controller will use the discharge air sensor to detect a potential freezing condition. The set point will be 5°

higher than the set point of the factory freeze-stat. If such a condition occurs, the outside air damper will close, the fan will shut off and an alarm will be displayed on the front-end and an email will be sent from the DDC front-end system to those recipients designated by the District. The alarm and email messages will indicate which unit caused the alarm and be stamped with the date and time that the alarm occurred.

- c. The units shall be tied into the building's Andover DDC control system for occupied/un-occupied cycle operation. All setpoints will be adjustable from the front-end.
- d. Occupied Period: During the occupied period, the supply fan will run continuously and indicate to the DDC controller via a current relay wired to a binary input of the controller that the fan is running. Once the fan is proven running, the outside air damper shall modulate open to minimum position (adjustable), to provide the minimum required volumetric flow rate of outside air. Whenever the space temperature is below the space set point of 68°F (adjustable), the face & bypass damper will be fully open to the heating coil to maintain the discharge air temperature at the discharge heating setpoint. The discharge air setpoint shall reset automatically between the discharge high limit of 120°F (adjustable) and low limit of 60°F (adjustable) reset based on deviation of the space temperature from the space heating setpoint. As the space temperature rises above the space set point (adjustable), the face & bypass damper will fully face the bypass and the outside air damper shall modulate open beyond their minimum position to maintain the cooling space setpoint. The controller's program will maintain a minimum discharge temperature of 60°F (adjustable) by modulating the F&B damper and modulating the outside air damper, beyond the minimum position required volumetric flow rate of outside air, in sequence without overlap.
- e. Occupied Period – Cooling Mode (For units with CHW cooling): The FX front-end will determine the heating and cooling modes of the unit based on the outdoor air temperature/free cooling availability. When indexed into mechanical cooling mode, the supply fan will run and indicate to the DDC controller via a current relay wired to a binary input of the controller that the fan is running. The outdoor air damper will be at its minimum position (adjustable from the front-end). The DDC controller will modulate the face/bypass damper to maintain the space cooling set point.
- f. During the unoccupied cycle the unit's supply fan shall be cycled to maintain space setback temperature set point. The face/bypass damper will fully face the coil. The outside air damper shall be closed. There will be no cooling operation during the unoccupied mode.
- g. The outside air damper shall fail in the closed position.
- h. For any new units that have existing, or new auxiliary finned tube radiation as shown on the plans, a dedicated control signal from the DDC controller will cycle a new auxiliary radiation control valve (provided by ATC contractor and installed by Mechanical Contractor) to maintain the space setpoint. A lower setpoint will be maintained during the unoccupied cycle. For hot water applications, the ftr control valve will be 2-position. For steam applications, the ftr control valve will be modulating control, temperature rated for steam.

Dynamic Color Graphics Requirements

- a. The color graphics that the user will see to operate the system shall be resident in the front-end. The main graphic shall be a three-dimensional floor plan of the building with links to each room and its HVAC system. The display will provide links to all DDC equipment in the building. Links to data trends and schedules shall be located on each system's graphic screen.

- b. The minimum point information that is to be mapped to the front-end panel and shown in the color graphic screens is as follows:

Unit Ventilators				
Description	Point	History	Alarm	Totalize
Damper Command	AO	X		
Discharge Air Temperature	AI	X	X	
Discharge Low Limit Set Point	AV	X		
F&B damper	AO	X		
Minimum Outdoor Air Damper Position (adjustable)	AV	X		
Occupied Command	BV			
Occupied Space Set Point	AV	X		
Occupied Status	BV	X		
Outside Air Temperature	AI	X		
Space Temperature	AI	X	X	
Status of DDC controller	BV		X	
Supply Fan Command	BO	X	X	
Supply Fan Status	BI	X	X	X
Unoccupied Space Set Point	AV	X		
Working Setpoint	AV	X		

G. Split AC Units (VRF Systems)

- a. The VRF systems will operate under standalone factory controls.
- b. The ATC contractor will install and wire the factory furnished wall thermostat and will provide the low voltage interlock control wiring to the condensing unit.
- c. Provide an interlock between the new VRF cooling equipment & the existing heating & ventilating equipment (where applicable) such that there can be no simultaneous heating & cooling operation and that during winter heating, only economizer cooling can be used in the event that the space exceeds it's heating setpoint. Heating and cooling setpoints shall maintain a 5 deg. F. minimum offset.
- d. Provide interface to the Schneider BMS and provide graphics to show each space, with all setpoints, H&V unit status, VRF indoor unit status, outdoor VRF unit status, & status of interlocks.
- e. Additionally, the Split AC units will be provided with factory provided BACnet communication cards and/or gateway controllers. Programming and startup of the Split AC unit BACnet cards/gateway controllers will be provided by the Split AC Unit manufacturer. The ATC contractor will provide the communication wiring between these units and the front-end. All DDC points on these BACnet cards will be seamlessly mapped to the DDC front-end, with setpoints adjustable from the BMS front-end. The ATC contractor will include all BACnet licenses, hardware, programming, software necessary for the expanded front-end to accomplish this.
- f. An individual graphic shall be provided for each unit. For multiple Splits units serving a common space, a common graphic will be provided controlling the equipment

in the room with common sequenced heating and cooling setpoints. Additional graphics will be provided for each individual unit.

- g. The VRF condensing unit will be networked to the BMS front-end via a factory BACnet MSTP card. The ATC contractor will include the wiring, addressing and integration of the VRF BACnet points to the BMS front-end.

Dynamic Color Graphics Requirements

- c. The color graphics that the user will see to operate the system shall be resident in the Andover front-end. The main graphic shall be a three-dimensional floor plan of the building with links to each room and its HVAC system. The display will provide links to all DDC equipment in the building. Links to data trends and schedules shall be located on each system's graphic screen.
- d. The minimum point information that is to be mapped to the front-end panel and shown in the color graphic screens is as follows:

Split AC Units				
Description	Point	History	Alarm	Totalize
Integrated DDC Points		X	X	X
Occupied Command	BV	X		
Status of DDC controller	BV		X	

VRF Condensing Unit				
Description	Point	History	Alarm	Totalize
Integrated points of factory VRF controller (BACnet)	AV/BV	X	X	
Status of DDC controller	BV		X	

H. Air Handling Units

Temperature controls for the new air handling units for the Main Office Suite area and the Lobby area shall meet the following sequence of operation:

1. Heating Mode – Unoccupied: During the unoccupied mode, the unit shall remain off, with the outdoor air damper fully closed. A low limit thermostat installed in the unit will allow flow through the heating coil if temperatures below 40 deg. F. (adjustable) are sensed within the unit.
2. Heating Mode, Occupied: During the occupied mode, the unit shall start, the unit shall open the outdoor air damper to it's minimum code required ventilation position, maintaining code required ventilation rates and the unit shall modulate the heating coil control valve as required to maintain neutral air discharge (+/-62 deg. F., adjustable). The unit main / return fans VFD will run. The unit will run in this fashion for the entirety of the occupied cycle. The unit shall be equipped with a freezestat covering the entire face of the coil. If a freezing condition occurs, the unit shall close the outdoor air damper, shut the fan down and send an alarm to the BMS. Note that the room thermostat shall modulate the existing fin tube radiator control valve within the room as required to perform the remainder of the heating for each room.

3. Cooling Mode, Unoccupied: During the unoccupied mode, mechanical cooling shall be locked out and the unit shall remain off, with the outdoor air damper fully closed.
4. Cooling Mode, Occupied: During the cooling occupied mode, the outdoor air dampers shall modulate to the open position required for code required ventilation. Outdoor air / economizer will act as stage 1 cooling. Should temperature / humidity conditions of the outdoor air be insufficient to meet discharge air setpoint, mechanical cooling will be enabled. Mechanical cooling will be cycled as required to maintain a 78 deg. F. / 60% RH discharge air setpoint, adjustable. Provide discharge air temperature sensors. Provide a discharge air humidity sensor so that the unit may operate in a "dehumidification (reheat via existing heating coil) mode if desired by the owner. Note that the classroom (or Office) VRF cassette will be modulated by it's related thermostat as required to perform the remainder of the cooling requirement.

All fans shall be proven running when commanded to do so and shall show status at the head end graphic.

Damper & valve actuators shall be mapped up to show their actual position at the head end.

All coils shall show inlet water temperature and discharge water temperature at the head end graphic.

All units shall read discharge air temperature, return air temperature and mixed air temperature at the graphic.

All unit alarms (temperature / freezestat / fan fault / etc.) shall be transmitted to the head end graphic for that unit and shall also be transmitted to the main alarm page at the BMS.

I. Exhaust Fans

- a. The ATC contractor shall supply and install all required DDC controllers, controls and required hardware to allow the following sequences of operation to occur.
- b. The exhaust fan will run continuously during the occupied mode and be off during the unoccupied mode based on schedule resident in the BMS front-end. Fan status will be monitored at the BMS.

Dynamic Color Graphics Requirements

The color graphics that the user will see to operate the system shall be resident in the Andover web-based front-end controller. PC-based systems are not acceptable. The main graphic shall be a three-dimensional floor plan of the building with links to each room and its HVAC system. The display will provide links to all DDC equipment in the building. Links to data trends and schedules shall be located on each system's graphic screen. The minimum point information that is to be mapped to the front-end panel and shown in the color graphic screens is as follows:

<u>Air Handling Units / Unit Ventilators</u>				
<u>Description</u>	<u>Point</u>	<u>History</u>	<u>Alarm</u>	<u>Totalize</u>
<u>Discharge Air Temperature</u>	<u>AI</u>	<u>X</u>	<u>X</u>	

<u>Mixed Air Temperature</u>	<u>AI</u>	<u>X</u>	<u>X</u>	
<u>Unit discharge RH</u>	<u>AI</u>	<u>X</u>	<u>X</u>	
<u>Unit discharge RH setpoint</u>	<u>AV</u>	<u>X</u>		
<u>Pre-Occupancy Purge Command</u>	<u>AV</u>	<u>X</u>		
<u>Pre-Occupancy Purge Max Runtime Allowed</u>	<u>AV</u>	<u>X</u>		
<u>Post-Flush Command</u>	<u>AV</u>	<u>X</u>		
<u>Post-Flush Max Runtime Allowed</u>	<u>AV</u>	<u>X</u>		
<u>Space Temperature</u>	<u>AI</u>	<u>X</u>	<u>X</u>	
<u>Space Relative Humidity</u>	<u>AI</u>	<u>X</u>	<u>X</u>	
<u>Outside Air Temperature</u>	<u>AV</u>	<u>X</u>		
<u>Occupied Space Temperature Heating Set Point</u>	<u>AV</u>	<u>X</u>		
<u>Occupied Space Temperature Cooling Set Point</u>	<u>AV</u>	<u>X</u>		
<u>Occupied Space Relative Humidity Set Point</u>	<u>AV</u>	<u>X</u>		
<u>Unoccupied Space Temperature Heating Set Point</u>	<u>AV</u>	<u>X</u>		
<u>Unoccupied Space Temperature Cooling Set Point</u>	<u>AV</u>	<u>X</u>		
<u>Active Temperature Setpoint</u>	<u>AV</u>	<u>X</u>		
<u>Active Relative Humidity Setpoint</u>	<u>AV</u>	<u>X</u>		
<u>Mixed Air Low Limit Set Point</u>	<u>AV</u>	<u>X</u>		
<u>Discharge Air Low Limit Set Point</u>	<u>AV</u>	<u>X</u>		
<u>Heating Command</u>	<u>AO</u>	<u>X</u>		
<u>Cooling Command</u>	<u>BO</u>	<u>X</u>		
<u>Outside Air Damper Command</u>	<u>AO</u>	<u>X</u>		
<u>Exhaust Air Damper Command</u>	<u>AO</u>	<u>X</u>		
<u>Return Air Damper Command</u>	<u>AO</u>	<u>X</u>		
<u>Dehumidification/Hot Gas Reheat Command</u>	<u>AO</u>	<u>X</u>		
<u>Supply Fan Status</u>	<u>BI</u>	<u>X</u>	<u>X</u>	<u>X</u>
<u>Supply Fan Command</u>	<u>BO</u>	<u>X</u>	<u>X</u>	
<u>Exhaust Fan Status</u>	<u>BI</u>	<u>X</u>	<u>X</u>	<u>X</u>
<u>Exhaust Fan Command</u>	<u>BO</u>	<u>X</u>	<u>X</u>	
<u>Occupied Command</u>	<u>BV</u>			
<u>Occupied Status</u>	<u>BV</u>	<u>X</u>		
<u>Status of DDC controller</u>	<u>BV</u>		<u>X</u>	

Exhaust Fans				
Description	Point	History	Alarm	Totalize
Fan Command	BO	X	X	
Fan Status	BI	X		
Occupied Command	BV			
Occupied Status	BV	X		
Status of DDC controller	BV		X	

Hot Water Hydronic Cabinet Heaters with No Fresh Air

A. Hot Water Cabinet Heater (CH-Tags) Unit (Heating)

1. General

- a. The Contractor shall provide, install, wire the following: Johnson F4-CGM controller, TE-6314P-1 wall temperature sensor, TE-6315P-1 (8' averaging discharge air sensor), current relay wired to monitor the supply fan, fail-safe, normally closed outside air damper actuator, fail-safe, normally open, modulating heating control valve.
- b. Occupied/unoccupied cycle determination will be made via the BMS front-end.
- c. All setpoints will be adjustable from the BMS front-end.
- d. Dedicated Outdoor Air System (DOAS) serving this space shall be running to provide tempered fresh air to space. Refer to DOAS sequence of operations in this specification for further details.

2. Occupied Hours

- a. During occupied hours, the CH-Tags shall be enabled:
 - i. The supply fan shall run continuously.
 - ii. CH-Tags Supply fan shall be enabled.
 - iii. New DDC modulating glycol hot water control valve shall modulate the supply air discharge temperature based on a new DDC room thermostat (72 F adjust). Whenever the space temperature is below the space set point of (adjustable), the heating valve will be open to maintain the discharge air temperature at the discharge heating setpoint. The discharge air setpoint shall reset automatically between the discharge high limit of 100°F (adjustable) and low limit of 60°F (adjustable) reset based on deviation of the space temperature from the space heating setpoint. As the space temperature rises above the space set point (adjustable), the glycol hot water control valve shall modulate & slowly close until the space temperature setpoint is met.
- b. In the event that CH-Tags has a command to enable either the supply air fan, modulating hot water control

- valve, return air damper positions and is still disabled, an alarm will be displayed on the BMS.
 - c. Heating shall be enabled when outside air temperature is 65 deg F (adj) and space cooling unit shall be locked out.
3. Unoccupied Hours
- a. During unoccupied hours, the CH-Tags shall be enabled:
 - i. Supply fan shall be enabled.
 - ii. Return air damper shall be 100% open.
 - iii. New DDC modulating glycol hot water control valve shall modulate the supply air discharge temperature based on a new DDC room thermostat (60 F adjust)
 - b. In the event that CH-Tags has a command to enable either the supply air fan, modulating glycol hot water control valve & return damper positions and is still disabled, an alarm will be displayed on the BMS.

HOT WATER CABINET UNIT HEATERS SEQUENCE OF OPERATIONS:

A. Hot Water Cabinet Unit Heater (CUH-Tags) Unit (Heating)

1. General

- a. The Contractor shall provide, install, wire the following: Schneider controller, wall temperature sensor, 8' averaging discharge air sensor, current relay wired to monitor the supply fan, fail-safe, normally closed outside air damper actuator, fail-safe, normally open, modulating heating control valve.
- b. Occupied/unoccupied cycle determination will be made via the BMS front-end.
- c. All setpoints will be adjustable from the BMS front-end.
- d. Heating-Ventilation (H-V) unit serving this space shall be running to provide tempered fresh air to space. Refer to H-V Unit sequence of operations in this specification for further details.

2. Occupied Hours

- a. During occupied hours, the CUH shall be enabled:
 - i. The supply fan shall run continuously.
 - ii. CUH Supply fan shall be enabled.

- iii. New DDC modulating hot water control valve shall modulate the supply air discharge temperature based on a new DDC room thermostat (72 F adjust). Whenever the space temperature is below the space set point of (adjustable), the heating valve will be open to maintain the discharge air temperature at the discharge heating setpoint. The discharge air setpoint shall reset automatically between the discharge high limit of 100°F (adjustable) and low limit of 60°F (adjustable) reset based on deviation of the space temperature from the space heating setpoint. As the space temperature rises above the space set point (adjustable), the glycol hot water control valve shall modulate & slowly close until the space temperature setpoint is met.
 - b. In the event that CUH has a command to enable either the supply air fan, modulating hot water control valve and is still disabled, an alarm will be displayed on the BMS.
 - c. Heating shall be enabled when outside air temperature is 65 deg F (adj) and space cooling unit (if applicable) shall be locked out.
- 3. Unoccupied Hours
 - a. During unoccupied hours during heating season, the CUH shall be enabled:
 - i. Supply fan shall be enabled.
 - ii. New DDC modulating glycol hot water control valve shall modulate the supply air discharge temperature based on a new DDC room thermostat (60 F adjust)
 - b. In the event that CUH has a command to enable either the supply air fan, modulating glycol hot water control valve and is still disabled, an alarm will be displayed on the BMS.

DEDICATED OUT AIR SYSTEMS (DOAS) SEQUENCE OF OPERATIONS:

Notes:

- A. AHU-1 has an electric duct coil (EHC-1)

1. General

- a. The Contractor shall provide, install, wire the following for each DOAS unit: Schneider controller, return air temperature and RH sensor, (8' averaging discharge air sensor), (8' averaging mixed air sensor), current relay wired to monitor the supply fan, fail-safe, normally closed outside air damper actuator, fail-safe, normally open, modulating heating control valve.
- b. The ATC contractor will provide and install a freeze-stat, wired to shut of the supply and exhaust fan in all positions of the H-O-A switch. Manual reset of the freezestat is required. As an added feature, the DDC controller will use the discharge air sensor to detect a potential freezing condition. The set point will be 5° higher than the set point of the freeze-stat. If such a condition occurs, the outside air damper shall close, the fans will shut down, the heating valve shall open, and an alarm generated at the DDC front-end.
- c. Whenever the unit's supply fan is off, the outside air damper shall be fully closed.
- d. Occupied/unoccupied cycle determination will be made via the BMS front-end.
- e. All setpoints will be adjustable from the BMS front-end.

2. Occupied Hours (Cooling Mode)

- f. During occupied hours, DOAS unit shall be enabled:
 - i. The supply and exhaust fans shall run continuously.
 - ii. Once the supply fan is proven running, the Outside air damper shall open to minimum outside air position and the Return air damper shall open to a percentage based on (100% open – Minimum Outside Air Damper Position %)
 - iii. DX Cooling stage(s) shall be enabled. Unit shall modulate supply air discharge dry bulb & wet bulb air temperature to maintain 70 deg F (dry bulb-adj.) and 60 deg F (wet bulb-adj.) to send into supply air ductwork.

- g. In the event that DOAS has a command to enable either the supply air fan, exhaust/relief air fan, return & outside air damper positions, DX cooling stage(s) and is still disabled, an alarm will be displayed on the BMS.
- 3. Unoccupied Hours (Cooling Mode)
 - h. During unoccupied hours, AHU-1 shall be disabled with outside air damper position & relief air damper position at 0% open.
- 4. Occupied Hours (Heating Mode)
 - i. During occupied hours, RTU shall be enabled:
 - i. Outside air damper shall open to 100% fully open position.
 - ii. Relief/Exhaust air damper shall open to 100% fully open position.
 - iii. Upon proof of dampers opening, Supply fan & Exhaust/Relief Fan shall both be enabled.
 - j. New Hot Water Coil (AHU-1)
 - i. New DDC modulating control valve shall modulate to maintain the supply air discharge temperature set point (68 F adjustable).
 - k. In the event that unit has a command to enable either the supply air fan, modulating control valve, return & outside air damper positions, new modulating hot water control valve is still disabled, or freeze stat trips on hot water coil, an alarm will be displayed on the BMS.
- 5. Unoccupied Hours (Heating Mode)
 - l. During unoccupied hours, AHU-1 shall be off and hw heating valve shall be closed. Upon a call for heat at the unoccupied heating set point:
 - i. Supply fan blower shall be enabled.
 - ii. Outside air damper shall be at 0% open (Recirculation Mode).
 - iii. Return air damper shall be 100% open
 - iv. DDC modulating control valve shall modulate open to maintain the heating set point.
 - m. In the event that AHU-1 has a command to enable either the supply air fan, return & outside air damper positions, new modulating hot water control valve is still disabled, or freeze stat trips on hot water duct coil, an alarm will be displayed on the BMS.
 - i. DDC modulating control valve shall modulate open to maintain the heating set point.

- n. In the event that AHU-1 has a command to enable either the supply air fan, modulating hot water control valve, return & outside air damper positions, new modulating hot water control valve is still disabled, or freeze stat trips on hot water duct coil, an alarm will be displayed on the BMS.

HOT WATER PERIMETER FIN TUBES SEQUENCE OF OPERATIONS:

A. Hot Water Perimeter Fin Tube Unit (Heating)

1. General

- a. The Contractor shall provide, install, wire the following: Schneider controller, wall temperature sensor, fail-safe, normally open, modulating heating control valve.
- b. Occupied/unoccupied cycle determination will be made via the BMS front-end.
- c. All setpoints will be adjustable from the BMS front-end.
- d. Heating-Ventilation (H-V) or Dedicated Outdoor Air System (DOAS) unit serving this space shall be running to provide tempered fresh air to space. Refer to H-V Unit or DOAS Unit sequence of operations in this specification for further details.

2. Occupied Hours

- a. During occupied hours, the FT shall be enabled:
 - i. New DDC modulating hot water control valve shall modulate the water flow for the perimeter finned tube based on a new DDC room thermostat (72 F adjust). Whenever the space temperature is below the space set point of (adjustable), the heating valve will be open to maintain the room temperature heating setpoint. As the space temperature rises above the space set point (adjustable), the hot water control valve shall modulate & slowly close until the space temperature setpoint is met.
- b. In the event that the FT modulating hot water control valve has a command to open and is still disabled, an alarm will be displayed on the BMS.
- c. Heating shall be enabled when outside air temperature is 64 deg F (adj) and space cooling unit (if applicable) shall be locked out.

3. Unoccupied Hours

- a. During unoccupied hours during heating season, the FT shall be disabled. FT shall become enabled if the space temperature drops below the night setback temperature setting.
- b. In the event that FT has a command to enable modulating glycol hot water control valve and is still disabled, an alarm will be displayed on the BMS.

EXHAUST FAN SEQUENCE OF OPERATIONS:

A. General

- a. Fan shall be in the “enabled” position during occupied hours.
- b. Occupied hours shall be adjusted on BMS schedule menu (adj.).
- c. All setpoints will be adjustable from the BMS front-end.

B. Occupied Hours

- a. During occupied hours, EF Unit shall be enabled.
 - i. Exhaust Fan shall run continuously.

C. Unoccupied Hours

- b. During unoccupied hours, EF Unit shall be disabled.

D. Interlocks

- a. New unit for Main Office area relief air shall be interlocked with the exhaust fan system serving that area.
- b. Sequence: Upon proof of motorized exhaust dampers opening, outside damper shall open to full. Main Office exhaust fan shall all energize.

<u>H&V Units / Cabinet Heaters / Fin Tube Elements</u>				
<u>Description</u>	<u>Point</u>	<u>History</u>	<u>Alarm</u>	<u>Totalize</u>
Discharge Air Temperature	AI	X	X	
Mixed Air Temperature	AI	X	X	
Space Temperature	AI	X	X	
Outside Air Temperature	AV	X		
Occupied Space Temperature Heating Set Point	AV	X		
Occupied Space Temperature Cooling Set Point	AV	X		
Unoccupied Space Temperature Heating Set Point	AV	X		
Unoccupied Space Temperature Cooling Set Point	AV	X		
Active Temperature Setpoint	AV	X		
Mixed Air Low Limit Set Point	AV	X		
Heating Command	AO	X		
Cooling Command	BO	X		

<u>Outside Air Damper Command</u>	<u>AO</u>	<u>X</u>		
<u>Exhaust Air Damper Command</u>	<u>AO</u>	<u>X</u>		
<u>Return Air Damper Command</u>	<u>AO</u>	<u>X</u>		
<u>Dehumidification/Hot Gas Reheat Command</u>	<u>AO</u>	<u>X</u>		
<u>Supply Fan Status</u>	<u>BI</u>	<u>X</u>	<u>X</u>	<u>X</u>
<u>Supply Fan Command</u>	<u>BO</u>	<u>X</u>	<u>X</u>	
<u>Exhaust Fan Status</u>	<u>BI</u>	<u>X</u>	<u>X</u>	<u>X</u>
<u>Exhaust Fan Command</u>	<u>BO</u>	<u>X</u>	<u>X</u>	
<u>Occupied Command</u>	<u>BV</u>			
<u>Occupied Status</u>	<u>BV</u>	<u>X</u>		
<u>Status of DDC controller</u>	<u>BV</u>		<u>X</u>	

END OF SECTION 23 09 23

GENERAL NOTES	
1.	REMOVAL & RELOCATION OF CERTAIN EXISTING WORK SHALL BE NECESSARY FOR THE PERFORMANCE OF THE NEW WORK SHOWN HEREIN. ALL EXISTING CONDITIONS ARE NOT COMPLETELY DETAILED ON THE DRAWINGS. THE CONTRACTOR SHALL SURVEY THE SITE & MAKE ALL NECESSARY CHANGES BASED ON EXISTING CONDITIONS AS REQUIRED FOR PROPER DEMOLITION OF EXISTING WORK & SHALL INCLUDE ALL MATERIALS & LABOR FOR SAME IN HIS BID PRICE. NO ALLOWANCE WILL BE MADE FOR FAILURE TO DO SO.
2.	PRIOR TO SUBMITTING A BID, THE CONTRACTOR SHALL VISIT THE PREMISES OF THE PROPOSED WORK & SHALL CAREFULLY EXAMINE THE ENGINEERING DRAWINGS, EXISTING CONDITIONS & LIMITATIONS THEREOF. VERIFY ACTUAL LOCATIONS WHERE THE NEW PIPING WILL BE ROUTED, COORDINATE WITH NEW & EXISTING WORK & PROVIDE CLEARANCE. W/ BUILDING, STRUCTURE, OTHER SERVICES, ETC. THE CONTRACTOR SHALL INCLUDE ALL COSTS WHATSOEVER WHICH ARE INCURRED AS A RESULT OF LIMITATIONS OF THE EXISTING & NEW CONDITIONS. LATER CLAIMS FOR EXTRA LABOR, EQUIPMENT, MATERIALS, ETC. REQUIRED DUE TO DIFFICULTIES WHICH COULD HAVE BEEN FORESEEN WILL NOT BE CONSIDERED AS EXTRA WORK.
3.	INSTALL WORK SO AS TO BE READILY ACCESSIBLE FOR OPERATING, MAINTENANCE & REPAIR. MINOR DEVIATIONS FROM DRAWINGS MAY BE MADE TO ACCOMPLISH THIS BUT CHANGES OF MAGNITUDE WHICH INVOLVE EXTRA COST SHALL NOT BE MADE WITHOUT APPROVAL.
4.	INVESTIGATE EACH SPACE THROUGH WHICH EQUIPMENT MUST BE MOVED. WHEN NECESSARY, EQUIPMENT SHALL BE SHIPPED FROM MANUFACTURER IN CRATED SECTIONS OF SIZE SUITABLE FOR MOVING THROUGH AREAS AVAILABLE. ASCERTAIN FROM BUILDING OWNER AT WHAT TIMES OF DAY EQUIPMENT MAY BE MOVED THROUGH THE BUILDING.
5.	COORDINATE THE EXACT SIZE & LOCATION OF NEW OPENINGS WITH EXISTING STRUCTURE. PATCH / INSULATE AS REQUIRED. CONTRACTOR SHALL FIRESTOP ALL PENETRATIONS FROM NEW PIPING, CONDUIT, DUCTWORK, ETC. THROUGH EXISTING OR NEW FIRE / SMOKE BARRIERS. REFER TO SPECIFICATION SECTION 230680 FOR FURTHER DETAILS.
6.	IT IS THE INTENT OF THIS CONTRACT FOR REMAINING SYSTEMS TO BE LEFT IN GOOD WORKING ORDER, READY FOR OPERATION. COORDINATE ANY REQUIRED SYSTEM SHUTDOWNS WITH OWNER 48 HOURS IN ADVANCE. EXISTING SYSTEM SHUTDOWNS WILL NOT BE PERMITTED IF THEY INTERFERE WITH THE DAILY OPERATIONS OF THE BUILDING. CONTRACTOR WILL BE REQUIRED TO TAKE PROPER PRECAUTIONS AGAINST DAMAGING OR DISRUPTING BUILDING SYSTEMS, WIRING, PIPING OR CONTROL TUBING. ANY DAMAGE TO THESE ITEMS SHALL BE REPAIRED AT THE CONTRACTOR'S COST AS A PART OF THIS CONTRACT.
7.	THE CONTRACTOR SHALL REPAIR / RESTORE TO ORIGINAL CONDITION ANY EXISTING EQUIPMENT OR MATERIALS DAMAGED IN THE PROCESS OF INSTALLATION. ON DEMOLITION TO THE SATISFACTION OF THE OWNER'S REPRESENTATIVE. CONTRACTOR SHALL MAKE REPAIRS USING THE SAME OR EQUIVALENT MATERIALS. WORK WILL BE PERFORMED AT THE CONTRACTOR'S COST.
8.	CONTRACTOR SHALL INCUR ANY COSTS OR BURDENS ASSOCIATED WITH LOST OR STOLEN EQUIPMENT MATERIALS.
9.	DURING THE LIFE OF THE CONTRACT PERIOD, CONTRACTOR SHALL REMOVE ALL RUBBISH / EXCESS MATERIAL ACCUMULATED AS A RESULT OF HIS OPERATIONS ON A DAILY BASIS. ALL AREAS / EQUIPMENT AFFECTED UNDER THIS CONTRACT SHALL BE KEPT CLEAN OF DUST / DEBRIS. ALL AREAS SHALL RECEIVE A FINAL CLEANING PRIOR TO FINAL ACCEPTANCE BY THE OWNER.
10.	PROVIDE FOR LEGAL REMOVAL / DISPOSAL OF ALL RUBBISH / DEBRIS FROM THE BUILDING & SITE. PROTECT ALL WORK NOT SLATED FOR DEMOLITION.
11.	THIS CONTRACTOR SHALL COORDINATE HIS WORK WITH ALL OTHER TRADES PRIOR TO SCHEDULING THE WORK. WORK SHALL BE PERFORMED IN PROPER SEQUENCE, AS AGREED TO BY ALL TRADES. ANY COSTS INCURRED BY THE OWNER DUE TO IMPROPER SEQUENCING OF WORK WILL BE PAID FOR BY THIS CONTRACTOR.
12.	CONTRACTOR SHALL OBTAIN ALL PERMITS, PAY ALL FEES, CONNECTION CHARGES, ETC. ASSOCIATED WITH THE WORK UNDER THEIR CONTRACT.
13.	PAIN / TOUCH UP ALL SURFACES MARRED AS A RESULT OF THE PERFORMANCE OF THE CONTRACT WORK.
14.	THE MECHANICAL CONTRACTOR SHALL REFER TO / REVIEW ALL OTHER TRADE DRAWINGS IN THE BID PACKAGE & SHALL BE RESPONSIBLE FOR / PERFORM ALL WORK INDICATED AS (M.C.) MECHANICAL WORK AS A PART OF THE BASE BID UNLESS SPECIFICALLY NOTED OTHERWISE.
15.	SUBSTITUTED EQUIPMENT OF GREATER OR LARGER POWER, DIMENSIONS, CAPACITIES & RATINGS MAY BE FURNISHED PROVIDED THAT SAID EQUIPMENT IS APPROVED IN WRITING PRIOR TO ORDER. ANY CONNECTING MECHANICAL SERVICES, ELECTRICAL SERVICES, BASES, STRUCTURAL ADJUSTMENTS, ETC. REQUIRED TO BE INCREASED DUE TO THE USE OF SAID EQUIPMENT WILL BE PAID FOR IN FULL BY THE MECHANICAL CONTRACTOR, INCLUDING ANY ADDITIONAL REQUIRED ENGINEERING FEES.
16.	EACH PIECE OF EQUIPMENT SHALL BE PROVIDED WITH A PERMANENT TYPE LAMINATED, BLACK FINISH, WHITE CORE, PHENOLIC NAMEPLATE. NAMEPLATES SHOULD INDICATE THE NAME & NUMBER OF THE UNIT, UNIT VOLTAGE, & ANY INTERLOCK REFERENCE. STARTERS / DISCONNECT SWITCHES SHOULD ALSO BE EQUIPPED WITH AN IDENTICAL NAMEPLATE WITH THE SAME INFORMATION.
17.	"ATTIC STOCK" - UPON COMPLETION OF THE PROJECT, MECHANICAL CONTRACTOR SHALL COMPLETELY REMOVE / DISPOSE OF FILTERS USED DURING CONSTRUCTION & START-UP PROCEDURES. INSTALL NEW FILTERS IN ALL EQUIPMENT, MERV-8 OR BETTER UPON TURN OVER OF THE PROJECT TO THE OWNER. IN ADDITION, PROVIDE (2) COMPLETE SETS OF FILTERS FOR EACH PIECE OF EQUIPMENT & TURN OVER TO OWNER.
18.	MECHANICAL CONTRACTOR SHALL PROVIDE (1) SPARE MOTOR FOR EACH SIZE MOTOR USED ON THE PROJECT. IN INSTANCES WHERE MORE THAN TEN OF THE SAME MOTOR ARE USED, MECHANICAL CONTRACTOR SHALL PROVIDE (1) SPARE MOTOR FOR EVERY TEN MOTORS OF A GIVEN SIZE USED ON THE PROJECT.
19.	MAINTENANCE MANUAL- UPON COMPLETION OF THE PROJECT, THE MECHANICAL CONTRACTOR SHALL PROVIDE A BINDER CONTAINING THE OPERATIONS & MAINTENANCE MANUALS FOR EACH NEW PIECE OF EQUIPMENT INSTALLED UNDER THIS PROJECT. THE FIRST SECTION OF THE MAINTENANCE MANUAL SHALL CONTAIN A LIST OF EACH PIECE OF EQUIPMENT, COMPLETE WITH INFORMATION SHOWING APPROPRIATE REPLACEMENT FILTER SIZES / TYPES, APPROPRIATE REPLACEMENT BELT SPECIFICATIONS, REPLACEMENT MOTOR SPECIFICATIONS, REPLACEMENT BEARING SPECIFICATIONS, VOLTAGES OF UNIT, ETC. THIS SHALL SERVE AS A WRITTEN DATABASE DESCRIBING ALL MAINTENANCE INFORMATION FOR EACH NEW PIECE OF EQUIPMENT USED.

PIPING NOTES	
1.	THE DRAWINGS SHOW THE GENERAL ARRANGEMENT OF ALL PIPING & EQUIPMENT, & INDICATE THE REQUIRED SIZE / POINTS OF TERMINATION OF THE PIPING & SUGGEST PROPER ROUTING OF SAME. IT IS NOT THE INTENTION OF THE DRAWINGS TO SHOW ALL NECESSARY OFFSETS, RISES, DROPS, OBSTRUCTIONS OR STRUCTURAL CONDITIONS. IT SHALL BE THE RESPONSIBILITY OF THIS CONTRACTOR TO INSTALL HIS WORK IN SUCH A MANNER THAT IT WILL CONFORM TO THE STRUCTURE. AVOID OBSTRUCTIONS, PRESERVE HEADROOM & KEEP OPENINGS / PASSAGEWAYS CLEAR WITHOUT FURTHER CONSTRUCTION OR COST.
2.	MECHANICAL CONTRACTOR SHALL PROVIDE & INSTALL ALL REQUIRED STRUCTURAL SUPPORTS FOR ALL PIPING SYSTEMS & EQUIPMENT AS REQUIRED. PIPING SYSTEMS SHALL BE EQUIPPED WITH EXPANSION COMPENSATORS AT THE INTERVALS REQUIRED. PROVIDE PIPING GUIDES / ANCHORS AS REQUIRED.
3.	MECHANICAL CONTRACTOR SHALL PROPERLY INSULATE ALL NEW PIPING SYSTEMS & EQUIPMENT. REFER TO SPECIFICATION SECTION 230700 FOR FURTHER DETAILS REGARDING INSULATION REQUIREMENTS. UPON COMPLETION OF INSULATION WORK, MECHANICAL CONTRACTOR SHALL PROPERLY LABEL EACH PIPING RUN SHOWING THE TYPE OF FLUID CARRIED & DIRECTION OF FLOW. PIPE IDENTIFICATION MARKERS SHALL BE INSTALLED EVERY 20 FEET IN THE PIPING RUNS.
4.	ALL VALVES WITHIN PIPING SYSTEMS SHALL BE TAGGED USING A 1-1/2" DIA. BRASS TAG. PROVIDE A LEGEND LISTING VALVE #, TYPE OF VALVE, SERVICE TYPE, & LOCATION OF VALVE. KEY VALVES TO AS-BUILT DRAWINGS UPON COMPLETION OF PROJECT.

FIRESTOPPING NOTES	
1.	ALL PENETRATIONS RELATED TO MECHANICAL WORK THROUGH FIRE RATED WALLS, FLOORS OR OTHER STRUCTURES SHALL BE FIRE STOPPED AS REQUIRED TO MAINTAIN THE RATING OF THE WALL BY MECHANICAL CONTRACTOR. IT IS ASSUMED THAT ALL WALLS IN THE CONSTRUCTION CARRY A MINIMUM FIRE RATING OF 1 HR. IT SHOULD BE ASSUMED THAT ALL MACHINE ROOM WALLS / BOILER ROOM WALLS / ELECTRIC ROOM WALLS CARRY A RATING OF 2 HR. MECHANICAL CONTRACTOR SHALL BE RESPONSIBLE FOR A COMPLETE REVIEW OF THE ARCHITECTURAL DRAWINGS IN ORDER TO DETERMINE FIRE RATINGS OF ALL WALLS / PARTITIONS RELATED TO WORK UNDER THIS CONTRACT.
2.	MECHANICAL CONTRACTOR SHALL REVIEW THE COMPLETE ARCHITECTURAL SET OF DRAWINGS IN ORDER TO DETERMINE WHERE DUCT PENETRATIONS THROUGH RATED BARRIERS, DUCTS PENETRATING SAID RATED BARRIERS SHALL BE EQUIPPED WITH A UL LISTED FUSIBLE LINK TYPE FIRE DAMPER, RATED FOR SERVICE FOR WHICH IT IS BEING USED. FIRE DAMPERS SHALL BE PROVIDED & INSTALLED BY THE MECHANICAL CONTRACTOR. COMPLETE W/ DUCT ACCESS DOORS DIRECTLY ADJACENT TO THE DAMPER, POSITIONED FOR EASY REPLACEMENT OF THE LINK.
3.	MECHANICAL CONTRACTOR SHALL REVIEW THE COMPLETE ARCHITECTURAL SET OF DRAWINGS IN ORDER TO DETERMINE WHERE DUCT PENETRATIONS THROUGH RATED BARRIERS OCCUR BETWEEN SEPARATE SMOKE ZONES. DUCTS PENETRATING SAID FIRE / SMOKE BARRIERS SHALL BE EQUIPPED WITH A UL LISTED COMBINATION FIRE / SMOKE DAMPER, RATED FOR SERVICE FOR WHICH IT IS BEING USED. FIRE / SMOKE DAMPERS SHALL BE PROVIDED & INSTALLED BY THE MECHANICAL CONTRACTOR. COMPLETE W/ DUCT ACCESS DOORS DIRECTLY ADJACENT TO THE DAMPER. DAMPER ACCESS DOORS & RELATED WIRING SHALL BE PROVIDED & INSTALLED BY THE ELECTRICAL CONTRACTOR. COORDINATE DAMPER INSTALLATIONS W/ E.C. TO VERIFY PROPER CLEARANCES TO ASSURE PROPER DAMPER OPERATION.
4.	MECHANICAL CONTRACTOR SHALL PROVIDE A FULL SET OF AS-BUILT DRAWINGS, SHOWING EACH DAMPER LOCATION, TYPE OF DAMPER, ACCESS DOOR LOCATIONS, ETC.
5.	CONTRACTOR SHALL REFER TO SPECIFICATION SECTION 230680 FOR FURTHER DETAILS REGARDING FIRESTOPPING MATERIALS & METHODS.
6.	CONTRACTOR SHALL SUBMIT SHOP DRAWINGS OF PRODUCTS TO BE USED. FIRESTOP MATERIALS OTHER THAN THE PRODUCTS SPECIFIED SHALL INCLUDE FULL TECHNICAL DATA WITH SHOP DRAWINGS TO DEMONSTRATE EQUALITY WITH THE SPECIFIED FIRESTOPPING MATERIALS.

GENERAL INSTRUMENTATION NOTES	
1.	AT A MINIMUM, PROVIDE THERMOMETERS / WELLS AT THE FOLLOWING LOCATIONS: - AT INLETS & OUTLET OF EACH THREE WAY VALVE (UNIT VENTILATORS / CABINET UNIT HEATER INSTALLATIONS EXCEPTED). - AT INLET & OUTLET OF EACH HYDRONIC BOILER, CHILLER OR COOLING TOWER. - AT INLET & OUTLET OF EACH HYDRONIC COIL IN AIR HANDLING UNITS & BUILT-UP CENTRAL SYSTEMS.
2.	AT A MINIMUM, PROVIDE LIQUID FILLED PRESSURE GAUGES / WELLS AT THE FOLLOWING LOCATIONS: - AT SUCTION & DISCHARGE OF EACH PUMP. - FOR EACH MAKEUP WATER LINE. - BEFORE & AFTER ALL PRESSURE REDUCING VALVES. - AT ACCESSIBLE HIGH POINT OF ALL HYDRONIC PIPING SYSTEMS. - AT ALL EXPANSION / COMPRESSION TANKS.

EQUIPMENT VENTING NOTES	
1.	MECHANICAL CONTRACTOR WILL BE RESPONSIBLE FOR THE PROPER VENTING OF ALL NEWLY INSTALLED HYDRONIC PIPING SYSTEMS. AUTOMATIC AIR VENTS SHALL BE INSTALLED AT EVERY HIGH POINT IN THE PIPING SYSTEM WHERE AIR CAN COLLECT. PROVIDE COCK IN RISER PRIOR TO AUTOMATIC AIR VENT. NEW AIR VENTS SHALL BE "TACO" #H1-VENT OR EQUIVALENT.
2.	MECHANICAL CONTRACTOR SHALL PROVIDE & INSTALL NEW AUTOMATIC AIR VENT FOR EACH AIR HANDLING UNIT COIL OR DUCT MOUNTED COIL. INSTALL SHUT-OFF COCK PRIOR TO VENT TIE-IN.
3.	MECHANICAL CONTRACTOR SHALL PROVIDE NEW MANUAL AIR VENTS FOR ALL UNIT VENTILATORS, COILS, CONVECTORS, FAN UNITS, FIN TUBE RADIATORS, ETC. MANUAL VENTS SHALL BE "TACO" #41T COIN VENT OR EQUIVALENT. PROVIDE SHUT-OFF COCK PRIOR TO VENT. AIM COIN VENT DISCHARGE IN AN APPROPRIATE MANNER AS TO FACILITATE THE CAPTURE OF BLEED WATER WHILE PERFORMING SYSTEM BLEEDING OPERATIONS.

ELECTRICAL WORK UNDER MECHANICAL CONTRACT	
1.	MECHANICAL CONTRACTOR SHALL PROVIDE ALL STARTERS & DISCONNECT SWITCHES REQUIRED FOR ALL NEW MECHANICAL EQUIPMENT. STARTER / DISCONNECT SWITCH INSTALLATION TO BE PERFORMED UNDER THE ELECTRICAL CONTRACT. COORDINATE WORK W/ ELECTRICAL CONTRACTOR PRIOR TO START OF WORK.
2.	POWER WIRING REQUIRED FOR CONTROLS SHALL BE PERFORMED UNDER THE MECHANICAL CONTRACT UNLESS SPECIFICALLY NOTED OTHERWISE ON THE ELECTRICAL DRAWINGS. MECHANICAL CONTRACTOR SHALL OBTAIN THE SERVICES OF A LICENSED ELECTRICIAN (PER NEC REQUIREMENTS) TO PERFORM ALL ELECTRICAL WORK.

DUCTWORK NOTES	
1.	PROVIDE ALL NEW DUCTWORK AS SHOWN AND SPECIFIED UNDER SPECIFICATION SECTION 231313, AND IN CONFORMANCE WITH SMACNA SPECIFICATIONS.
2.	IF A DUCT ELBOW IS SHOWN TO BE RADIUSUED, THEN RADIUSUED ELBOWS SHALL BE INSTALLED. SQUARE ELBOWS MAY NOT BE SUBSTITUTED WHERE RADIUSUED ELBOWS ARE SHOWN. WHERE SQUARE ELBOWS ARE SHOWN, TURNING VANES SHALL BE INSTALLED UPON APPROVAL BY THE ENGINEER.
3.	PROVIDE DUCT LINING IN ALL DUCTWORK THAT IS CONVEYING BELOW AMBIENT TEMPERATURE AIR & IS NOT INSULATED. PROVIDE LINING IN SUPPLY & RETURN AIR DUCTWORK FROM AIR HANDLING EQUIPMENT TO 20 FEET AWAY FROM THE UNITS). IN ADDITION, INCLUDE LINING IN ANY OTHER DUCT SPECIFICALLY SHOWN OR SPECIFIED TO BE EQUIPPED WITH LINING. REFER TO SPECIFICATION SECTION 231313 & 230713 FOR FURTHER INFORMATION.
4.	WHERE FLEXIBLE DUCTWORK IS USED, LENGTHS MAY NOT EXCEED 4 FEET TOTAL IN ANY ONE RUN OF FLEXIBLE DUCTWORK. FLEXIBLE DUCTWORK SHALL BE RATED IN ACCORDANCE WITH UL 181, CLASS 1. REFER TO SPECIFICATION SECTION 231313 FOR FURTHER INFORMATION.
5.	MECHANICAL CONTRACTOR SHALL PROVIDE A BUTTERFLY TYPE VOLUME DAMPER WITH LOCKING QUADRANT HANDLE PRIOR TO EACH AIR OUTLET SHOWN. INSTALL DAMPER AT LEAST 5 FEET AWAY FROM AIR OUTLET WHEREVER POSSIBLE.
6.	MECHANICAL CONTRACTOR SHALL PROVIDE FLEXIBLE DUCT CONNECTIONS WHERE DUCT SYSTEMS CONNECT TO EQUIPMENT. REFER TO SPECIFICATION SECTION 231313 FOR FURTHER INFORMATION.

TESTING and BALANCING NOTES	
1.	MECHANICAL CONTRACTOR WILL BE REQUIRED TO PERFORM ALL EQUIPMENT & SYSTEM TESTING / BALANCING REQUIRED UNDER THIS CONTRACT. PROVIDE A FULL REPORT DETAILING ALL DESIGN & ACTUAL CONDITIONS FOR ALL AIR & HYDRONIC SYSTEMS SHOWN ON THE DRAWINGS. REFER TO SPECIFICATION SECTIONS 230693 & 230680 FOR FURTHER DETAILS.
2.	UPON NOTICE OF COMPLETION OF WORK BY THE CONTRACTOR, OWNER WILL OBTAIN THE SERVICES OF AN INDEPENDENT TESTING & BALANCING CONTRACTOR TO VERIFY THE RESULTS OF THE TESTING & BALANCING REPORT SUBMISSION. INDEPENDENT TESTING AGENCY SHALL SELECT A RANDOM NUMBER OF MEASUREMENTS TO BE CHECKED. MEASUREMENTS WILL BE CHECKED IN THE SAME MANNER AS ORIGINALLY MEASURED. NUMBER OF VERIFICATION MEASUREMENTS SHALL BE APPROXIMATELY 25% OF THE TOTAL MEASUREMENTS FOR THE PROJECT.
3.	IF MORE THAN 10% OF THE VERIFICATION TESTING SHOWS DEVIATIONS OF 10% OR MORE / SOUND LEVEL OF 2dB DIFFERENT THAN THAT ORIGINALLY MEASURED, THE ORIGINAL REPORT WILL BE REJECTED. ALL SYSTEMS WILL THEN BE REQUIRED TO BE COMPLETELY RE-TESTED WITH A SECOND REPORT SUBMITTED. IN THE EVENT THAT THE ORIGINAL REPORT IS REJECTED, ALL SYSTEMS SHALL BE RE-QUALIFIED & TESTED. NEW CERTIFIED REPORTS SUBMITTED, AND NEW VERIFICATION TESTS MADE, AT NO ADDITIONAL COST TO THE OWNER. THE CONTRACTOR WILL BE RESPONSIBLE FOR ALL COSTS INVOLVED WITH THE VERIFICATION TESTS.

ABBREVIATIONS	
A.F.F.	ABOVE FINISHED FLOOR
B.D.	BACKDRAFT DAMPER
CWS	COLD WATER SUPPLY
CFM	CUBIC FEET OF AIR PER MINUTE
D	DEEP / DEPTH
DIAM	DIAMETER
F&T	FLOAT & THERMOSTATIC
FM	FEET PER MINUTE
FSD	FIRE DAMPER - DUCT MOUNTED
FLEX	FLEXIBLE
FO	FLAT OVAL DUCTWORK
GAL	GALLONS
GPH	GALLONS PER HOUR
GPM	GALLONS PER MINUTE
H	HIGH
H.C.	HANDICAPPED
HWS	HEATING SYSTEM HOT WATER SUPPLY
HWR	HEATING SYSTEM HOT WATER RETURN
HP	HORSEPOWER
ID.	INSIDE DIAMETER
KW	KILOWATT
L	LONG
LAT	LEAVING AIR TEMPERATURE
LWT	LEAVING WATER TEMPERATURE
MAX	MAXIMUM
MIN	MINIMUM
MBH	BTU x 1,000
MFR	MANUFACTURER
M.H.	MANHOLE
MISC.	MISCELLANEOUS
MTD	MOUNTED
G	NATURAL GAS
N.I.C.	NOT IN CONTRACT
No. / #	NUMBER
NOM.	NOMINAL
N.T.S.	NOT TO SCALE
O.A.	OUTSIDE AIR
O.C.	ON CENTER
O.D.	OUTSIDE DIAMETER
O.S. & Y	OUTSIDE SCREW & YOKE
O.C.	ON CENTER
PE	PNEUMATIC / ELECTRIC
PRFAB	PREFABRICATED
PRV	PRESSURE REDUCING VALVE
PSI	POUNDS PER SQUARE INCH
R.A.	RETURN AIR
REQD.	REQUIRED
RPM	REVOLUTIONS PER MINUTE
S.A.	SUPPLY AIR
SCH.	SCHEDULE
S.P.	STATIC PRESSURE
STD.	STANDARD
T	TEMPERATURE
TXV	THERMAL EXPANSION VALVE
TYF	TYPICAL
VOL	VOLUME
V.D.	VOLUME DAMPER
VOL	VELOCITY
VFD	VARIABLE FREQUENCY DRIVE
W	WIDE
WB	WET BULB TEMPERATURE
WTD	WATER TEMPERATURE DROP
WTR	WATER TEMPERATURE RISE
WPD	WATER PRESSURE DROP

MECHANICAL SYMBOL LEGEND	
SYMBOL	DESCRIPTION
	RECTANGULAR GALVANIZED DUCTWORK - DIMENSIONS W' x H'
	NEW SUPPLY DUCTWORK TO RISE UP
	NEW SUPPLY DUCTWORK TO DROP DOWN
	NEW RETURN DUCTWORK TO RISE UP
	NEW RETURN DUCTWORK TO DROP DOWN
	TRANSITION IN DUCTWORK
	FIRE DAMPER INSTALLED IN DUCTWORK
	VOLUME DAMPER IN DUCT (W/ LOCKING QUADRANT HANDLE)
	ROUND DUCTWORK TO RISE UP
	ROUND DUCTWORK TO DROP DOWN
	FLAT OVAL DUCT WORK
	RECTANGULAR TO ROUND DUCT TRANSITION
	ELBOW IN DUCTWORK w/ TURNING VANES
	ELBOW IN DUCTWORK (RADIUS x 1.5 x D)
	45 DEG. TAKEOFF FITTING
	90 DEG. TAKEOFF w/ BELLMOUTH FITTING
	FLEXIBLE DUCTWORK TO DIFFUSER (4 FT. MAX. RUN)
	4-WAY PATTERN CEILING DIFFUSER
	3-WAY PATTERN CEILING DIFFUSER
	2-WAY PATTERN CEILING DIFFUSER (90 DEG. / OPPOSING PATTERN)
	CEILING RETURN AIR REGISTER
	LINEAR SLOT DIFFUSER
	ROOF MOUNTED EXHAUST FAN

ROOFTOP UNIT ANCHORING

BASED ON 140 MPH WIND (50 PSF) AND 200 LB SHEAR AND PULL-OUT FOR FASTENERS.

W = WEIGHT OF UNIT IN LBS.

F_U = MINIMUM QUANTITY OF FASTENERS FOR UNIT TO CURB AND CURB TO DECK

F_R = MINIMUM QUANTITY OF FASTENERS FOR RAIL TO DECK. (UNIT TO RAIL SHOULD BE WITH THE MANUFACTURER PROVIDED TABS)

F_S = MINIMUM QUANTITY OF 3/4" DIA. SHEET SCREWS PER STRAP ANCHOR POINT. STRAPS SHALL BE 12GA. x 1/2" ALUMINUM.

FASTENERS SHALL BE:

- UNIT TO CURB/RAIL - 3/4" DIA. SHEET METAL SCREWS
- CURB/RAIL TO METAL DECK - 3/4" DIA. SHEET METAL SCREWS
- CURB/RAIL TO CONCRETE - 1/2" DIA. TAPCONS
- CURB/RAIL TO TECTUM DECK - 3/4" DIA. TOGGLE BOLTS

TYPE A - HORIZONTAL				
	X	Y + 1	W	F _U
UP TO 5'	5'	4'	500	4
UP TO 8'	8'	5'	900	6
UP TO 12'	12'	6'	1,500	12

Diagram showing the broad side of a rooftop unit (X) anchored to a curb (Y) and then to a deck. The curb is 1 inch thick. The unit is labeled 'UNIT BROAD SIDE' and the deck is labeled 'DECK'.

TYPE A - VERTICAL				
	X	Y + 1	F _R	F _S
UP TO 2'	2'	4'	4	1
UP TO 3'	3'	6'	4	1
UP TO 4'	4'	7'	6	2

Diagram showing the end side of a rooftop unit (X) anchored to a curb (Y) and then to a deck. The curb is 1 inch thick. The unit is labeled 'UNIT BROAD SIDE' and the deck is labeled 'DECK'. The diagram also shows 'STRAPS (2 PER SIDE)' and 'RAIL L = UNIT Y (MIN.)'.

Diagram showing the typical curb / rail installation detail. The curb is 1 inch thick and is anchored to the deck. The rail is 1 inch thick and is anchored to the curb. The diagram shows the unit, curb, rail, and deck. The unit is labeled 'MECHANICAL UNIT'. The curb is labeled 'CURB/RAIL MANUFACTURER SUPPLIED GALVANIZED CAP FLASHING'. The rail is labeled 'CURB/RAIL FASTENED DIRECT TO DECK. NO BLOCKING, NO CANT'. The deck is labeled 'ROOF DECK'. The diagram also shows 'CUT AND PATCH ROOFING AS REQUIRED'.

TYPICAL CURB / RAIL INSTALLATION DETAIL

SCALE: N.T.S.

PIPING SYMBOL LEGEND	
SYMBOL	DESCRIPTION
	PIPING TO RISE UP
	PIPING TO DROP DOWN
	PIPING ANCHOR
	PIPING GUIDE
	COLD WATER SUPPLY PIPING
	HEATING SYSTEM SUPPLY PIPING
	HEATING SYSTEM RETURN PIPING
	CHILLED WATER SUPPLY PIPING
	CHILLED WATER RETURN PIPING
	CONDENSER WATER SUPPLY PIPING
	CONDENSER WATER RETURN PIPING
	CONDENSATE DRAINAGE PIPING
	FUEL OIL SUPPLY PIPING
	FUEL OIL RETURN PIPING
	LOW PRESSURE NATURAL GAS PIPING
	ELEVATED PRESSURE NATURAL GAS PIPING
	GAS COOK
	DIRT LEG IN PIPING
	LIQUEFIED PETROLEUM GAS PIPING
	VENT PIPING
	LINEAR EXPANSION COMPENSATOR
	EXPANSION LOOP IN PIPING
	UNION IN PIPING
	PIPING STRAINER (w/ BLOWDOWN VALVE)
	REDUCER / INCREASER FITTINGS IN PIPING
	ECCENTRIC REDUCER IN PIPING
	THERMOMETER
	PRESSURE GAUGE
	FULL PORT BALL VALVE
	GATE VALVE
	SWING CHECK VALVE
	BALANCING VALVE
	3-WAY VALVE (w/ OPERATOR)
	CIRCUIT SETTER
	TRIPLE DUTY VALVE
	WAFER VALVE
	PLUG / CAP IN PIPING
	PNEUMATIC CONTROL VALVE OPERATOR
	ELECTRIC CONTROL VALVE OPERATOR
	AUTOMATIC AIR VENT
	EXISTING PIPING TO BE REMOVED
	POINT OF DISCONNECT
	POINT OF CONNECTION BETWEEN NEW & EXISTING

REV.	DATE	ITEM
1	03/06/25	BID ADDENDUM No. 1

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KEY PLAN

NOT TO SCALE

BEDFORD CENTRAL SCHOOL DISTRICT
PHASE 2 - BOND IMPROVEMENTS
FOX LANE MIDDLE SCHOOL
TOWN OF BEDFORD / WESTCHESTER COUNTY

GENERAL NOTES, LEGENDS, ETC.

PROJECT

DWG TITLE

DRAWING BY: JH
CHECK BY: CW

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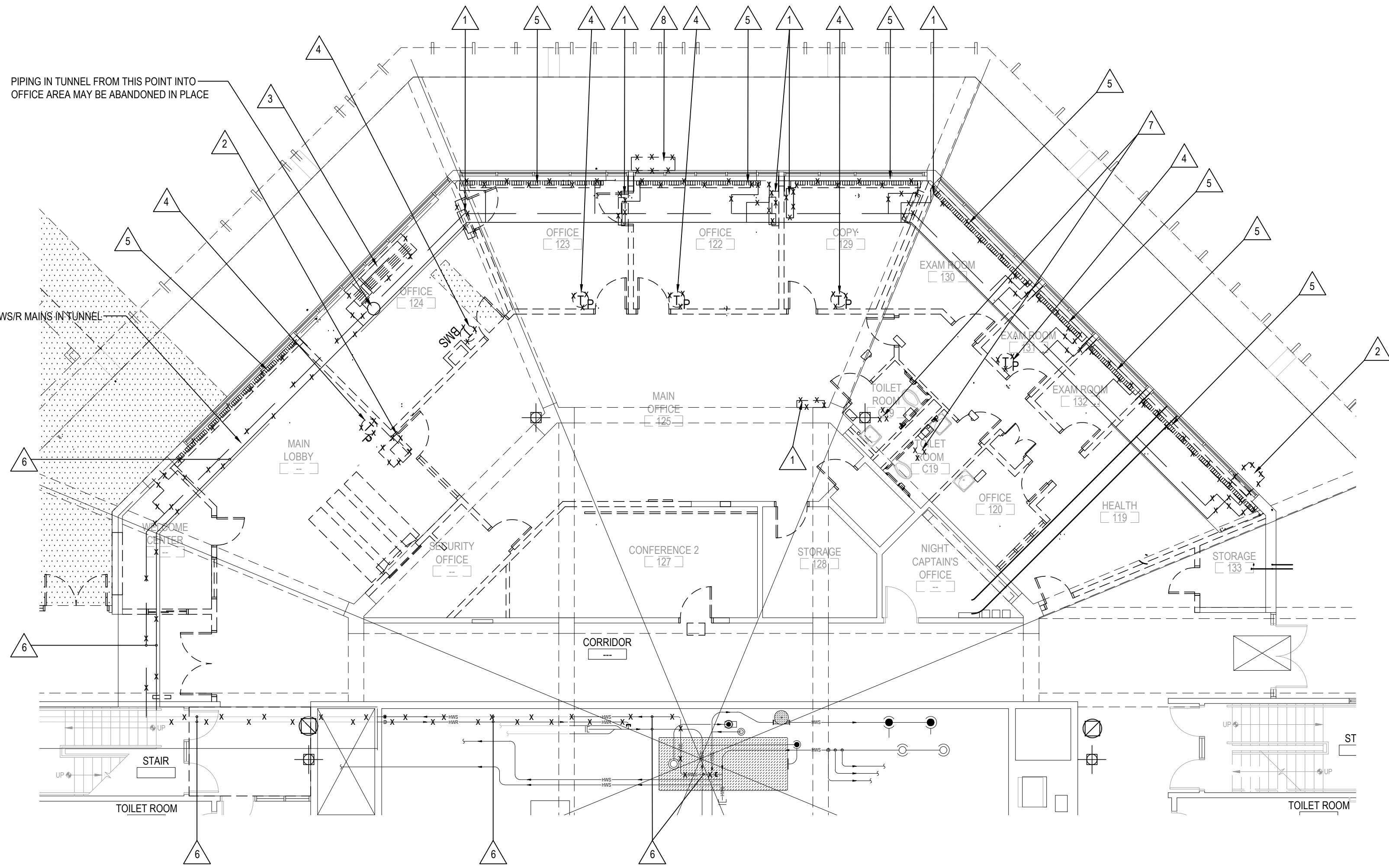
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SED No.	66-01-02-06-0-007-013
DISTRICT	BEDFORD CENTRAL SCHOOL DISTRICT
PROJECT	PHASE 2 - BOND IMPROVEMENTS
DWG TITLE	GENERAL NOTES, LEGENDS ETC.
SCALE	AS NOTED
DATE	APRIL 2024
BID PICK-UP	FEBRUARY 24, 2025
FILE No.	23-1316 FLMS

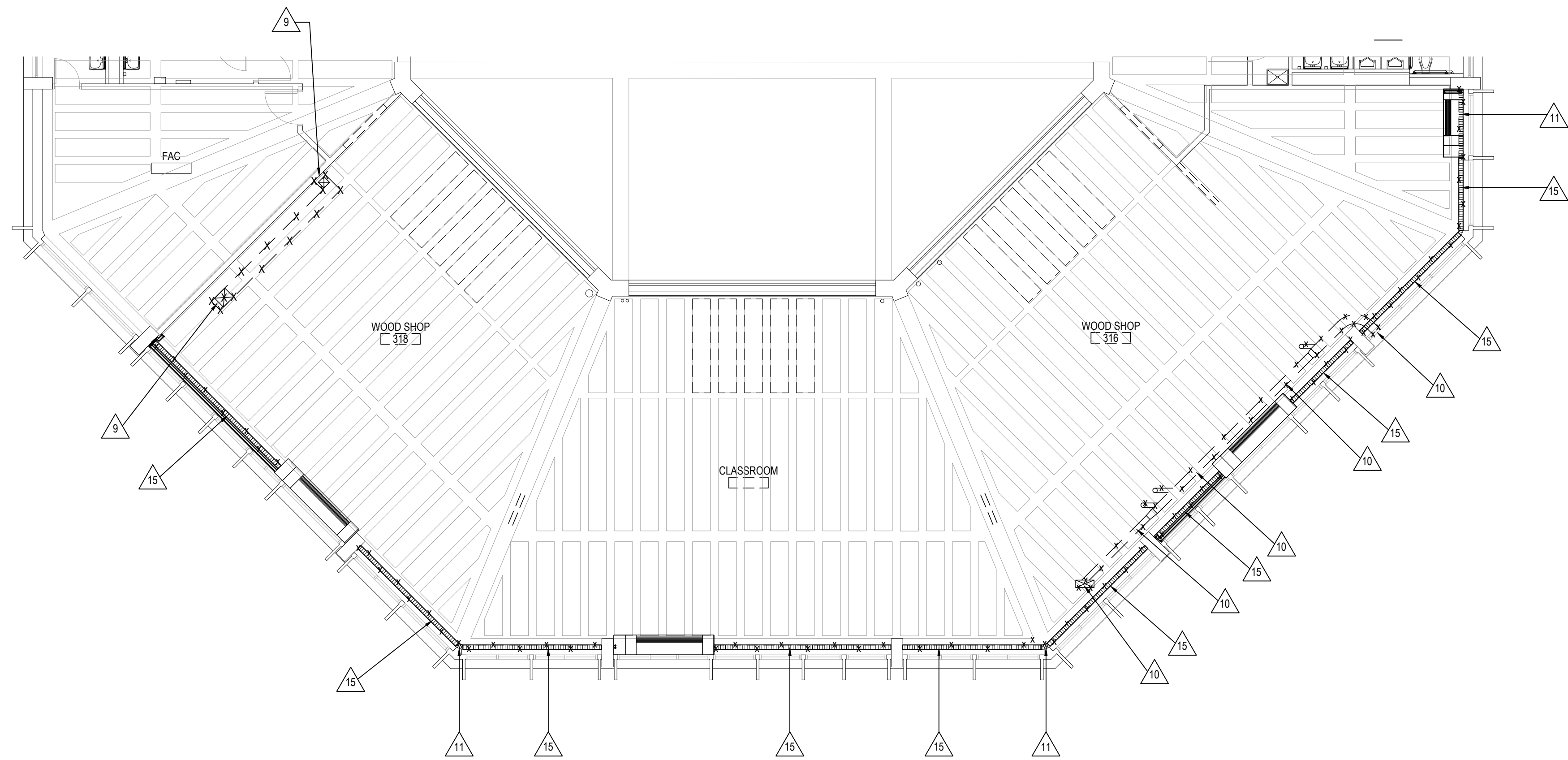
M0.01



MECHANICAL FIRST FLOOR DEMOLITION PLAN

NOTE:

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



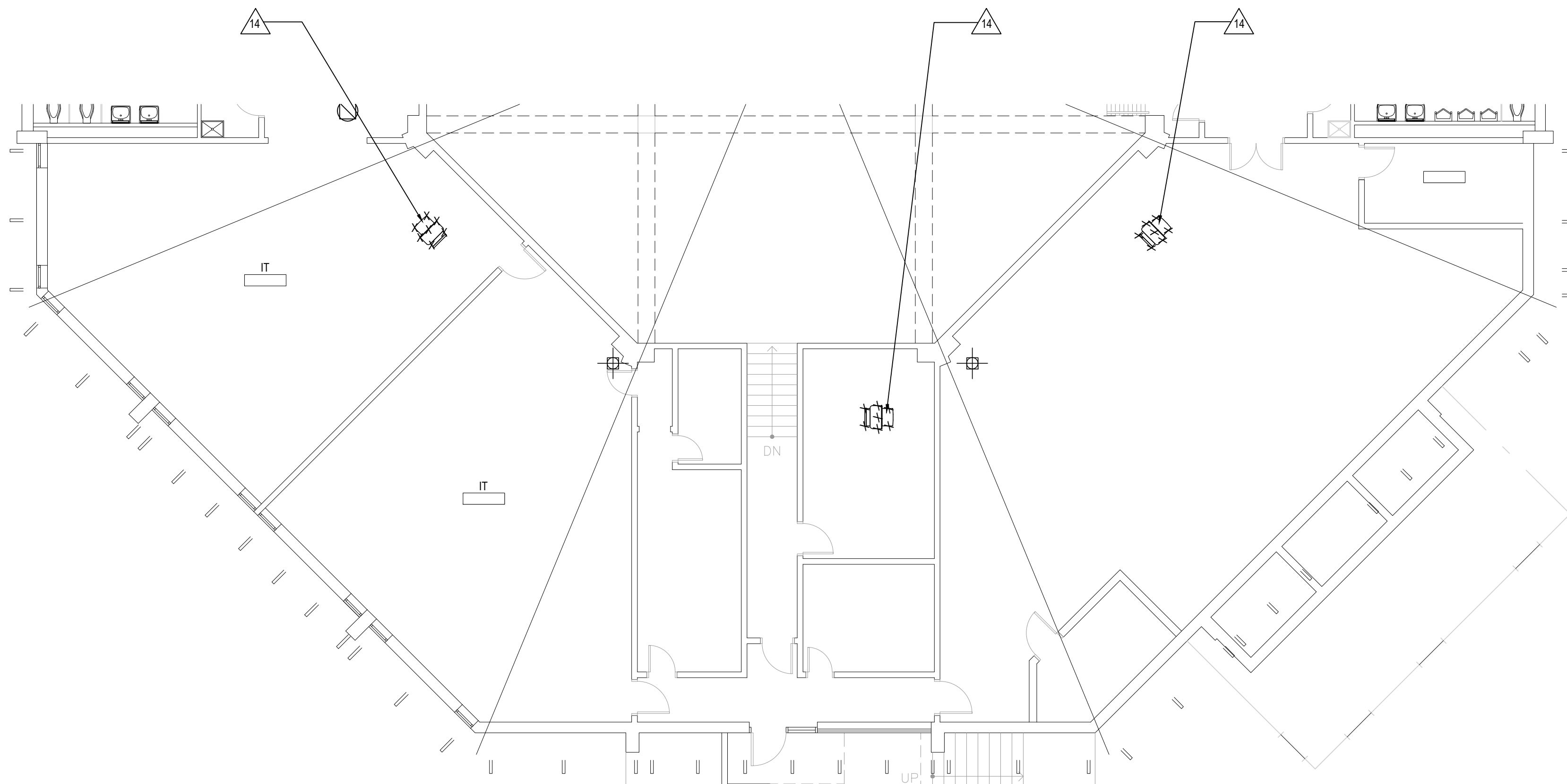
MECHANICAL THIRD FLOOR DEMOLITION PLAN

NOTE:

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

DEMOLITION KEY NOTES

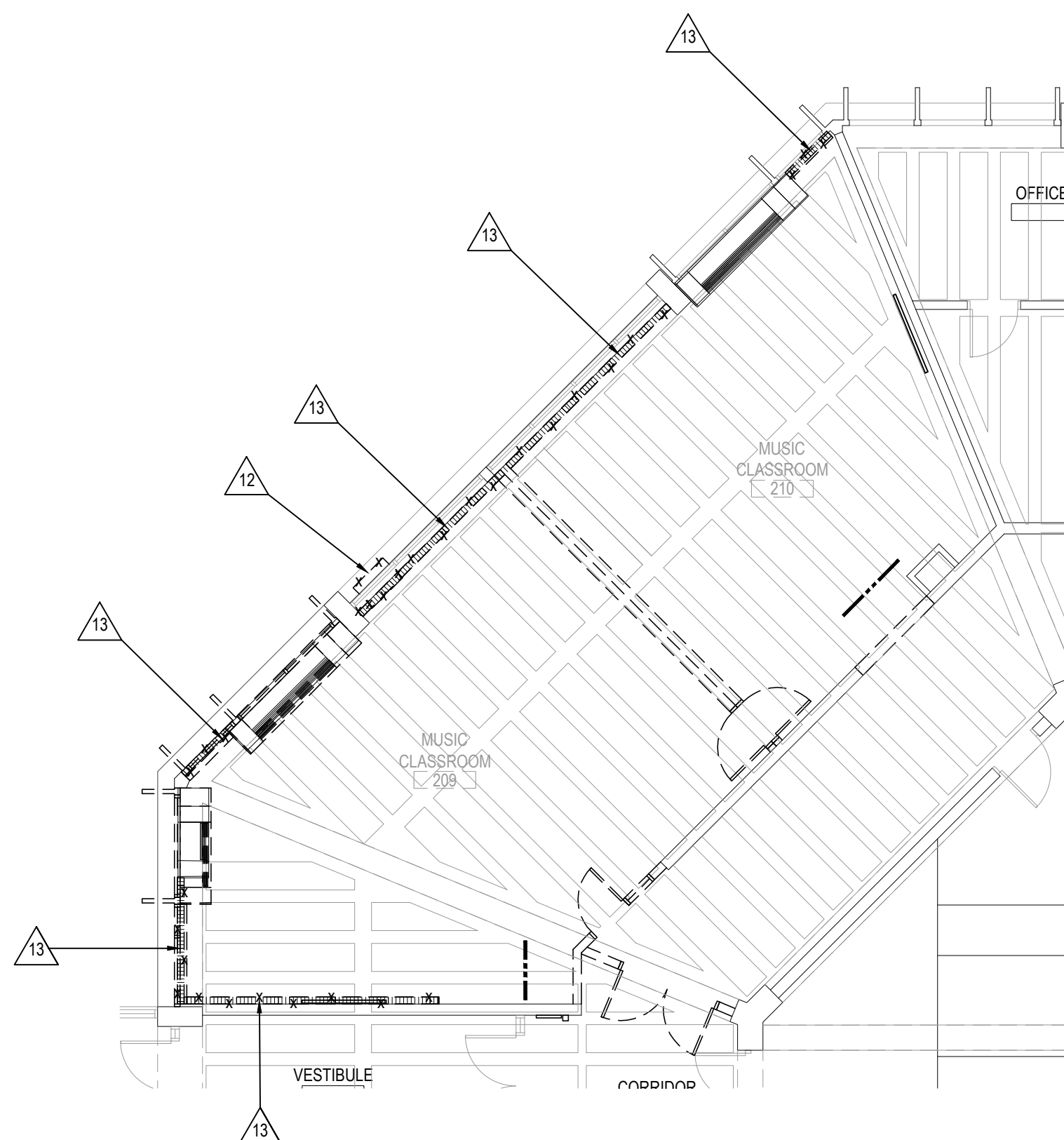
- MC SHALL REMOVE EXISTING WALL MOUNTED SPLIT SYSTEMS & RELATED SUPPORTS. RECLAIM REFRIGERANT CHARGE. REMOVE REFRIGERATION LINESETS / LINESET & PIPING ENCLOSURES. REMOVE RELATED TEMPERATURE CONTROLS, WIRING & WIRING RACEWAYS. TURN ALL REMOVED EQUIPMENT OVER TO OWNER UPON COMPLETION. EC TO DISCONNECT & REMOVE POWER WIRING.
- MC TO REMOVE EXISTING WINDOW AC UNITS & TURN ALL UNITS OVER TO THE OWNER. REMOVE UNIT SUPPORTS. RECEPTACLES / WIRING / CONDUIT TO BE REMOVED BY THE E.C..
- MC TO REMOVE UNIT VENTILATOR & RELATED CONTROLS, CONTROL WIRING, BASES, CABINETRY, ETC. GC TO REMOVE WALL LOUVER & PATCH WALL OPENING. E.C. TO DISCONNECT POWER & REMOVE WIRING / CONDUITS BACK TO POINT OF CONNECTION W/ POWER PANEL.
- MC TO REMOVE ALL EXISTING THERMOSTATS. REMOVE ANY WIRING / RACEWAYS ASSOCIATED W/ CONTROLS BACK TO POINT OF CONNECTION W/ CONTROLLER. REMOVE CONTROLLER & ALL RELATED CONTROLS / INTERCONNECTIONS WITH THE BMS BUSS. RETAIN BMS SYSTEM BUSS WIRING FOR FUTURE CONNECTION OF NEW EQUIPMENT TO BMS.
- MC TO REMOVE ALL EXISTING FIN TUBE RADIATORS, RELATED CONTROLS, ENCLOSURES & ENCLOSURE SUPPORTS. REMOVE ALL CONTROL WIRING & RACEWAYS BACK TO POINT OF CONNECTION W/ CONTROLLERS. REMOVE CONTROLLERS / RELATED CONTROLS. RETAIN BMS BUSS WIRING. WHERE PIPING STUBS UP FROM PIPE TUNNEL BELOW, REMOVE STUB UP & PERMANENTLY CAP PIPING BELOW FLOOR.
- MC TO CUT & CAP EXISTING HWS / HWR LINES AT THE LOCATIONS SHOWN. REMOVE EXISTING HWS/R PIPING FOR TYHE MAIN OFFICE AREA TO THE EXTENT SHOWN, FROM POINTS OF DISCONNECT @ HEADERS ALL THE WAY THRU THE BOILER ROOM, INTO THE TUNNEL & UP TO POINT OF CONN. @ THE FIRST OFFICE #124.
- MC TO REMOVE EXISTING EXHAUST GRILLES IN OFFICE AREA BATHROOMS. DISPOSE OF ALL DEBRIS FROM SITE. RETAIN ANY GRILLES WHERE STATED TO BE RE-USED.
- MC TO REMOVE EXISTING SPLIT SYSTEM CONDENSING UNIT & ALL ASSOCIATED REFRIGERANT LINESETS / LINESET ENCLOSURES / MOUNTING HARDWARE, ETC. PROPERLY RECOVER REFRIGERANT. GC TO PATCH WALL / FILL REMAINING HARDWARE HOLES / PIPING PENETRATIONS & PAINT TO MATCH EXISTING CONDITIONS.
- MC TO DEMO & CAP EXISTING DUCTWORK TO THE EXTENT SHOWN. GC TO PATCH WALL PENETRATION(S) & PAINT TO MATCH EXISTING CONDITIONS.
- MC TO DEMO EXISTING DUST COLLECTION DUCTWORK. GC TO REPLACE GLASS PANE AT LOC. WHERE DUCT PASSED TO THE OUTSIDE.
- MC TO DEMO EXISTING FIN TUBE ENCLOSURE. FIN TUBE ELEMENTS / PIPING TO REMAIN. MODIFY EXISTING PIPING AT NEW UNIT VENT LOCATION AS REQUIRED TO INSTALL / PIPE IN NEW UNIT VENT. REFER TO M2 & M6. SERIES DRAWINGS FOR FURTHER DETAILS.
- NOT USED.
- MC TO REMOVE EXISTING FIN TUBE ENCLOSURES AT EACH LOCATION SHOWN. FIN TUBE ELEMENTS / PIPING TO REMAIN. RETAIN ENCLOSURES IF SLATED TO BE REFINISHED / REINSTALLED.
- MC TO REMOVE EXISTING EXHAUST FANS AT EACH LOCATION SHOWN. EC TO DISCONNECT POWER / MC TO DISCONNECT CONTROLS / WIRING. GC TO MODIFY OPENINGS AS NEEDED TO ACCOMMODATE NEW EQUIPMENT.
- MC TO REMOVE EXISTING FIN TUBE ENCLOSURE THE LOCATIONS SHOWN.



MECHANICAL - UPPER 3rd. FLOOR / ROOF DEMOLITION PLAN

NOTE:

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



MECHANICAL SECOND FLOOR DEMOLITION PLAN

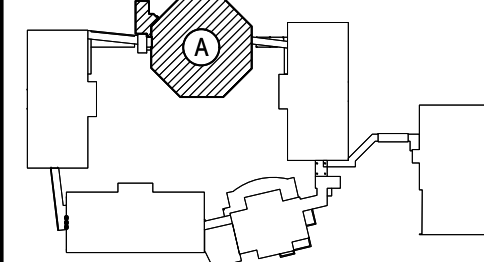
NOTE:

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

REV.	DATE	ITEM
1	03/06/25	BID ADDENDUM No. 1

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KEY PLAN

NOT TO SCALE

BEDFORD CENTRAL SCHOOL DISTRICT
PHASE 2 - BOND IMPROVEMENTS
FOX LANE MIDDLE SCHOOL
TOWN OF BEDFORD / WESTCHESTER COUNTY

PROJECT
DWG TITLE

DRAWING BY: JH
CHECK BY: CW

NOTICE

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SED No: 66-01-02-06-0-007-013

DISTRICT: BEDFORD CENTRAL
SCHOOL DISTRICT

PROJECT: PHASE 2 -
BOND IMPROVEMENTS

DWG TITLE: DEMOLITION PLANS

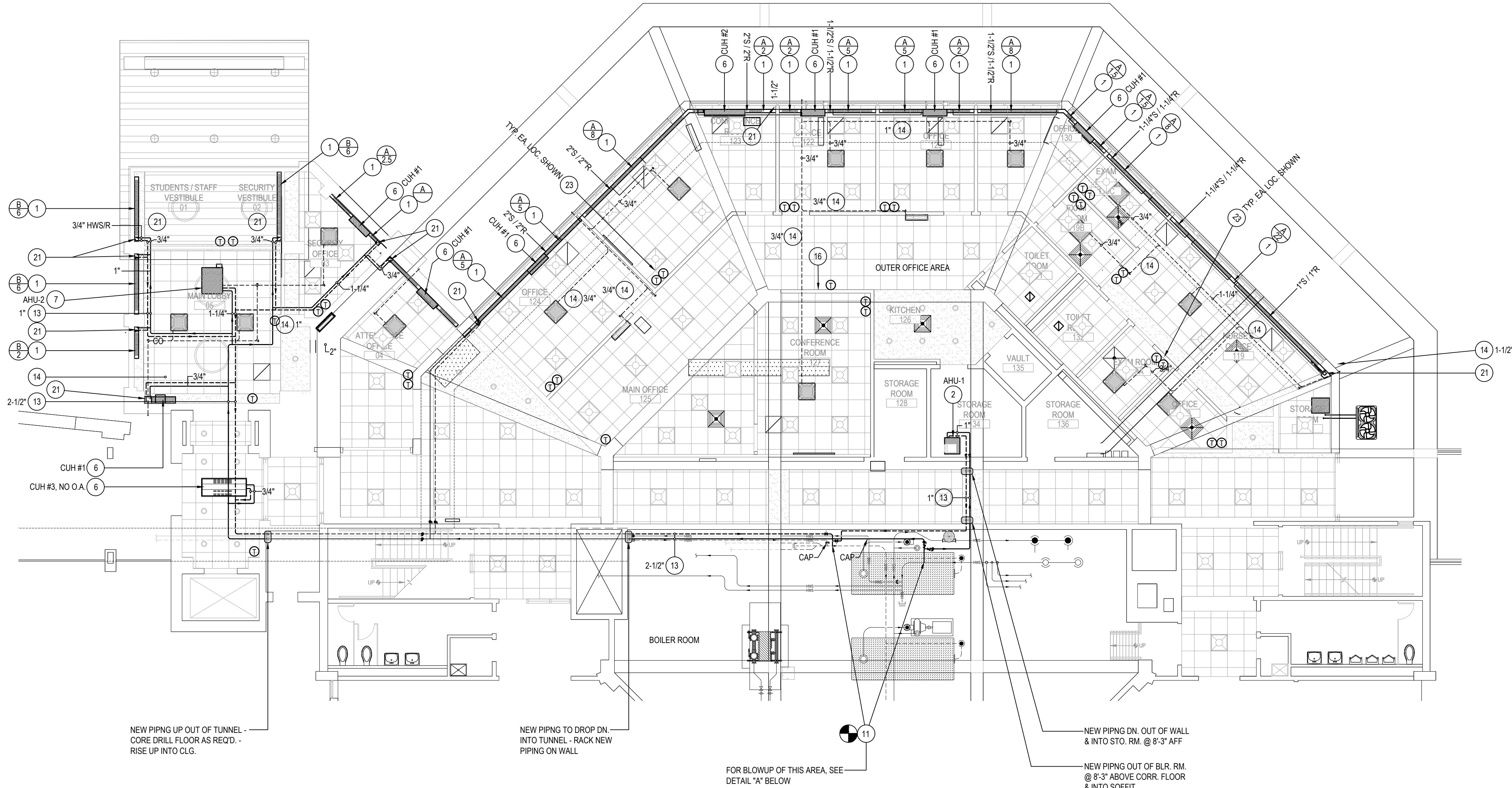
SCALE: AS NOTED

DATE: APRIL 2024

BID PICK-UP: FEBRUARY 24, 2025

FILE No: 23-131b FLMS

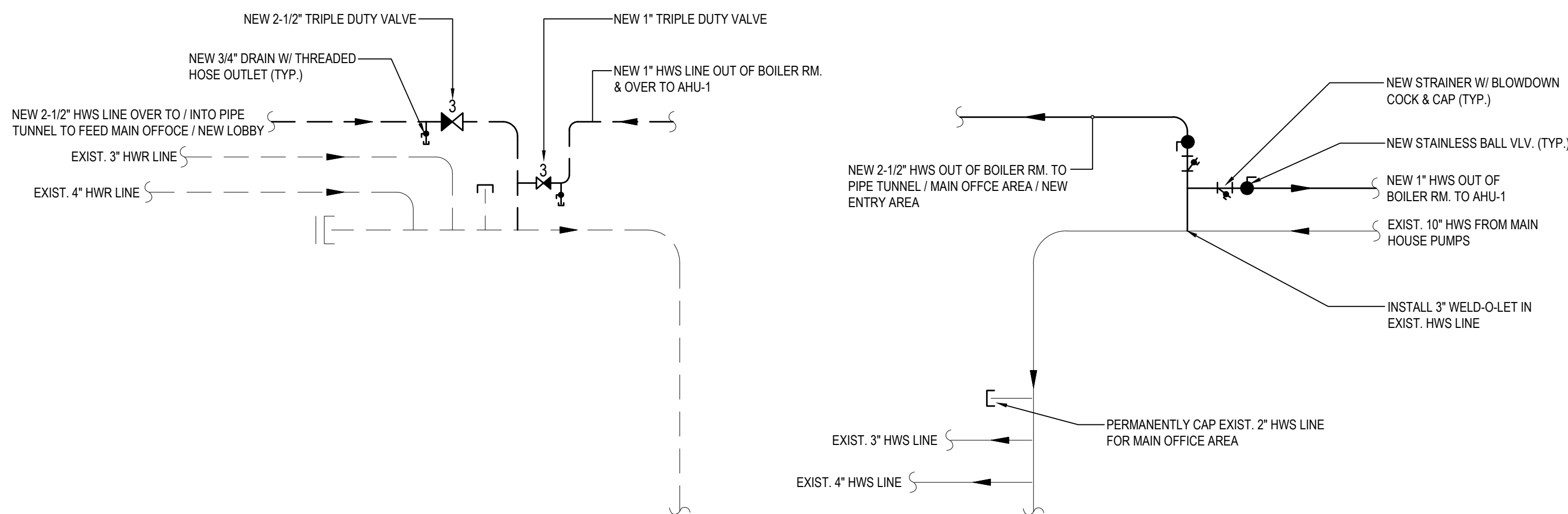
M1.01



FIRST FLOOR MECHANICAL PROPOSED PLAN - PIPING

NOTE:

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



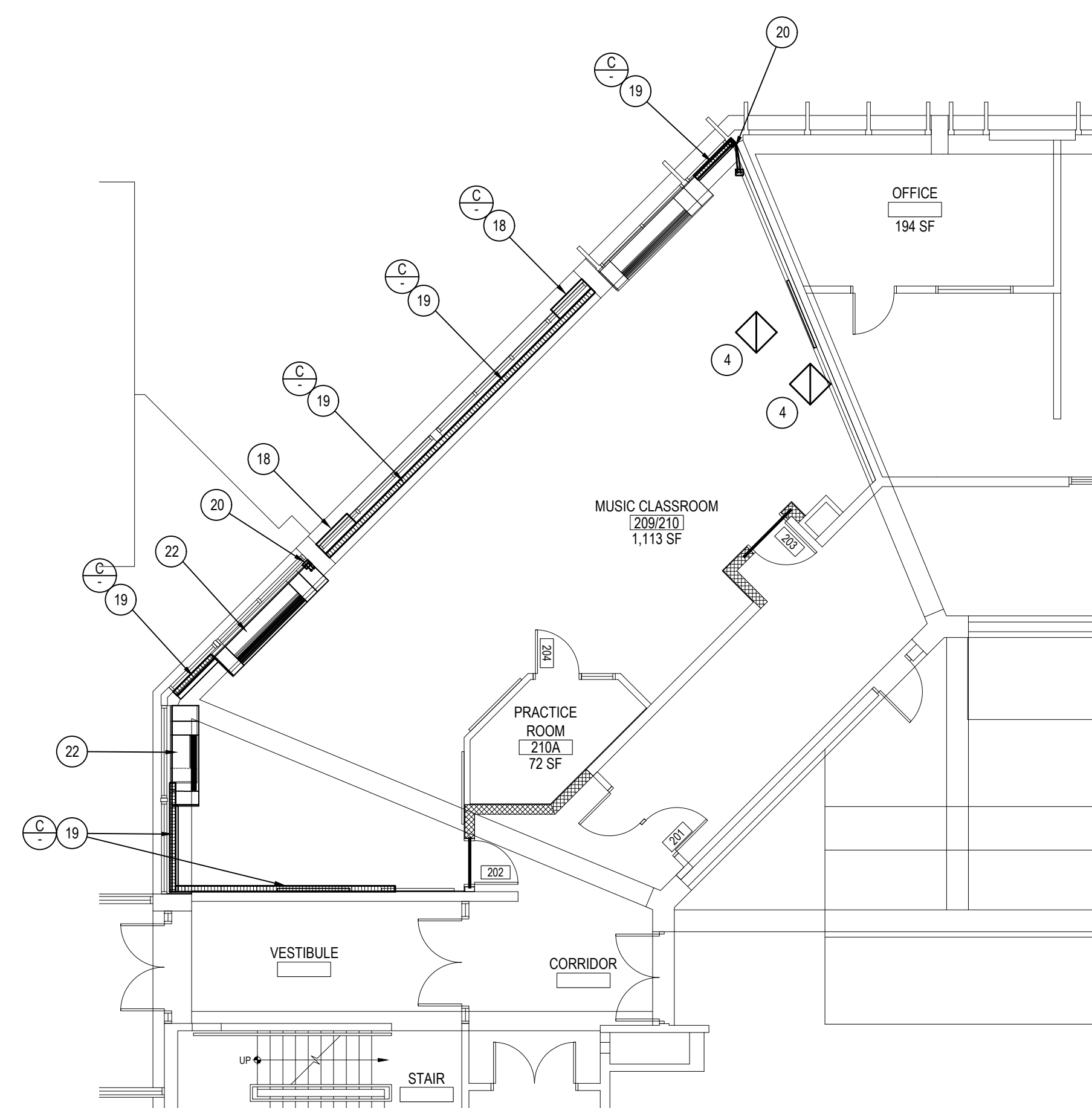
DETAIL "A" - NEW PIPING CONNECTIONS AT BOILER ROOM

NOTE:

NOT TO SCALE

PROPOSED KEY NOTES

- MC TO INSTALL NEW FIN TUBE & ENCLOSURES AT THE LOCATION SHOWN. PROVIDE THERMOSTAT & RELATED CONTROLS / CONTROL VALVES. PROVIDE PIPING ENCLOSURES FOR PIPING DROPS FROM CEILING. REFER TO DWG. #M6.01 & DETAIL #3 & 10 FOR MORE INFORMATION.
- MC TO INSTALL NEW AIR HANDLER AS SHOWN. REFER TO DWG. #M6.02 FOR MORE INFORMATION. PROVIDE 4" T. CONC. SUPPORT PAD, NEW DUCTWORK, NEW HWS/R PIPING, NEW REFR. PIPING & NEW TEMPERATURE CONTROLS FOR UNIT.
- MC TO INSTALL NEW DUCTWORK & DIFFUSERS AS SHOWN. PROVIDE DUCT SUPPORTS, 2" T. INSULATION FOR NEW DUCTWORK. DUCTWORK DIMENSIONS SHOWN ON DRAWINGS ARE "CLEAR" INSIDE DIMENSIONS. BALANCE SYSTEM TO THE AIRFLOW VALUES SHOWN. REFER TO DWG. #M6.01 FOR MORE INFORMATION.
- MC TO INSTALL NEW EXHAUST EGG CRATE GRILLES (TYPE R-1) AT THE LOCATIONS SHOWN. REFER TO DWG. #M6.01 FOR MORE INFORMATION.
- MC TO INSTALL NEW INLINE FANS AT THE LOCATIONS SHOWN. REFER TO DWG. #M6.01 FOR FURTHER DETAILS. TEMPERATURE CONTROLS BY MC / POWER WIRING BY EC.
- MC TO INSTALL NEW FLOOR MOUNTED HOT WATER CABINET UNIT HEATERS W/ OUTDOOR AIR OPENINGS / DAMPERS AT EACH LOCATION SHOWN. MC TO PROVIDE AUTOMATED DAMPER & NEW LOUVER. GC TO CUT OPENING IN WALL & INSTALL LOUVER. GC / MC TO COORDINATE FINAL LOCATIONS. REFER TO DWG. #M6.02 & #M6.05 FOR FURTHER DETAILS.
- MC TO INSTALL NEW CEILING HUNG AHU UNIT & RUN DUCT WORK IN THE VESTIBULE AS SHOWN. PROVIDE DIFFUSERS / GRILLES & BALANCE TO THE AIRFLOW VALUES SHOWN. SEE DWG. #M6.05 FOR MORE INFORMATION.
- MC TO PROVIDE & INSTALL NEW VRF CEILING CASSETTES / THERMOSTATS / CONDENSATE PUMPS & PIPING AS SHOWN. PROVIDE SUPPORTS / REFR. PIPING / TEMPERATURE CONTROLS & WIRING AS REQUIRED. REFER TO DWG. #M6.02 & M6.03 FOR FURTHER DETAILS.
- MC TO PROVIDE & INSTALL NEW VRF WALL UNITS W/ CONDENSATE PUMPS & PIPING AS SHOWN. PROVIDE SUPPORTS, REFR. PIPING / PIPING ENCLOSURES / TEMPERATURE CONTROLS & CONTROL WIRING. REFER TO DWG. #M6.02 FOR FURTHER INFORMATION.
- MC TO PROVIDE & INSTALL NEW CONDENSING UNIT ON RAILS IN THE LOCATION SHOWN. ALL REFRIGERANT PIPING TO BE INSULATED & INSTALLED MY MC. REFER TO DWG. #M6.02 & M6.03 FOR FURTHER DETAILS.
- MC TO TIE NEW HWS/R PIPING INTO EXISTING PIPING WITHIN BOILER ROOM WHERE SHOWN. PROVIDE VALVES / FITTINGS AS SHOWN. PROVIDE CIRCUIT SETTERS ON (2) RETURN BRANCHES COMING BACK TO BOILER ROOM. RUN NEW PIPING THROUGHOUT MAIN OFFICE / NURSE'S OFFICE AREAS AS SHOWN. REFER TO DWG. #M6.01 & DWG. #M6.04, DETAIL #1 FOR FURTHER INFORMATION.
- MC TO PROVIDE & INSTALL NEW ENERGY RECOVERY VENTILATOR WHERE SHOWN. SUSPENDED FROM THE CEILING STRUCTURE. SUPPLY CFM TO BE SET AT 130 CFM / RETURN CFM TO BE SET AT 150CFM. GC TO CUT OUTDOOR AIR OPENINGS IN THE WALL. MC TO PROVIDE & INSTALL ALL DUCTWORK, INSULATION, WALL GRILLES / JACKS, SUPPORTS, TEMPERATURE CONTROLS & WIRING ETC. AS REQUIRED FOR A COMPLETE & OPERATIONAL INSTALLATION. REFER TO DWG. #M6.01 FOR MORE INFORMATION.
- MC TO INSTALL NEW HWS / HWR PIPING / SUPPORTS AS SHOWN. PROVIDE & INSTALL 2" INSULATION FOR ALL PIPING.
- MC TO RUN NEW CONDENSATE LINES FROM EACH VRF CASSETTE / WALL UNIT & RUN TO EXTERIOR WALL AS SHOWN. CORE DRILL AS REQUIRED. ALL CONNECTIONS BETWEEN CONDENSATE LINES MUST BE T-Y FITTINGS. CONDENSATE LINE TO BE TYPE "M" COPPER. REFER TO DWG. #M6.05 FOR FURTHER INFORMATION.
- MC TO INSTALL "1" OR "2" DUCTS, ACOUSTICALLY LINED DUCTWORK AT EACH LOCATION SHOWN. DUCTWORK DIMENSIONS SHOWN ON DRAWINGS ARE "CLEAR" INSIDE DIMENSIONS. SEE DWG. #M6.05 FOR MORE INFORMATION.
- MC TO PROVIDE & INSTALL NEW TRANSFER GRILLS AT EACH LOCATION SHOWN. GC TO CUT WALL OPENINGS FOR GRILLES. MC / GC TO COORDINATE FINAL LOCATIONS. SEE DWG. #M6.05 FOR FURTHER INFORMATION.
- MC TO PROVIDE & INSTALL NEW FIRE SMOKE DAMPER AT THE LOCATIONS SHOWN. GC TO CUT HOLE FOR DAMPER. GC / MC TO COORDINATE LOCATION. EC TO WIRE DAMPER. SEE DWG. #M6.05 FOR FURTHER INFORMATION.
- MC TO PROVIDE & INSTALL NEW BAROMETRIC RELIEF DAMPERS / OUTDOOR AIR LOUVERS AT EACH LOCATION SHOWN. REFER TO DWG. #M6.01 FOR FURTHER INFORMATION.
- MC TO PROVIDE & INSTALL NEW FIN TUBE RADIATOR ENCLOSURES. PROVIDE NEW FULL BACK PLATE SUPPORTS, ELEMENT SUPPORTS, ETC. AS REQ'D. TO INSTALL NEW ENCLOSURE WHERE SHOWN / INSTALL NEW ENCLOSURE OVER EXISTING FTR ELEMENT WHERE SHOWN. REFER TO DWG. #M6.0 FOR FURTHER INFORMATION.
- MC TO RUN NEW REFRIGERANT LINES FROM THE ROOF TO EACH DX COOLING COIL IN THEIR RESPECTIVE UNIT VENT / CEILING CASSETTE / WALL MOUNT UNIT. PROVIDE & INSTALL NEW 6x6 18 GA. METAL PAINTED PIPING ENCLOSURE. FLOOR TO CEILING TO CONCEAL NEW REFR. PIPING. SEE DWG. #M6.02 FOR FURTHER INFORMATION.
- MC TO PROVIDE & INSTALL A NEW PIPING ENCLOSURE. ENCLOSURE TO BE 18 GA. STEEL, PAINTED TO MATCH ADJACENT SURFACES. ENCLOSURE TO RUN FROM FIN. FLOOR UP TO CEILING. PROVIDE SIDE ACCESS OPENING TO FEED PIPING INTO FIN TUBE ENCLOSURE / UNIT VENT / CABINET UNIT HEATER.
- MC SHALL DISCONNECT EXISTING UNIT VENTILATOR / SHALL DISCONNECT EXISTING EXHAUST UNIT. GC TO PROVIDE 28" BASE FOR UNITS AT THE SAME LOCATION. UPON COMPLETION OF BASES, REINSTALL EXISTING UNITS ON NEW BASE & MODIFY HWS/R PIPING AS REQUIRED TO RECONNECT UNIT(S). REFER TO DETAIL # , DWG. #M6.0 FOR FURTHER DETAILS.
- TYP. FOR NEW HEATING THERMOSTAT (TO BMS) & NEW THERMOSTAT / CONTROLLER FOR VRF COOLING.



SECOND FLOOR MECHANICAL PROPOSED PLAN

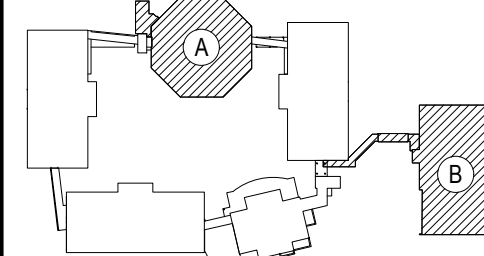
NOTE:

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

REV	DATE	ITEM
1	03/06/25	BID ADDENDUM No. 1

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KEY PLAN

NOT TO SCALE

BEDFORD CENTRAL SCHOOL DISTRICT
PHASE 2 - BOND IMPROVEMENTS
FOX LANE MIDDLE SCHOOL
TOWN OF BEDFORD / WESTCHESTER COUNTY

PROJECT

DWG TITLE

DRAWING BY: JH

CHECK BY: CW

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SED No:

66-01-02-06-0-007-013

DISTRICT

BEDFORD CENTRAL
SCHOOL DISTRICT

PROJECT

PHASE 2 -
BOND IMPROVEMENTS

DWG TITLE

PROPOSED FIRST AND
SECOND FLOOR PLANS

SCALE:

AS NOTED

DATE:

APRIL 2024

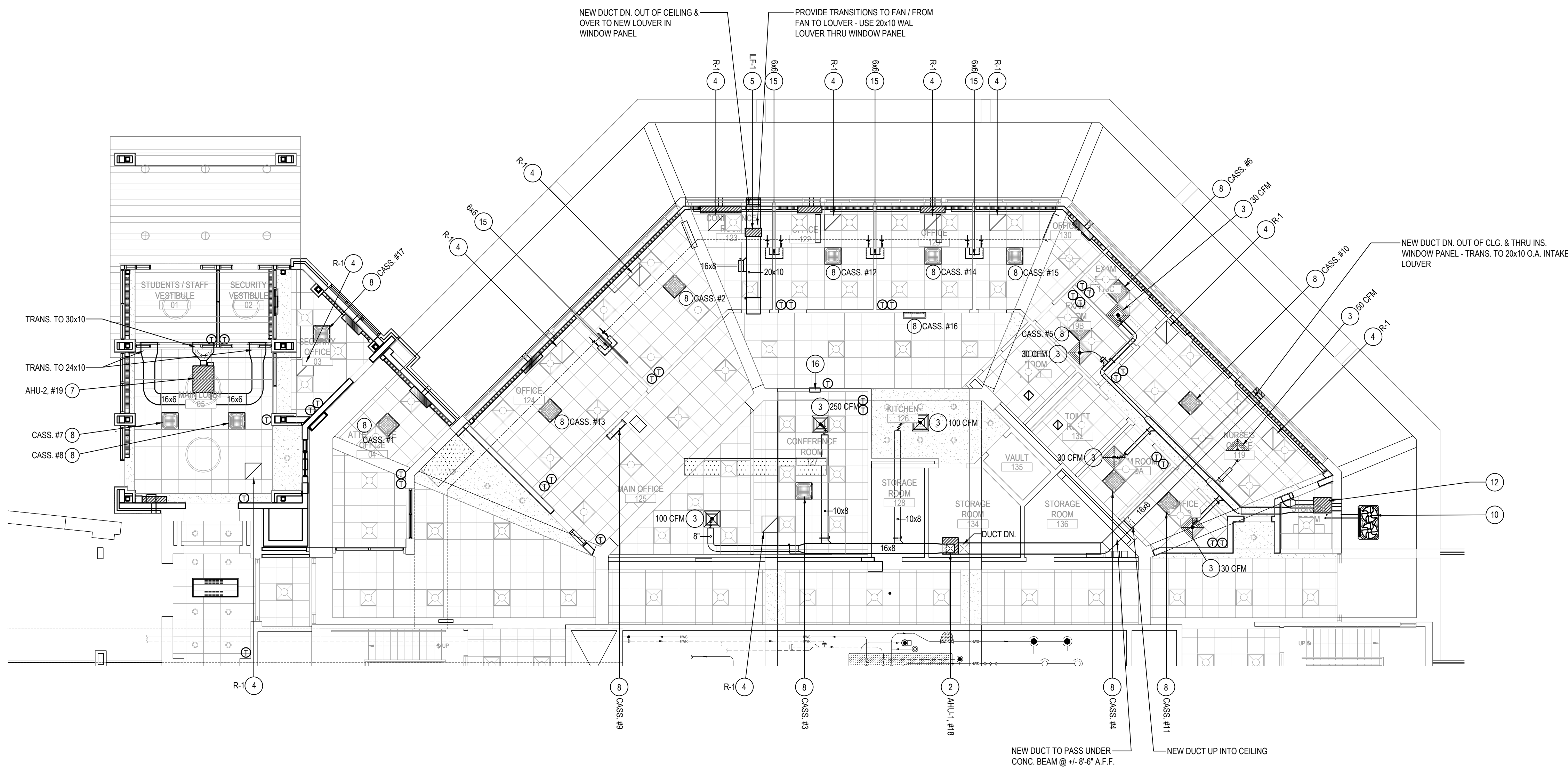
BID PICK-UP:

FEBRUARY 24, 2025

FILE No:

23-131b FLMS

M2.01



FIRST FLOOR MECHANICAL PROPOSED PLAN - DUCTWORK

NOTE:

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

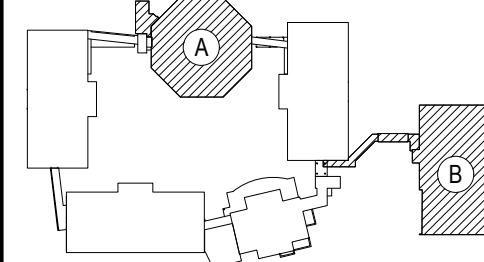
PROPOSED KEY NOTES

- 1 MC TO INSTALL NEW FIN TUBE & ENCLOSURES AT THE LOCATION SHOWN. PROVIDE THERMOSTAT & RELATED CONTROLS / CONTROL VALVES. PROVIDE PIPING ENCLOSURES FOR PIPING DROPS FROM CEILING. REFER TO DWG. #M6.01 & DETAIL #3 & 10 FOR MORE INFORMATION.
- 2 MC TO INSTALL NEW HANDLER AS SHOWN. REFER TO DWG. #M6.02 FOR MORE INFORMATION. PROVIDE 4" CONC. SUPPORT PAD, NEW DUCTWORK, NEW HWS/R PIPING, NEW REFR. PIPING & NEW TEMPERATURE CONTROLS FOR UNIT.
- 3 MC TO INSTALL NEW DUCTWORK & DIFFUSERS AS SHOWN. PROVIDE DUCT SUPPORTS, 2" INSULATION FOR NEW DUCTWORK. DUCTWORK DIMENSIONS SHOWN ON DRAWINGS ARE "CLEAR" INSIDE DIMENSIONS. BALANCE SYSTEM TO THE AIRFLOW VALUES SHOWN. REFER TO DWG. #M6.01 FOR MORE INFORMATION.
- 4 MC TO INSTALL NEW EXHAUST EGG CRATE GRILLES (TYPE R-1) AT THE LOCATIONS SHOWN. REFER TO DWG. #M6.01 FOR MORE INFORMATION.
- 5 MC TO INSTALL NEW INLINE FANS AT THE LOCATIONS SHOWN. REFER TO DWG. #M6.01 FOR FURTHER DETAILS. TEMPERATURE CONTROLS BY MC / POWER WIRING BY EC.
- 6 MC TO INSTALL NEW FLOOR MOUNTED HOT WATER CABINET UNIT HEATERS W/ OUTDOOR AIR OPENINGS / DAMPERS AT EACH LOCATION SHOWN. MC TO PROVIDE AUTOMATED DAMPER & NEW LOUVER. GC TO CUT OPENING IN WALL & INSTALL LOUVER. GC / MC TO COORDINATE FINAL LOCATIONS. REFER TO DWG. #M6.02 & #M6.05 FOR FURTHER DETAILS.
- 7 MC TO INSTALL NEW CEILING HUNG AHU UNIT & RUN DUCT WORK IN THE VESTIBULE AS SHOWN. PROVIDE DIFFUSERS / GRILLES & BALANCE TO THE AIRFLOW VALUES SHOWN. SEE DWG. #M6.05 FOR MORE INFORMATION.
- 8 MC TO PROVIDE & INSTALL NEW VRF CEILING CASSETTES / THERMOSTATS / CONDENSATE PUMPS & PIPING AS SHOWN. PROVIDE SUPPORTS / REFR. PIPING / TEMPERATURE CONTROLS & WIRING AS REQUIRED. REFER TO DWG. #M6.02 & M6.03 FOR FURTHER DETAILS.
- 9 MC TO PROVIDE & INSTALL NEW VRF WALL UNITS W/ CONDENSATE PUMPS & PIPING AS SHOWN. PROVIDE SUPPORTS, REFR. PIPING / PIPING ENCLOSURES / TEMPERATURE CONTROLS & CONTROL WIRING. REFER TO DWG. #M6.02 FOR FURTHER INFORMATION.
- 10 MC TO PROVIDE & INSTALL NEW CONDENSING UNIT ON RAILS IN THE LOCATION SHOWN. ALL REFRIGERANT PIPING TO BE INSULATED & INSTALLED BY MC. REFER TO DWG. #M6.02 & M6.03 FOR FURTHER DETAILS.
- 11 NOT USED.
- 12 MC TO PROVIDE & INSTALL NEW ENERGY RECOVERY VENTILATOR WHERE SHOWN. SUSPENDED FROM THE CEILING STRUCTURE. SUPPLY CFM TO BE SET AT 130 CFM / RETURN CFM TO BE SET AT 150CFM. GC TO CUT OUTDOOR AIR OPENINGS IN THE WALL. MC TO PROVIDE & INSTALL ALL DUCTWORK, INSULATION, WALL GRILLES / JACKS, SUPPORTS, TEMPERATURE CONTROLS & WIRING ETC. AS REQUIRED FOR A COMPLETE & OPERATIONAL INSTALLATION. REFER TO DWG. #M6.01 FOR MORE INFORMATION.
- 13 MC TO INSTALL NEW HWS / HWR PIPING / SUPPORTS AS SHOWN. PROVIDE & INSTALL 2" INSULATION FOR ALL PIPING.
- 14 MC TO RUN NEW CONDENSATE LINES FROM EACH VRF CASSETTE / WALL UNIT & RUN TO EXTERIOR WALL AS SHOWN. CORE DRILL AS REQUIRED. ALL CONNECTIONS BETWEEN CONDENSATE LINES MUST BE T-Y FITTINGS. CONDENSATE LINE TO BE TYPE "M" COPPER. REFER TO DWG. #M6.05 FOR FURTHER INFORMATION.
- 15 MC TO INSTALL "1" OR "2" DUCTS, ACOUSTICALLY LINED DUCTWORK AT EACH LOCATION SHOWN. DUCTWORK DIMENSIONS SHOWN ON DRAWINGS ARE "CLEAR" INSIDE DIMENSIONS. SEE DWG. #M6.05 FOR MORE INFORMATION.
- 16 MC TO PROVIDE & INSTALL NEW TRANSFER GRILLS AT EACH LOCATION SHOWN. GC TO CUT WALL OPENINGS FOR GRILLS. MC / GC TO COORDINATE FINAL LOCATIONS. SEE DWG. #M6.05 FOR FURTHER INFORMATION.
- 17 MC TO PROVIDE & INSTALL NEW FIRE SMOKE DAMPER AT THE LOCATIONS SHOWN. GC TO CUT HOLE FOR DAMPER. GC / MC TO COORDINATE LOCATION. EC TO WIRE DAMPER. SEE DWG. #M6.05 FOR FURTHER INFORMATION.
- 18 MC TO PROVIDE & INSTALL NEW BAROMETRIC RELIEF DAMPERS / OUTDOOR AIR LOUVERS AT EACH LOCATION SHOWN. REFER TO DWG. #M6.01 FOR FURTHER INFORMATION.
- 19 MC TO PROVIDE & INSTALL NEW FIN TUBE RADIATOR ENCLOSURES. PROVIDE NEW FULL BACK PLATE SUPPORTS, ELEMENT SUPPORTS, ETC. AS REQ'D. TO INSTALL NEW ENCLOSURE WHERE SHOWN / INSTALL NEW ENCLOSURE OVER EXISTING FTR ELEMENT WHERE SHOWN. REFER TO DWG. #M6.0 FOR FURTHER INFORMATION.
- 20 MC TO RUN NEW REFRIGERANT LINES FROM THE ROOF TO EACH DX COOLING COIL IN THEIR RESPECTIVE UNIT VENT / CEILING CASSETTE / WALL MOUNT UNIT. PROVIDE & INSTALL NEW 6x6 18 GA. METAL PAINTED PIPING ENCLOSURE. FLOOR TO CEILING TO CONCEAL NEW REFR. PIPING. SEE DWG. #M6.02 FOR FURTHER INFORMATION.
- 21 MC TO PROVIDE & INSTALL A NEW PIPING ENCLOSURE. ENCLOSURE TO BE 18 GA. STEEL, PAINTED TO MATCH ADJACENT SURFACES. ENCLOSURE TO RUN FROM FIN. FLOOR UP TO CEILING. PROVIDE SIDE ACCESS OPENING TO FEED PIPING INTO FIN TUBE ENCLOSURE / UNIT VENT / CABINET UNIT HEATER.

REV	DATE	ITEM
1	03/06/25	BID ADDENDUM No. 1

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KEY PLAN

NOT TO SCALE

PROJECT
BEDFORD CENTRAL SCHOOL DISTRICT
PHASE 2 - BOND IMPROVEMENTS
FOX LANE MIDDLE SCHOOL
TOWN OF BEDFORD / WESTCHESTER COUNTY

DWG TITLE
PROPOSED
FIRST and SECOND FLOOR PLANS

DRAWING BY: JH
CHECK BY: CW

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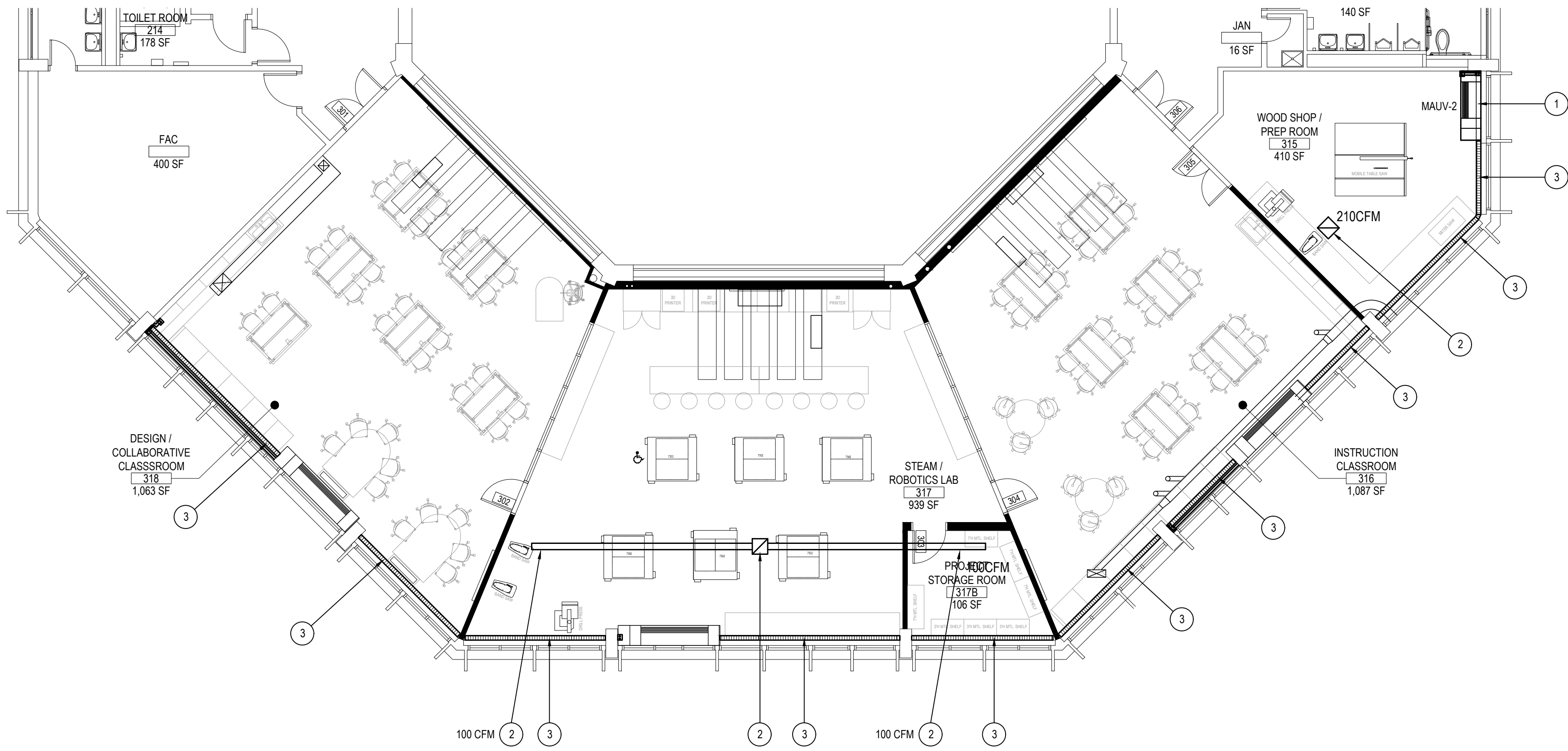
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SED No.	66-01-02-06-0-007-013
DISTRICT	BEDFORD CENTRAL SCHOOL DISTRICT
PROJECT	PHASE 2 - BOND IMPROVEMENTS
DWG TITLE	PROPOSED FIRST and SECOND FLOOR PLANS
SCALE	AS NOTED
DATE	APRIL 2024
BID PICK-UP	FEBRUARY 24, 2025
FILE No.	23-1316 FLMS

M2.02



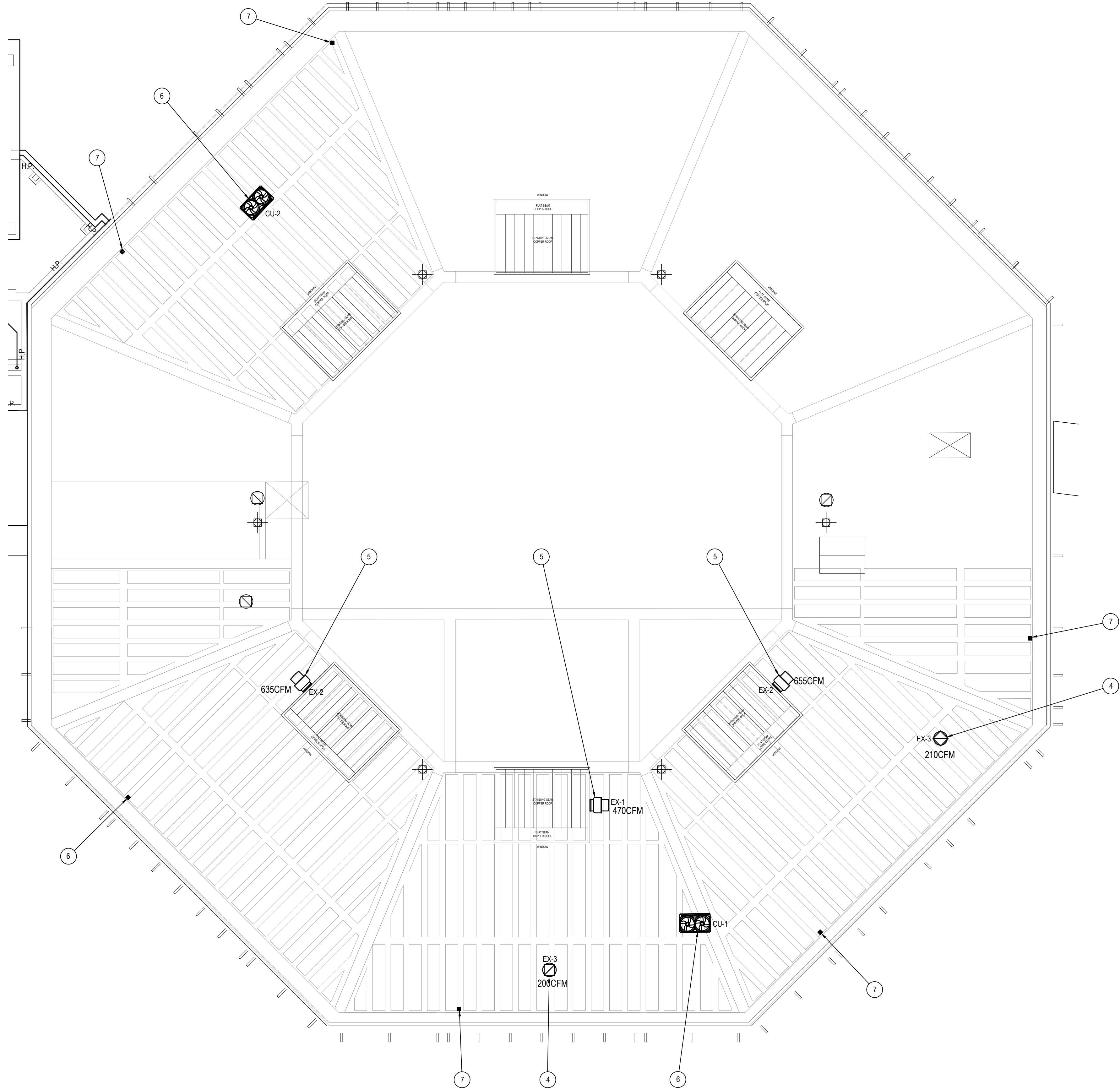
MECHANICAL THIRD FLOOR PROPOSED PLAN

NOTE:

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

PROPOSED KEY NOTES

- 1 MC TO INSTALL NEW HOT WATER UNIT VENTILATOR & INTAKE LOUVER. GC TO CUT OPENING IN NEW WALL PANEL. COORDINATE OPENING SIZE & LOCATION W/ THE GC. MC TO INSTALL END PANELS ON UNIT VENT. MC TO MODIFY EXISTING PIPING AS NECESSARY TO INSTALL NEW UV. SEE DRAWING M6.03 FOR UNIT SIZING. REFER TO SPECIFICATION SECTION 23 09 23 FOR NEW UNIT VENTILATOR TEMPERATURE CONTROL REQUIREMENTS.
- 2 MC TO INSTALL NEW EXHAUST DUCT WORK / "ANEMOSTAT" RECAP EXHAUST GRILLES ON THE SPIRAL DUCT WHERE SHOWN. SEE DWG M6.01 FOR FURTHER INFORMATION.
- 3 MC TO REPLACE ALL FIN TUBE ENCLOSURE WITH 20" DEEP ENCLOSURE. USE "STERLING" #JVB-T SERIES OR SIMILAR. SEE DWG M6.01 FOR FURTHER INFORMATION.
- 4 NEW EXHAUST FAN LOCATED ON ROOF BY MC. GC TO CUT OPENING & INSTALL CURB. CURB PROVIDED BY MC. MC TO INSTALL EXHAUST FAN / CONTROLS / CONTROL WIRING. COORDINATE OPENING LOCATION & TIMING W/ GC. FOR FURTHER INFORMATION / DETAILS, REFER TO DWGS. M6.01 / M6.04.
- 5 MC TO REPLACE EXISTING SIDE WALL EXHAUST FANS ON ROOF AS SHOWN. GC TO MODIFY OPENING AND INSTALL CURB. MC TO INSTALL EXHAUST FAN / CONTROLS / CONTROL WIRING. COORDINATE OPENING LOCATION & TIMING W/ GC.
- 6 NEW CONDENSERS INSTALLED ON ROOF BY MC. ROOF RAILS SUPPLIED BY MC & INSTALLED BY GC. REFRIGERANT PIPING TO BE RUN BY MC TO PIPING PORTAL / DOWN CHASES TO UNIT VENTS BELOW. CHASES TO BE PROVIDED BY GC. SEE DWGS. #s M6.02 & M6.04 FOR FURTHER INFORMATION.
- 7 PIPING PORTAL TO BE SUPPLIED BY MC. GC TO INSTALL PIPING PORTAL AND CORE DRILL FOR REFRIGERANT PIPING. SEE DWG. #s M6.02 & M6.04 FOR FURTHER DETAILS.



MECHANICAL THIRD FLOOR PROPOSED PLAN

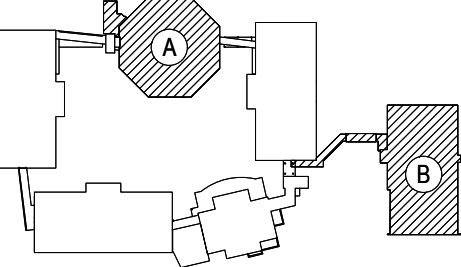
NOTE:

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

REV.	DATE	ITEM
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PHASE 2 - BOND IMPROVEMENTS
FOX LANE MIDDLE SCHOOL
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DWG TITLE
PROPOSED
THIRD FLOOR and SECOND FLOOR PLANS

DRAWING BY: JH
CHECK BY: CW

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PROJECT	PHASE 2 - BOND IMPROVEMENTS
DWG TITLE	PROPOSED THIRD FLOOR and SECOND FLOOR PLANS
SCALE	AS NOTED
DATE	APRIL 2024
BID PICK-UP	FEBRUARY 24, 2025
FILE No.	23-131b FLMS

M2.03

CU-1
System Data

System Model Selection - ODU

System Name: CU-1
System No.: 1/2

Date: 03/05/2024

1. Design conditions - Outdoor

	Cooling			Heating		
	DBT(F)	WB(T/F)	RH(%)	DBT(F)	WB(T/F)	RH(%)
DBT	91.9	73.9	43.3	10.9	10.2	86.0
WBT	80.0	67.0	51.2	70.0	58.0	43.0

2. Outdoor Units

Model Name	No. of Rows (Current / Max)	Combination Ratio (Current / Max)	Corrected Capacity (Cooling / Heating) (kW)	Pre-charged Ref. amount (Psi)	Additional Ref. Amount (Psi)
ARUM192DTE5	4 / 12	89 / 100	0.0 / 0.0	30.00	10.02

3. Pipes

Dimensions (in. (x) (x) (x))	Length (ft)
3/8" x 1/8"	130.0
3/8" x 3/4"	40.0
3/8" x 1/2"	20.0
3/8" x 1/8"	20.0

4. Branch/Header

Model Name	Quantity
ARBLN0321	1
ARBLN0321	1
ARBLN0321	1
ARBLN0321	1

VRF Outdoor Condensing
Unit Data

CU-1

Tag No.: 1

ARUM192DTE5
Multi V™ 5 with LGRED™ 460V ODU
16 Ton Single Frame Heat Pump and Heat Recovery

Performance:

Cooling Mode:	5-122	
Heating Mode:	22-61	

Operating Range:

Cooling (T DBT)°	5-122	
Heating (T WB)°	22-61	

Unit Data:

Refrigerant Type	R410A	
Refrigerant Control	EVV	
Max. Number of Indoor Units*	32	
Sound Pressure* (dB(A))	62.0	

Electrical:

Frame	ARUM192DTE5	
Power Supply (V/Hz/Ph)	460/50/3	
MOP (A)	50	
MCA (A)	50	
Rated Amps (A)	32.0	
Compressor A (A)	14.8	
Compressor B (A)	12.2	
Fan (A)	5.0	

Piping:

Frame	ARUM192DTE5	
Refrigerant Charge (Btu.)	30.9	
Liquid (in. O.D.)	5/8 Braid	
High Pressure Vapor (in. O.D.)	1.1/8 Braid	
Low Pressure Vapor (in. O.D.)	1.1/8 Braid	

Job Name/Location:

ARUM192DTE5
Multi V™ 5 with LGRED™ 460V ODU
16 Ton Single Frame Heat Pump and Heat Recovery

Tag No.:
Date:
PO No.:

AHRI Data:

Reference Number	Indoor Type	Cooling Capacity (BTU/h)	EER (BTU/h)	SEER	High Heating Capacity (BTU/h)	High COP (EHP)	Low Heating Capacity (BTU/h)	Low COP (LHP)
21391612	Ducted Indoor Units	184,000	10.5	21.7	206,000	3.80	134,000	2.41
21391630	Non-Ducted Indoor Units	184,000	9.9	21.4	206,000	3.75	134,000	2.64

EEV Kit
UV-XX
Qty. (6)

Tag No.: 1

PRUX04840
Electronic Expansion Valve Kit
for AHU Communications Kit

Electrical:

Power Supply:	Powered by AHU Comm Kit (12 VDC)	

Environmental Data:

Operating Temperature	-4 ~ 149 °F	
Humidity	0.98 % (non-condensing)	

Unit Data:

Dimensions (in.)	8-5/8 W x 15-15/16 H x 3-5/16 D	
Net Weight (lb.)	6.8	
Shipping Weight (lb.)	7.9	

Capacity:

Maximum AHU Capacity (BTU/h)	96,000	

AHU Communication Kit
Qty. (6)

Tag No.: 1

PAHCMR000
AHU Communications Kit
Return Air

Electrical:

Power Supply:	208-230VAC, 60Hz, 1Ph	
Rated Current	0.1A	

Environmental Data:

Operating Temperature	-4 to +149°F	
Humidity	0-98% (Non-condensing)	

Unit Data:

Dimensions (in.)	11-13/16 W x 11-13/16 D x 6-3/32 H	
Net Weight (lb.)	13.1	
Shipping Weight (lb.)	16.4	

Communications Module

Tag No.: 1

PAHCMR000
AHU Communications Kit
Return Air

Electrical:

Power Supply:	208-230VAC, 60Hz, 1Ph	
Rated Current	0.1A	

Environmental Data:

Operating Temperature	-4 to +149°F	
Humidity	0-98% (Non-condensing)	

Unit Data:

Dimensions (in.)	11-13/16 W x 11-13/16 D x 6-3/32 H	
Net Weight (lb.)	13.1	
Shipping Weight (lb.)	16.4	

Communications Module

LG VRF SYSTEM MUSIC ROOM/STEAM LAB (SECOND AND THRID FLOOR)

NOTE:

NTS

CU-2
System Data

System Model Selection - ODU

System Name: CU-2
System No.: 2/2

Date: 03/05/2024

1. Design conditions - Outdoor

	Cooling			Heating		
	DBT(F)	WB(T/F)	RH(%)	DBT(F)	WB(T/F)	RH(%)
DBT	91.9	73.9	43.3	10.9	10.2	86.0
WBT	80.0	67.0	51.2	70.0	58.0	43.0

2. Outdoor Units

Model Name	No. of Rows (Current / Max)	Combination Ratio (Current / Max)	Corrected Capacity (Cooling / Heating) (kW)	Pre-charged Ref. amount (Psi)	Additional Ref. Amount (Psi)
ARUM096DTE5	2 / 10	100 / 100	0.0 / 0.0	20.00	6.70

3. Pipes

Dimensions (in. (x) (x) (x))	Length (ft)
3/8" x 1/8"	65.0
3/8" x 1/8"	40.0

4. Branch/Header

Model Name	Quantity
ARBLN0321	1
ARBLN0321	1

VRF Outdoor Condensing
Unit Data

CU-2

Tag No.: 1

ARUM096DTE5
Multi V™ 5 with LGRED™ 460V ODU
8 Ton Single Frame Heat Pump and Heat Recovery

Performance:

Cooling Mode:	5-122	
Heating Mode:	22-61	

Operating Range:

Cooling (T DBT)°	5-122	
Heating (T WB)°	22-61	

Unit Data:

Refrigerant Type	R410A	
Refrigerant Control	EVV	
Max. Number of Indoor Units*	16	
Sound Pressure* (dB(A))	58.0	

Electrical:

Frame	ARUM096DTE5	
Power Supply (V/Hz/Ph)	460/50/3	
MOP (A)	25	
MCA (A)	16.4	
Rated Amps (A)	14.1	
Compressor A (A)	9.1	
Compressor B (A)	5.0	
Fan (A)	5.0	

Piping:

Frame	ARUM096DTE5	
Refrigerant Charge (Btu.)	23.2	
Liquid (in. O.D.)	3/8 Braid	
High Pressure Vapor (in. O.D.)	3/4 Braid	
Low Pressure Vapor (in. O.D.)	7/8 Braid	

Job Name/Location:

ARUM096DTE5
Multi V™ 5 with LGRED™ 460V ODU
8 Ton Single Frame Heat Pump and Heat Recovery

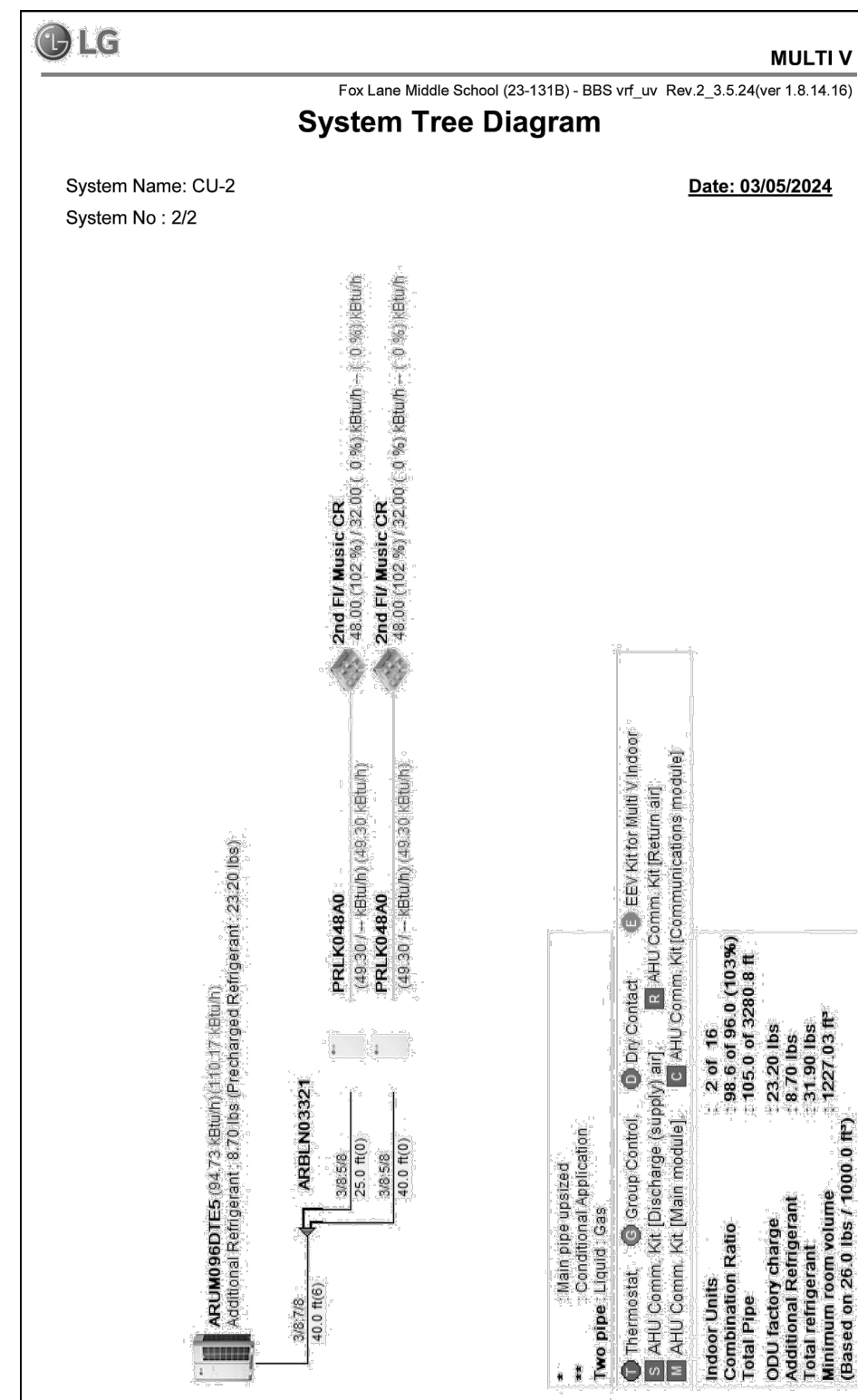
Tag No.:
Date:
PO No.:

AHRI Data:

Reference Number	Indoor Type	Cooling Capacity (BTU/h)	EER (BTU/h)	SEER	High Heating Capacity (BTU/h)	High COP (EHP)	Low Heating Capacity (BTU/h)	Low COP (LHP)
21391629	Ducted Indoor Units	90,000	11.9	20.1	103,000	3.46	67,000	2.71
21391628	Non-Ducted Indoor Units	90,000	10.4	20.6	103,000	4.33	67,000	2.85

UV Data

WOOD SHOP PREP RM.



Fox Lane Middle School UV

Manufacturer: MAGiCare
Performance Details: Vertical Floor Mounted
Base Unit Size: UV-Wood Shop
Quantity: 1
Altitude: 0
Configuration: 4 Pipe
Nominal Airflow (CFM): 750
External Static Pressure (ESP) (WEG): 0.1

Cooling Coil: 4 Row DX (R-410A)
Rows: 4
EAT Dry Bulb (F): 80
EAT Wet Bulb (F): 67
LAT Dry Bulb (F): 60.14
LAT Wet Bulb (F): 56.43
Leaving Dew Point (F): 53.93
Total Capacity (BTU/hr): 23440
Sensible Capacity (BTU/hr): 18620
Saturated Condensing Temp (F): 95
Saturated Evap Temp (F): 42

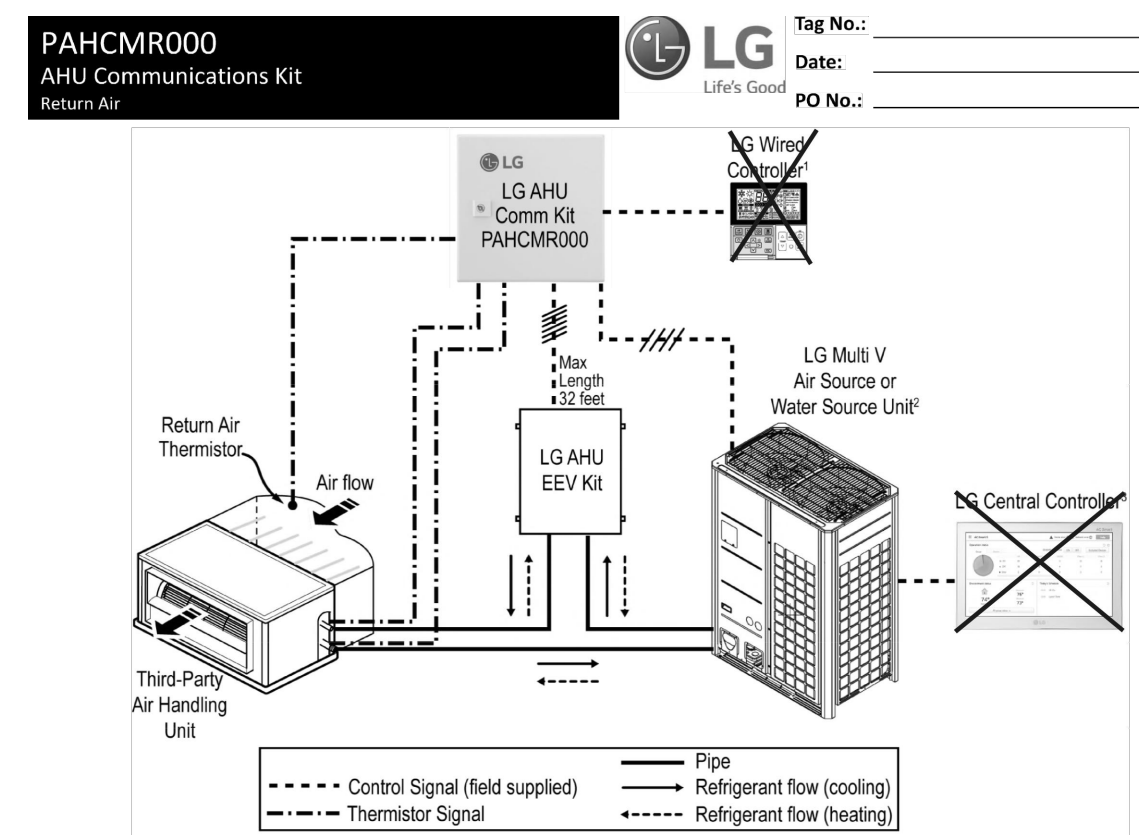
See VRF Data Performance

2 Row Hot Water Coil
Rows: 2
EAT Dry Bulb (F): 95
LAT Dry Bulb (F): 103.04
LAT Wet Bulb (F): 40.74
EWT (F): 170
LWT (F): 149.34
GPM: 4
WFO (R w.g.): 1.2
Heating Fluid: Water

Heating Coil: 2 Row Hot Water Coil
Rows: 2
EAT Dry Bulb (F): 95
LAT Dry Bulb (F): 103.04
LAT Wet Bulb (F): 40.74
EWT (F): 170
LWT (F): 149.34
GPM: 4
WFO (R w.g.): 1.2
Heating Fluid: Water

Electrical Data: ECM
Voltage (V): 208
Phase: 1
Frequency: 60
Motor HP: 1/3
Motor FLA (at V): 2.3
Unit MCA (at V): 2.9
Unit MOP (at V): 15

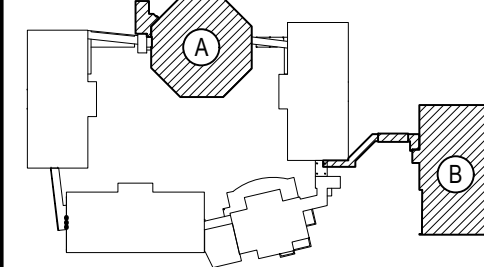
Filters: Nominal Size (in.) - MERV13
Quantity (per unit): 1



REV.	DATE	ITEM
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NOT TO SCALE

BEDFORD CENTRAL SCHOOL DISTRICT
PHASE 2 - BOND IMPROVEMENTS
FOX LANE MIDDLE SCHOOL
TOWN OF BEDFORD / WESTCHESTER COUNTY

SCHEDULES AND DETAILS

PROJECT
DRAWING BY: JH
CHECK BY: CW

DWG TITLE

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DISTRICT

BEDFORD CENTRAL
SCHOOL DISTRICT

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PHASE 2 -
BOND IMPROVEMENTS

DWG TITLE

SCHEDULES AND DETAILS

SCALE:

AS NOTED

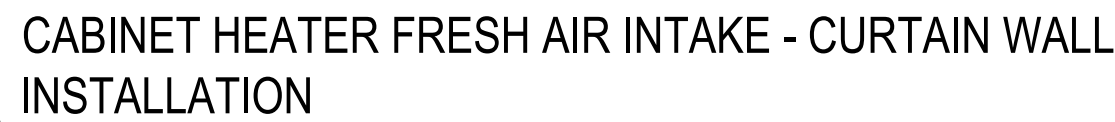
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APRIL 2024

BID PICK-UP: FEBRUARY 24, 2025

FILE NO.: 23-1316 FLMS

M6.03



18 CABINET HEATER FRESH AIR INTAKE - BLOCK WALL



SCALE: N.T.S.

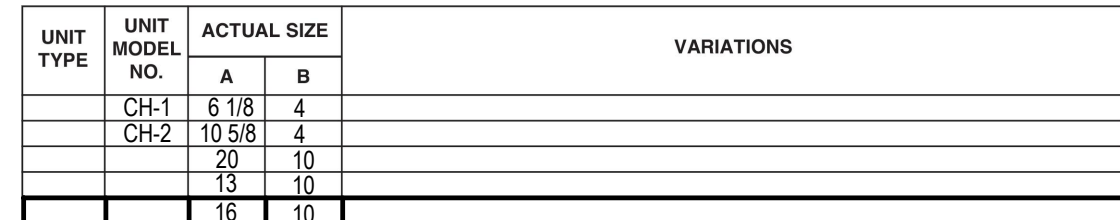


SCALE: N.T.S



OUTDOOR AIR LOUVER FOR UNIT VENT

NTS

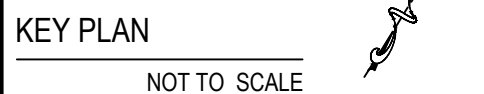


OUTDOOR AIR BRICK VENTS FOR CABINET HEATERS & EXHAUST DUCTWORK

NTS

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PHASE 2 - BOND IMPROVEMENTS
FOX LANE MIDDLE SCHOOL
TOWN OF BEDFORD / WESTCHESTER COUNTY**

PROJECT

DRAWING BY:	JH
CHECK BY:	CW

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DISTRICT BEDFORD CENTRAL
SCHOOL DISTRICT

PROJECT PHASE 2 -
BOND IMPROVEMENTS

DWG TITLE SCHEDULES AND DETAILS

SCALE:	AS NOTED
DATE:	APRIL 2004

BID PICK-UP: FEBRUARY 24, 2025

M6.05