Progressive Design Collaborative, Ltd
3101 Poplarwood Court, Suite 320
Raleigh, North Carolina 27604
919-790-9989

ADDENDUM 01 – MECHANICAL

DATE: June 27, 2023

PROJECT: ENCSD Alford Hall HVAC Upgrades
PDC Project No. 22034
SCO # 22-24313-01

6/27/23

This Addendum, applicable to the work designed below, shall be understood to be and is a change to the bid documents and shall be part of and included in the contract for the above referenced project. All General, Supplementary and Special Conditions, etc., as originally specified or as modified below shall apply to these items.

Changes to Specifications:

Section 23 09 01 *Building Management System* – Added section

Section 23 09 13.13 *BAS Actuators and Operators* – Added section

Section 23 09 13.33 *BAS Control Valves – Added section*

Section 23 09 13.43 *BAS Control Dampers* – Added section

Changes to Drawings:

M3.01 – Added location for DDC panel

M6.01 – Added list of BACnet integration points for RTU

M6.02 – Revised controls schematic

M7.01 – Revised pump schedule note

END OF ADDENDUM 02 – MECHANICAL

Attachments: See list above

SECTION 23 09 01
BUILDING MANAGEMENT SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Building Management System (BMS), utilizing direct digital controls.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Products Furnished But Not Installed Under This Section:
   1. Control valves.
   2. Flow switches.
   3. Wells, sockets and other inline hardware for water sensors (temperature, pressure, flow).
   4. Automatic control dampers, where not supplied with equipment.
   5. Airflow measuring stations when not insertion style.
   6. Variable frequency drives. (This does not include VFDs integral to machinery such as chillers or boilers).

B. Products Not Furnished or Installed But Integrated with the Work of This Section:
   1. Smoke detectors (through alarm relay contacts).

C. Work Required Under Other Divisions Related to This Section:
   1. Power wiring to line side of motor starters, disconnects or variable frequency drives.
   2. Power wiring to load side mechanical equipment.
   3. Provision and wiring of smoke detectors and other devices relating to fire alarm system.
   4. Campus LAN (Ethernet) connection adjacent to Network Area Controller (JACE).

1.03 SYSTEM DESCRIPTION

A. Scope: Furnish all labor, materials and equipment necessary for a complete and operating Building Management System (BMS), utilizing Direct Digital Controls as shown on the drawings and as described herein. Drawings are diagrammatic only. All controllers furnished in this section shall communicate on a peer-to-peer bus over a BACnet/MSTP open protocol bus.
   1. The intent of this specification is to provide a system that is consistent with BMS systems throughout the owner's facilities running the Niagara 4 Framework.
   2. System architecture shall fully support a multi-vendor environment and be able to integrate third party systems via existing vendor protocols including, as a minimum, LonTalk, BACnet and MODBUS.
   3. System architecture shall provide secure Web access using any of the current versions of Microsoft Edge, Mozilla Firefox, or Google Chrome browsers from any computer on the owner's LAN.
   4. Only systems that utilize the Niagara 4 Framework shall satisfy the requirements of this section.
   5. One (1) laptop computer including engineering/programming software to modify Operating System Server BMS programs and graphics shall be included. The Notebook Workstations shall be a minimum Intel Core i3 Dual core 3.4 GHz processor with 8 GB RAM and a 1TB SATA hard drive with 6 GB/s transfer rate. It shall include a minimum 32X CD-ROM drive, and 3-USB ports, minimum 15” LED display capable of as a minimum 1024 x 768 resolution. Include 5-year SMA (Software Maintenance Agreement). Labor for software maintenance is not included.
   6. Owner shall receive all Administrator level login and passwords for engineering toolset at first training session. The Owner shall have full licensing and full access rights for all network management, operating system server, engineering and programming software required for the ongoing maintenance and operation of the BMS.
   7. OPEN NIC STATEMENTS - All Niagara 4 software licenses shall have the following NiCS: "accept.station.in=*"; "accept.station.out=*"and "accept.wb.in=*"and "accept.wb.out=*". All open NIC statements shall follow Niagara Open NIC specifications.
   8. All NAC hardware licenses and certificates shall be stored on local MicroSD memory card employing encrypted “safe boot” technology.

9. All NAC provided as part of this project shall be the appropriate JACE-8000 model licensed with all necessary drivers.
10. All NAC's provided as part of this project shall be licensed to accommodate a minimum of 10% additional controllers and points.

1.04 SPECIFICATION NOMENCLATURE

A. Acronyms used in this specification are as follows:
1. Actuator: Control device that opens or closes valve or damper in response to control signal.
2. AI: Analog Input.
3. AO: Analog Output.
4. Analog: Continuously variable state over the stated range of values.
5. BMS: Building Management System.
6. DDC: Direct Digital Control.
7. Discrete: Binary or digital state.
8. DI: Discrete Input.
9. DO: Discrete Output.
10. FC: Fail Closed position of control device or actuator. Device moves to closed position on loss of control signal or energy source.
11. FO: Fail open (position of control device or actuator). Device moves to open position on loss of control signal or energy source.
12. GUI: Graphical User Interface.
13. HVAC: Heating, Ventilating and Air Conditioning.
14. IDC: Interoperable Digital Controller.
15. ILC: Interoperable Lon Controller.
16. LAN: Local Area Network.
17. Modulating: Movement of a control device through an entire range of values, proportional to an infinitely variable input value.
18. Motorized: Control device with actuator.
19. NAC: Network Area Controller (JACE).
20. NC: Normally closed position of switch after control signal is removed or normally closed position of manually operated valves or dampers.
21. NO: Normally open position of switch after control signal is removed; or the open position of a controlled valve or damper after the control signal is removed; or the usual position of a manually operated valve.
22. OSS: Operating System Server, host for system graphics, alarms, trends, etc.
23. Operator: Same as actuator.
24. PC: Personal Computer.
25. Peer-to-Peer: Mode of communication between controllers in which each device connected to network has equal status and each shares its database values with all other devices connected to network.
26. P: Proportional control; control mode with continuous linear relationship between observed input signal and final controlled output element.
27. PI: Proportional-Integral control, control mode with continuous proportional output plus additional change in output based on both amount and duration of change in controller variable (reset control).
28. PICS: BACnet Product Interoperability Compliance Statement.
29. PID: Proportional-Integral-Derivative control, control mode with continuous correction of final controller output element versus input signal based on proportional error, its time history (reset) and rate at which it's changing (derivative).
30. Point: Analog or discrete instrument with addressable database value.
31. SMA: Software Maintenance Agreement. Maintenance agreement that provides future releases of Niagara 4 software at no licensing cost to owner. Labor to implement software upgrades is not covered under the Software Maintenance Agreement.
32. WAN: Wide Area Network.

1.05 SUBMITTALS

A. Submit under provisions of Division 1 specifications.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.

C. Submit documentation of contractor qualifications, including those indicated in "Quality Assurance" if requested by the A-E.

D. The control system submittal shall consist of shop drawings, manufacturers' catalog data sheets and installation instructions. Submit in printed and electronic format. Samples of written Controller Checkout Sheets and Performance Verification Procedures for applications similar in scope shall be included for approval. Provide x copies of the control system submittal.

E. As a minimum, shop drawings shall contain:
   1. A table of contents.
   2. Equipment schedules.
   3. Valve and damper schedules when applicable. Valve schedules shall include GPM, valve size, calculated Cv, valve Cv, pressure drop, close-off pressure, configuration (2-way or 3-way), and valve actuator data.
   4. VAV box schedule. VAV box schedule shall include box size, K-Factor, and flow setpoints.
   5. Schematic diagrams of all controlled equipment.
   6. Sequences of operation for all controlled equipment.
   7. Controller wiring diagrams, including terminal number identification for all control wiring.
   8. Wiring details for all field devices.
   9. A network architecture diagram showing a high-level overview of the installed system.
   10. A detailed control system bus layout depicted on building floorplans.
   11. Control panel layout diagrams depicting all panel mounted components.
   12. Any other details required to demonstrate that the system has been coordinated with other trades and will properly function as a system.
   13. Manufacturer’s data sheets for all installed components.

F. Upon completion of the work, provide three (3) complete sets of ' as-built' drawings and other project-specific documentation in 3-ring hard-backed binders and one electronic copy.

G. Any deviations from these specifications or the work indicated on the drawings shall be clearly identified in the Submittals.

1.06 QUALITY ASSURANCE

A. The Control System Contractor shall have a full service DDC office within 100 miles of the job site. This office shall be staffed with applications engineers, software engineers and field technicians. The Control System Contractor shall be staffed with a minimum of five (5) Niagara 4 certified software engineers and/or technicians. The Control System Contractor shall also be staffed with a minimum of ten (10) control system manufacturer certified software engineers and/or technicians. The Control System Contractor shall maintain parts inventory and shall have all testing and diagnostic equipment necessary to support this work, as well as staff trained in the use of this equipment.

B. Single Source Responsibility of Supplier: The Control System Contractor shall be responsible for the complete installation and proper operation of the control system. The Control System Contractor shall exclusively be in the regular and customary business of design, installation and service of computerized building management systems similar in size and complexity to the system specified. The Control System Contractor shall be the manufacturer of the primary DDC system components or shall have been the authorized representative for the primary DDC components manufacturer for at least 3 years. All control panels shall be assembled by the Control System Contractor in a UL-Certified 508A panel shop. Control panels shall be assembled such that all necessary I/O points are pre-wired from DDC controllers to terminal blocks. Wire ducts shall be installed within the panel as needed to accommodate field wiring.

C. Equipment and Materials: Equipment and materials shall be cataloged products of manufacturers regularly engaged in the production and installation of HVAC control systems. Products shall be manufacturer's latest standard design and have been tested and proven in actual use.

D. Approved Manufacturers:
   1. Distech, Tridium
   2. Honeywell
   3. Schneider
   4. Siemens

E. Approved Installation Contractors:
   1. Engineered Control Solutions
   2. Schneider
   3. Siemens

1.07 SOFTWARE OWNERSHIP

A. The Owner shall have full ownership and full access rights for all network management, operating system server, engineering and programming software required for the ongoing maintenance and operation of the BMS.

1.08 DELIVERY, STORAGE AND HANDLING

A. Maintain integrity of shipping cartons for each piece of equipment and control device through shipping, storage and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.

1.09 JOB CONDITIONS

A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to insure that the Work will be carried out in an orderly fashion. It shall be this Contractor's responsibility to check the Contract Documents for possible conflicts between his Work and that of other crafts in equipment location, pipe, duct and conduit runs, electrical outlets and fixtures, air diffusers and structural and architectural features.

1.10 SEQUENCING

A. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

PART 2 PRODUCTS

2.01 GENERAL

A. The Building Management System (BMS) shall be comprised of a network of interoperable, stand-alone digital controllers, a network area controller, graphics and programming and other control devices for a complete system as specified herein.

B. The installed system shall provide secure strong password access to all features, functions and data contained in the overall BMS.

2.02 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURE

A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system utilizing Open protocols in one open, interoperable system.

B. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. Physical connection of any BACnet control equipment, such as chillers, shall be via Ethernet, IP, or MS/TP.

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

D. The supplied system shall incorporate the ability to access all data using HTML5 enabled browsers without requiring proprietary operator interface and configuration programs or browser plug-ins. An Open Database Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on the

Operating System Server located in the Facilities Office on the LAN. Systems requiring proprietary database and user interface programs shall not be acceptable.

E. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a "flat" single tiered architecture shall not be acceptable.
   1. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.
   2. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

2.03 NETWORK AREA CONTROLLER (NAC)

A. These controllers are designed to manage communications between the Advanced Application Controllers (B-AAC), Application Specific Controllers (B-ASC) and Advanced Unitary Controllers (AUC) which are connected to its communications trunks, manage communications between itself and other system network controllers (NAC) and with any operator workstations (OWS) that are part of the BAS, and perform control and operating strategies for the system based on information from any controller connected to the BAS.

B. The controllers shall be fully programmable to meet the unique requirements of the facility it shall control.

C. The controllers shall be capable of peer-to-peer communications with other NAC's and with any OWS connected to the BAS, whether the OWS is directly connected, connected via cellular modem or connected via the Internet.

D. The communication protocols utilized for peer-to-peer communications between NAC's will be Niagara 4 Fox, BACnet TCP/IP and SNMP. Use of a proprietary communication protocol for peer-to-peer communications between NAC's is not allowed.

E. The NAC shall employ a device count capacity license model that supports expansion capabilities.

F. The NAC shall be enabled to support and shall be licensed with the following Open protocol drivers (client and server) by default:
   1. BACnet
   2. Lon
   3. MODBUS
   4. SNMP
   5. KNX

G. The NAC shall be capable of executing application control programs to provide:
   1. Calendar functions.
   2. Scheduling.
   3. Trending.
   4. Alarm monitoring and routing.
   5. Time synchronization.
   6. Integration of LonWorks, BACnet, and MODBUS controller data.
   7. Network management functions for all NAC, PEC and ASC based devices.

H. The NAC shall provide the following hardware features as a minimum:
   1. Two 10/100 Mbps Ethernet ports.
   2. Two Isolated RS-485 ports with biasing switches.
   3. 1 GB RAM
   4. 4 GB Flash Total Storage / 2 GB User Storage
   5. Wi-Fi (Client or WAP)
   6. USB Flash Drive
   7. High Speed Field Bus Expansion
   8. -20-60°C Ambient Operating Temperature
   9. Integrated 24 VAC/DC Global Power Supply
   10. MicroSD Memory Card Employing Encrypted Safe Boot Technology

I. The NAC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 16 simultaneous users.

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

K. The NAC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via cellular modem, or wide-area network.
   1. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but not limited to:
      a. Alarm.
      b. Return to normal.
      c. To default.
   2. Alarms shall be annunciated in any of the following manners as defined by the user:
      a. Screen message text.
      b. Email of complete alarm message to multiple recipients.
      c. Pagers via paging services that initiate a page on receipt of email message.
      d. Graphics with flashing alarm object(s).
   3. The following shall be recorded by the NAC for each alarm (at a minimum):
      a. Time and date.
      b. Equipment (air handler #, access way, etc.).
      c. Acknowledge time, date, and user who issued acknowledgement.

L. The NAC shall support the following security functions.
   1. Module code signing to verify the author of programming tool and confirm that the code has not been altered or corrupted.
   2. Role-Based Access Control (RBAC) for managing user roles and permissions.
   3. Require users to use strong credentials.
   4. Data in Motion and Sensitive Data at Rest be encrypted.
   5. LDAP and Kerberos integration of access management.

M. The NAC shall support the following data modeling structures to utilize Search; Hierarchy; Template; and Permission functionality:
   1. Metadata: Descriptive tags to define the structure of properties.
   2. Tagging: Process to apply metadata to components
   3. Tag Dictionary

N. The NAC shall employ template functionality. Templates are a containerized set of configured data tags, graphics, histories, alarms, etc. that are set to be deployed as a unit based upon manufacturer's controller and relationships. All lower level communicating controllers (PEC, AVAV, CVAV, VFD's, etc.) shall have an associated template file for reuse on future project additions.

O. The NAC shall be provided with a Software Maintenance Agreement as indicated in Paragraph 1.3.

2.04 BUILDING AUTOMATION SYSTEM CONTROLLERS

A. HVAC control shall be accomplished using BACnet based devices where the application has a BTL Listed PICS defined. The controller platform shall provide options and advanced system functions, programmable and configurable using the Niagara 4 Framework or through manufacturer supplied software, that allow standard and customizable control solutions required in executing the "Sequence of Operation". For systems that do not provide the ability to program DDC controllers through the Niagara 4 Framework, provide (4) copies of controller engineering/programming software, including any necessary licenses required for use of software.
   1. Advanced Application Controller (B-AAC) - a controller designed for more complex sequences of operations such as built up AHU's, central plant operations, electrical monitoring, and control and management for chillers, boilers and generators. The B-AAC's are to allow for the flexibility of custom control programming to meet the needed sequences of operation. B-AAC's shall be selected based upon I/O requirements. Additional I/O may be added via expansion modules.

a. All B-AAC's shall be application programmable and shall at all times maintain their certification. All control sequences within or programmed into the B-AAC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery to be retained.
b. The B-AAC shall provide LED indication of communication and controller performance to the technician, without cover removal.
c. B-AAC's shall have mixture of I/O including dry contact digital inputs, universal inputs (configurable as of 4-20 mA, 0-10 VDC, thermistor and RTD in the range 0 to 350,000 ohm), universal outputs (4-20mA, 0-10 VDC, or digital), and digital outputs (24 VAC TRIAC).

2. Advanced Variable Air Volume Controller (AVAV) - a controller designed specifically for room-level VAV control - pressure-independent air flow control, pressure dependent damper control, supply and exhaust pressurization/de-pressurization control; temperature, humidity, complex CO2, occupancy, and emergency control. Equipment includes: VAV terminal unit, VAV terminal unit with reheat, series fan powered terminal unit, parallel fan powered terminal unit, supply and exhaust air volume terminals and constant volume dual-duct terminal unit.
   a. The AVAV shall be application programmable and shall at all times maintain their certification. All control sequences within or programmed into the PEC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery to be retained.
   b. The controller shall have an internal velocity pressure sensor.
   c. The AVAV shall provide LED indication of communication and controller performance to the technician, without cover removal.
   d. AVAV's shall have mixture of I/O including dry contact digital inputs, universal inputs (configurable as of 4-20 mA, 0-10 VDC, thermistor and RTD in the range 0 to 350,000 ohm), universal outputs (4-20mA, 0-10 VDC, or digital), and digital outputs (24 VAC TRIAC).
   e. The controller shall provide an integrated actuator option.
3. Configurable VAV Controller (CVAV) - the configurable VAV controller platform shall be designed specifically for room-level VAV control – pressure-independent air flow control, pressure dependent damper control, supply and exhaust pressurization/de-pressurization control; temperature, humidity, complex CO2, occupancy, and emergency control. Equipment includes: VAV terminal unit, VAV terminal unit with reheat, series fan powered terminal unit, parallel fan powered terminal unit, supply and exhaust air volume terminals, and constant volume dual-duct terminal unit.
   a. The CVAV shall be application specific configuration and shall at all times maintain their certification. All control sequences within or programmed into the CVAV shall be stored in non-volatile memory, which is not dependent upon the presence of a battery to be retained.
   b. The controller shall have an internal velocity pressure sensor.
   c. The CVAV shall provide LED indication of communication and controller performance to the technician, without cover removal.
   d. CVAV's shall have mixture of I/O including dry contact digital inputs, universal inputs (configurable as of 4-20 mA, 0-10 VDC, thermistor and RTD in the range 0 to 350,000 ohm), universal outputs (4-20mA, 0-10 VDC, or digital), and digital outputs (24 VAC TRIAC).
   e. The controller shall provide an integrated actuator option.

2.05 OTHER CONTROL SYSTEM HARDWARE

A. Wall Mount Room Temperature sensors: Each room temperature sensor shall provide the current temperature value to the digital controller, provide the capability for a software-limited occupant set point adjustment (warmer-cooler slider bar or switch) and limited operation override capability. Room Temperature Sensors are not required to include an LCD display. Room Temperature Sensors shall be 10K type 3 thermistor with a temperature range of -40 to 140 degrees F (-38 to 60 degrees C). The sensor shall be complete with a decorative cover and suitable for mounting over a standard electrical utility box. These devices shall have an accuracy of 0.5 degrees F (.024 degrees C) over the entire range.

B. Duct-mounted and Outside Air Temperature Sensors: 10K type 3 thermistor temperature sensors with an accuracy of ±; 0.2 degrees C. Outside air sensors shall include an integral sun shield. Duct-mounted sensors shall have an insertion measuring probe of at least six (6) inches, but not less than 1/3 the duct width, with a temperature range of -40 to 160 degrees F(-38 to 71 degrees C) The sensor shall include a utility box and a gasket to prevent air leakage and vibration noise. For all mixed air and preheat air applications, install bendable averaging duct sensors with a minimum 8 feet (2438 mm) long sensor element. These devices shall have accuracy of 0.5 degrees F (.024 degrees C) over the entire range.

C. Humidity sensors shall be thin-film capacitive type sensor with on-board nonvolatile memory, accuracy to plus or minus three percent (3%) at 0 to 90% RH, 12 - 30 VDC input voltage, analog output (0 - 10 VDC or 4 - 20mA output). Operating range shall be 0 to 100% RH and 32 to 140 degrees F (0 to 60 degrees C). Sensors shall be selected for wall, duct or outdoor type installation as appropriate.

D. Carbon Dioxide Sensors (CO2): Sensors shall utilize Non-dispersive infrared technology (N.D.I.R.), repeatable to plus or minus 20 PPM. Sensor range shall be 0 - 2000 PPM. Accuracy shall be plus or minus five percent (5%) or 75 PPM, whichever is greater. Response shall be less than one minute. Input voltage shall be 20 to 30 VAC or DC. Output shall be 0 - 10 VDC. Sensor shall be wall or duct mounted type, as appropriate for the application, housed in a high impact plastic enclosure.

E. Current Sensitive Switches: Solid state, split core current switch that operates when the current level (sensed by the internal current transformer) exceeds the adjustable trip point. Current switch to include an integral LED for indication of trip condition and a current level below trip set point.

F. Differential Analog (duct) Static Pressure Transmitters Provide a pressure transmitter with integral capacitance type sensing and solid-state circuitry. Accuracy shall be plus or minus 1% of full range; range shall be selected for the specific application. Provide zero and span adjustment capability. Device shall have integral static pickup tube.

G. Differential Air Pressure Switches: Provide SPDT type, UL-approved, and selected for the appropriate operating range where applied. Switches shall have adjustable set points and barbed pressure tips.

H. Water Flow Switches: Provide a SPST type contact switch with bronze paddle blade, sized for the actual pipe size at the location. If installed outdoors, provide a NEMA-4 enclosure. Flow switch shall be UL listed.

I. Temperature Control Panels: Furnish temperature control panels of code gauge steel with locking doors for mounting all devices as shown. All electrical devices within a control panel shall be factory wired. Control panel shall be assembled by the BMS in a UL-Certified 508A panel shop. A complete set of ' as-built' control drawings (relating to the controls within that panel) shall be furnished within each control panel.

J. Pipe and Duct Temperature sensing elements: 10,000-ohm thermistor temperature sensors with and accuracy of ±1%. Their range shall be -5 to 250 degrees F (-20 to 121 degrees C). Limited range sensors shall be acceptable provided they are capable of sensing the range expected for the point at the specified accuracy. Thermal wells with heat conductive gel shall be included.

K. Low Air Temperature Sensors: Provide SPST type switch, with 15 to 55 degrees F (-9 to 13 degrees C), range, vapor-charged temperature sensor. Honeywell model L482A, or approved equivalent.

L. Relays: Start/stop relay model shall provide either momentary or maintained switching action as appropriate for the motor being started. All relays shall be plugged in, interchangeable, mounted on a sub base and wired to numbered terminals strips. Relays installed in panels shall all be DPDT with indicating lamp. Relays installed outside of controlled devices shall be enclosed in a NEMA enclosure suitable for the location. Relays shall be labeled with UR symbol. RIB-style relays are acceptable for remote enable/disable.

M. Emergency Stop Switches: Provide toggle-type switch with normally-closed contact. Switch shall be labeled "AIR HANDLER EMERGENCY SHUTOFF, NORMAL - OFF.".

N. Transducers: Differential pressure transducers shall be electronic with a 4-20 mA output signal compatible to the Direct Digital Controller. Wetted parts shall be stainless steel. Unit shall be designed to operate in the pressure ranges involved.

O. Control Power Transformers: Provide step-down transformers for all DDC controllers and devices as required. Transformers shall be sized for the load, but shall be sized for 50 watts, minimum. Transformers shall be UL listed Class 2 type, for 120 VAC/24 VAC operation.

P. Line voltage protection: All DDC system control panels that are powered by 120 VAC circuits shall be provided with surge protection. This protection is in addition to any internal protection provided by the manufacturer. The protection shall meet UL, ULC 1449, IEEE C62.41B. A grounding conductor, (minimum 12 AWG), shall be brought to each control panel.

2.06 BAS SERVER & WEB BROWSER GUI - SYSTEM OVERVIEW

A. The BAS Contractor shall provide system software based on server/thin-client architecture, designed around the open standards of web technology. The BAS server shall communicate using Ethernet and TCP. Server shall be accessed using a web browser over Owner intranet and remotely over the Internet.

B. The intent of the thin-client architecture is to provide the operator(s) complete access to the BAS system via a web browser. The thin-client web browser Graphical User Interface (GUI) shall be browser and operating system agnostic, meaning it will support HTML5 enabled browsers without requiring proprietary operator interface and configuration programs or browser plug-ins. Microsoft, Firefox, and Chrome browsers (current released versions), and Windows as well as non-Window operating systems.

C. The BAS server software shall support at least the following server platforms (Windows 7, 8.1, Server 12). The BAS server software shall be developed and tested by the manufacturer of the system stand-alone controllers and network controllers/routers.

D. The web browser GUI shall provide a completely interactive user interface and shall provide a HTML5 experience that supports the following features as a minimum:
   1. Trending.
   2. Scheduling.
   3. Electrical demand limiting.
   4. Duty Cycling.
   5. Downloading Memory to field devices.
   6. Real time 'live' Graphic Programs.
   7. Tree Navigation.
   8. Parameter change of properties.
   9. Set point adjustments.
   10. Alarm / event information.
   11. Configuration of operators.
   12. Execution of global commands.
   13. Add, delete, and modify graphics and displayed data.

E. Software Components: All software shall be the most current version. All software components of the BAS system software shall be provided and installed as part of this project. BAS software components shall include:
   1. Server Software, Database and Web Browser Graphical User Interface.
   2. Software Maintenance Agreement license as specified. Labor to implement future upgrades is not included.
   3. Embedded System Configuration Utilities for future modifications to the system and controllers.
   4. Embedded Graphical Programming Tools.
   5. Embedded Application Software.

F. BAS Server Database: The BAS server software shall utilize a Java Database Connectivity (JDBC) compatible database such as: MS SQL 8.0, Oracle 8i or IBM DB2. BAS systems written to Non - Standard and/or Proprietary databases are NOT acceptable.

G. Thin Client - Web Browser Based: The GUI shall be thin client or browser based and shall meet the following criteria:
   1. Web Browser's for PC's: Only the current released browser (Explorer/Firefox/Chrome) will be required as the GUI and a valid connection to the server network. No installation of any custom software shall be required on the operator's GUI workstation/client. Connection shall be over an intranet or the Internet.
   2. Secure Socket Layers: Communication between the Web Browser GUI and BAS server shall offer encryption using 128-bit encryption technology within Secure Socket Layers (SSL). Communication protocol shall be Hyper-Text Transfer Protocol (HTTP).

2.07 WEB BROWSER GRAPHICAL USER INTERFACE

A. Web Browser Navigation: The Thin Client web browser GUI shall provide a comprehensive user interface. Using a collection of web pages, it shall be constructed to "feel" like a single application, and provide a complete and intuitive mouse/menu driven operator interface. It shall be possible to navigate through the system using a web browser to accomplish requirements of this specification. The Web Browser GUI shall (as a minimum) provide for navigation, and for display of animated graphics, schedules, alarms/events, live graphic programs, active graphic set point controls, configuration menus for operator access, reports and reporting actions for events.

B. Login: On launching the web browser and selecting the appropriate domain name or IP address, the operator shall be presented with a login page that will require a login name and strong password. Navigation in the system shall be dependent on the operator's role-based application control privileges.

C. Navigation: Navigation through the GUI shall be accomplished by clicking on the appropriate level of a navigation tree (consisting of an expandable and collapsible tree control like Microsoft's Explorer program) and/or by selecting dynamic links to other system graphics. Both the navigation tree and action pane shall be displayed simultaneously, enabling the operator to select a specific system or equipment and view the corresponding graphic. The navigation tree shall as a minimum provide the following views: Geographic, Network, Groups and Configuration.
   1. Geographic View shall display a logical geographic hierarchy of the system including: cities, sites, buildings, building systems, floors, equipment and objects.
   2. Groups View shall display Scheduled Groups and custom reports.
   3. Configuration View shall display all the configuration categories (Operators, Schedule, Event, Reporting and Roles).

D. Action Pane: The Action Pane shall provide several functional views for each subsystem specified. A functional view shall be accessed by clicking on the corresponding button:
   1. Graphics: Using graphical format suitable for display in a web browser, graphics shall include aerial building/campus views, color building floor-plans, equipment drawings, active graphic set point controls, web content and other valid HTML elements. The data on each graphic page shall automatically refresh.
   2. Dashboards: User customizable data using drag and drop HTML5 elements. Shall include Web Charts, Gauges, and other custom developed widgets for web browser. User shall have ability to save custom dashboards.
   3. Search: User shall have multiple options for searching data based upon Tags. Associated equipment, real time data, Properties, and Trends shall be available in result.
   4. Properties: Shall include graphic controls and text for the following: Locking or overriding objects, demand strategies, and any other valid data required for setup. Changes made to the properties pages shall require the operator to depress an 'accept/cancel' button.
   5. Schedules: Shall be used to create, modify/edit and view schedules based on the systems hierarchy (using the navigation tree).
   6. Alarms: Shall be used to view alarm information geographically (using the navigation tree), acknowledge alarms, sort alarms by category, actions and verify reporting actions.
   7. Charting: Shall be used to display associated trend and historical data, modify colors, date range, axis and scaling. User shall have ability to create HTML charts through web browser without utilizing chart builder. User shall be able to drag and drop single or multiple data points, including schedules, and apply status colors for analysis.

8. Logic - Live Graphic Programs: Shall be used to display' live' graphic programs of the control algorithm, (micro block programming) for the mechanical/electrical system selected in the navigation tree.
9. Other actions such as Print, Help, Command, and Logout shall be available via a drop-down window.

E. High Resolution Color Graphics: The Web Browser GUI shall make extensive use of color in the graphic pane to communicate information related to set points and comfort. Animated .gifs, .png, or .jpg, vector scalable, active set point graphic controls shall be used to enhance usability. Graphics tools used to create Web Browser graphics shall be non-proprietary and conform to the following basic criteria:
   1. Display Size: The GUI workstation software shall graphically display in a minimum of 1024 by 768 pixels 24 bit True Color.
   2. General Graphic: General area maps shall show locations of controlled buildings in relation to local landmarks.
   3. Color Floor Plans: Floor plan graphics shall show heating and cooling zones throughout the buildings in a range of colors, as selected by Owner.
   4. Mechanical Components: Mechanical system graphics shall show the type of mechanical system components serving any zone through the use of a pictorial representation of components. Selected I/O points being controlled or monitored for each piece of equipment shall be displayed with the appropriate engineering units. Animation shall be used for rotation or moving mechanical components to enhance usability. .
   5. Minimum System Color Graphics: Color graphics shall be selected and displayed via a web browser for the following:
      a. Each piece of equipment monitored or controlled including each terminal unit.
      b. Each building.
      c. Each floor and zone controlled.

F. Hierarchical Schedules: Utilizing the Navigation Tree displayed in the web browser GUI, an operator (with proper access credentials) shall be able to define a Normal, Holiday or Override schedule for an individual piece of equipment or room, or choose to apply a hierarchical schedule to the entire system, site or floor area. For example, Independence Day ' Holiday' for every level in the system would be created by clicking at the top of the geographic hierarchy defined in the Navigation Tree. No further operator intervention would be required and every control module in the system with would be automatically downloaded with the ' Independence Day' Holiday. All schedules that affect the system/area/equipment highlighted in the Navigation Tree shall be shown in a summary schedule table and graph.
   1. Schedules: Schedules shall comply with the LonWorks and BACnet standards, (Schedule Object, Calendar Object, Weekly Schedule property and Exception Schedule property) and shall allow events to be scheduled based on:
      a. Types of schedule shall be Normal, Holiday or Override.
      b. A specific date.
      c. A range of dates.
      d. Any combination of Month of Year (1-12, any), Week of Month (1-5, last, any), Day of Week (M-Sun, Any).
      e. Wildcard (example, allow combinations like second Tuesday of every month).
   2. Schedule Categories: The system shall allow operators to define and edit scheduling categories (different types of "things" to be scheduled; for example, lighting, HVAC occupancy, etc.). The categories shall include: name, description, icon (to display in the hierarchy tree when icon option is selected) and type of value to be scheduled.
   3. Schedule Groups: In addition to hierarchical scheduling, operators shall be able to define functional Schedule Groups, comprised of an arbitrary group of areas/rooms/equipment scattered throughout the facility and site. For example, the operator shall be able to define an ' individual tenant' group - who may occupy different areas within a building or buildings. Schedules applied to the ' tenant group' shall automatically be downloaded to control modules affecting spaces occupied by the ' tenant group'.
   4. Intelligent Scheduling: The control system shall be intelligent enough to automatically turn on any supporting equipment needed to control the environment in an occupied space. If the

operator schedules an individual room in a VAV system for occupancy, for example, the control logic shall automatically turn on the VAV air handling unit, chiller, boiler and/or any other equipment required to maintain the specified comfort and environmental conditions within the room.

5. Partial Day Exceptions: Schedule events shall be able to accommodate a time range specified by the operator (ex: board meeting from 6 pm to 9 pm overrides Normal schedule for conference room).
6. Schedule Summary Graph: The schedule summary graph shall clearly show Normal versus Holiday versus Override Schedules and the net operating schedule that results from all contributing schedules. Note: In case of priority conflict between schedules at the different geographic hierarchy, the schedule for the more detailed geographic level shall apply.

G. Alarms: Alarms associated with a specific system, area, or equipment selected in the Navigation Tree, shall be displayed in the Action Pane by selecting an ' Alarms' view. Alarms, and reporting actions shall have the following capabilities:
   1. Alarms View: Each Alarm shall display an Alarms Category (using a different icon for each alarm category), date/time of occurrence, current status, alarm report and a bold URL link to the associated graphic for the selected system, area or equipment. The URL link shall indicate the system location, address and other pertinent information. An operator shall easily be able to sort events, edit event templates and categories, acknowledge or force a return to normal in the Events View as specified in this section.
   2. Alarm Categories: The operator shall be able to create, edit or delete alarm categories such as HVAC, Maintenance, Fire, or Generator. An icon shall be associated with each alarm category, enabling the operator to easily sort through multiple events displayed.
   3. Alarm Templates: Alarm template shall define different types of alarms and their associated properties. As a minimum, properties shall include a reference name, verbose description, severity of alarm, acknowledgement requirements, and high/low limit and out of range information.
   4. Alarm Areas: Alarm Areas enable an operator to assign specific Alarm Categories to specific Alarm Reporting Actions. For example, it shall be possible for an operator to assign all HVAC Maintenance Alarm on the 1st floor of a building to email the technician responsible for maintenance. The Navigation Tree shall be used to setup Alarm Areas in the Graphic Pane.
   5. Alarm Time/Date Stamp: All events shall be generated at the DDC control module level and comprise the Time/Date Stamp using the standalone control module time and date.
   6. Alarm Configuration: Operators shall be able to define the type of Alarm generated per object. A ' network' view of the Navigation Tree shall expose all objects and their respective Alarm Configuration. Configuration shall include assignment of Alarm, type of Acknowledgement and notification for return to normal or fault status.
   7. Alarm Summary Counter: The view of Alarm in the Graphic Pane shall provide a numeric counter, indicating how many Alarms are active (in alarm), require acknowledgement and total number of Alarms in the BAS Server database.
   8. Alarm Auto-Deletion: Alarms that are acknowledged and closed shall be auto-deleted from the database and archived to a text file after an operator defined period.
   9. Alarm Reporting Actions: Alarm Reporting Actions specified shall be automatically launched (under certain conditions) after an Alarm is received by the BAS server software. Operators shall be able to easily define these Reporting Actions using the Navigation Tree and Graphic Pane through the web browser GUI. Reporting Actions shall be as follows:
      a. Print: Alarm information shall be printed to the BAS server's PC or a networked printer.
      b. Email: Email shall be sent via any POP3-compatible e-mail server (most Internet Service Providers use POP3). Email messages may be copied to several email accounts. Note: Email reporting action shall also be used to support alphanumeric paging services, where email servers support pagers.
      c. File Write: The ASCII File write reporting action shall enable the operator to append operator defined alarm information to any alarm through a text file. The alarm information that is written to the file shall be completely definable by the operator. The operator may enter text or attach other data point information (such as AHU discharge temperature and fan condition upon a high room temperature alarm).

d. Write Property: The write property reporting action updates a property value in a hardware module.
e. SNMP: The Simple Network Management Protocol (SNMP) reporting action sends an SNMP trap to a network in response to receiving an alarm.
f. Run External Program: The Run External Program reporting action launches specified program in response to an event.

H. Trends: As system is engineered, all hard-wired points shall be enabled to trend. Trends shall both be displayed and user configurable through the Web Browser GUI. Trends shall comprise analog, digital or calculated points simultaneously. A trend log's properties shall be editable using the Navigation Tree and Graphic Pane.
1. Viewing Trends: The operator shall have the ability to view trends by using the Navigation Tree and selecting a Trends button in the Graphic Pane. The system shall allow y- and x-axis maximum ranges to be specified and shall be able to simultaneously graphically display multiple trends per graph.
2. Local Trends: Trend data shall be collected locally by Multi-Equipment/Single Equipment general-purpose controllers, and periodically uploaded to the BAS server if historical trending is enabled for the object. Trend data, including run time hours and start time date shall be retained in non-volatile module memory. Systems that rely on a gateway/router to run trends are NOT acceptable.
3. Resolution. Sample intervals shall be as small as one second. Each trended point will have the ability to be trended at a different trend interval. When multiple points are selected for displays that have different trend intervals, the system will automatically scale the axis.
4. Dynamic Update. Trends shall be able to dynamically update at operator-defined intervals.
5. Zoom/Pan. It shall be possible to zoom-in on a particular section of a trend for more detailed examination and ' pan through' historical data by simply scrolling the mouse.
6. Numeric Value Display. It shall be possible to pick any sample on a trend and have the numerical value displayed.
7. Copy/Paste. The operator shall have the ability to pan through a historical trend and copy the data viewed to the clipboard using standard keystrokes (i.e. CTRL+C, CTRL+V).

I. Security Access: Systems that Security access from the web browser GUI to BAS server shall require a Login Name and Strong Password. Access to different areas of the BAS system shall be defined in terms of Role-Based Access Control privileges as specified:
1. Roles: Roles shall reflect the actual roles of different types of operators. Each role shall comprise a set of ' easily understood English language' privileges. Roles shall be defined in terms of View, Edit and Function Privileges.
a. View Privileges shall comprise: Navigation, Network, and Configuration Trees, Operators, Roles and Privileges, Alarm/Event Template and Reporting Action.
b. Edit Privileges shall comprise: Set point, Tuning and Logic, Manual Override, and Point Assignment Parameters.
c. Function Privileges shall comprise: Alarm/Event Acknowledgement, Control Module Memory Download, Upload, Schedules, Schedule Groups, Manual Commands, Print and Alarm/Event Maintenance.
2. Geographic Assignment of Roles: Roles shall be geographically assigned using a similar expandable/collapsible navigation tree. For example, it shall be possible to assign two HVAC Technicians with similar competencies (and the same operator defined HVAC Role) to different areas of the system.

2.08 GRAPHICAL PROGRAMMING

A. The system software shall include a Graphic Programming Language (GPL) for all DDC control algorithms resident in all control modules. Any system that does not use a drag and drop method of graphical icon programming shall not be accepted. All systems shall use a GPL method used to create a sequence of operations by assembling graphic microblocks that represent each of the commands or functions necessary to complete a control sequence. Microblocks represent common logical control devices used in conventional control systems, such as relays, switches, high signal selectors etc., in addition to the more complex DDC and energy management strategies such as PID loops and optimum start. Each microblock shall be interactive and contain

the programming necessary to execute the function of the device it represents.

B. Graphic programming shall be performed while on screen and using a mouse; each microblock shall be selected from a microblock library and assembled with other microblocks necessary to complete the specified sequence. Microblocks are then interconnected on screen using graphic "wires," each forming a logical connection. Once assembled, each logical grouping of microblocks and their interconnecting wires then forms a graphic function block which may be used to control any piece of equipment with a similar point configuration and sequence of operation.

C. Graphic Sequence: The clarity of the graphic sequence shall be such that the operator has the ability to verify that system programming meets the specifications, without having to learn or interpret a manufacturer's unique programming language. The graphic programming shall be self-documenting and provide the operator with an understandable and exact representation of each sequence of operation.

D. GPL Capabilities: The following is a minimum definition of the capabilities of the Graphic Programming software:
   1. Function Block (FB): Shall be a collection of points, microblocks and wires which have been connected together for the specific purpose of controlling a piece of HVAC equipment or a single mechanical system.
   2. Logical I/O: Input/Output points shall interface with the control modules in order to read various signals and/or values or to transmit signal or values to controlled devices.
   3. Microblocks: Shall be software devices that are represented graphically and may be connected together to perform a specified sequence. A library of microblocks shall be submitted with the control contractors bid.
   4. Wires: Shall be Graphical elements used to form logical connections between microblocks and between logical I/O.
   5. Reference Labels: Labels shall be similar to wires in that they are used to form logical connections between two points. Labels shall form a connection by reference instead of a visual connection, i.e. two points labeled 'A' on a drawing are logically connected even though there is no wire between them.
   6. Parameter: A parameter shall be a value that may be tied to the input of a microblock.
   7. Properties: Dialog boxes shall appear after a microblock has been inserted which has editable parameters associated with it. Default parameter dialog boxes shall contain various editable and non-editable fields, and shall contain 'push buttons' for the purpose of selecting default parameter settings.
   8. Icon: An icon shall be graphic representation of a software program. Each graphic microblock has an icon associated with it that graphically describes its function.
   9. Menu-bar Icon: Shall be an icon that is displayed on the menu bar on the GPL screen, which represents its associated graphic microblock.
   10. Live Graphical Programs: The Graphic Programming software shall support a ' live' mode, where all input/output data, calculated data and set points shall be displayed in a ' live' real-time mode.

2.09 BACNET NETWORK MANAGEMENT

A. Systems requiring the use of third-party BACnet network management tools shall not be accepted.

B. Network management shall include the following services: device identification, device installation, device configuration, device diagnostics, device maintenance and network variable binding.

C. The Network configuration tool shall also provide diagnostics to identify devices on the network, to reset devices and to view health and status counters within devices.

D. These tools shall provide the ability to "learn" an existing BACnet network, regardless of what network management tool(s) were used to install the existing network, so that existing BACnet devices and newly added devices are part of a single network management database.

E. The network management database shall be resident in the Network Area Controller (NAC), ensuring that anyone with proper authorization has access to the network management database at all times. Systems employing network management databases that are not resident, at all times and within the control system shall not be accepted.

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 GENERAL

A. Install system and materials in accordance with manufacturer's instructions, and as detailed on the project drawing set.

B. Line and low voltage electrical connections to control equipment shown specified or shown on the control diagrams shall be furnished and installed by the Control System Contractor in accordance with these specifications.

C. Equipment furnished by the Mechanical Contractor that is normally wired before installation shall be furnished completely wired. Control wiring normally performed in the field will be furnished and installed by the Control System Contractor.

D. All control devices mounted on the face of control panels shall be clearly identified as to function and system served with permanently engraved phenolic labels.

3.04 WIRING

A. All control wiring to the control panels shall be the responsibility of the Control System Contractor. 120 VAC wiring to control panels shall be provided by Electrical Contractor. 120 VAC surge protector to be provided and installed by Control System Contractor.

B. All wiring shall be in accordance with the Project Electrical Specifications (Division 26), the National Electrical Code and any applicable local codes.

C. Cable that is UL listed for installation in a return air Plenum may be used where located in concealed, accessible locations. Provide raceway where exposed or where inaccessible.

D. Where conduit is not installed in raceway, neatly group and support with J-hooks, cable tray, or bridle rings. Zip-ties will NOT be an acceptable support method. Provide independent supports; do not hang or drape cable from/over other trades' Work.

E. All conduit installed by controls contractor shall be blue.

F. Excess wire shall not be looped or coiled in the controller cabinet.

G. Incorporate electrical noise suppression techniques in relay control circuits.

H. There shall be no drilling on the controller cabinet after the controls are mounted inside.

I. Careful stripping of wire while inside the cabinet is required to ensure that no wire strand fragments land on circuit boards.

J. Use manufacturer-specified wire for all network connections. LON network cable jacket shall be blue. Network cable for integration of RS-485 BACnet or Modbus devices shall have an orange jacket.

K. All Input/Output cable shall have a yellow jacket. All output wiring shall be 18 gauge, minimum. All input wiring shall be 22 gauge minimum.

L. Use approved optical isolation and lightning protection when penetrating building envelope.

M. Read installation instructions carefully. Any unavoidable deviations shall be approved by owner's rep prior to installation.

3.05 ACCEPTANCE TESTING

A. Upon completion of the installation, the Control System Contractor shall load all system software and start-up the system. The Control System Contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to insure that the system is functioning in full accordance with these specifications.

B. The Control System Contractor shall perform tests to verify proper performance of components, routines and points. Repeat tests until proper performance results are achieved. This testing shall include a point-by-point log to validate 100% of the input and output points of the DDC system operation.

C. System Acceptance: Satisfactory completion is when the Control System Contractor has performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

3.06 OPERATOR TRAINING

A. During system commissioning and at such time acceptable performance of the Control System hardware and software has been established, the Control System Contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction shall be done during normal working hours and shall be performed by a competent representative familiar with the system hardware, software and accessories.

B. The Control System Contractor shall provide forty (40) total hours of training in two 4-hour sessions for system orientation, product maintenance and troubleshooting, programming and engineering. These classes are to be spread out during the 1st year warranty period. The first class starting after final commissioning and the second class is to be in the last month of 1-year warranty period.

3.07 WARRANTY PERIOD SERVICES

A. Equipment, materials and workmanship incorporated into the work shall be warranted for a period of one year from the time of system acceptance.

B. Within this period, upon notice by the Owner, any defects in the BMS due to faulty materials, methods of installation or workmanship shall be promptly repaired or replaced by the Control System Contractor at no expense to the Owner.

C. Maintenance of Computer Software Programs: The Control System Contractor shall maintain all software during the standard first year warranty period. In addition, all factory or sub-vendor upgrades to software during the first year warranty period shall be added to the systems, when they become available, at no additional cost. In addition to first year standard warranty, software provided by Control System Contractor shall come with a Software Maintenance Agreement as defined in section 1.3. All NAC and BAS Servers are included in this coverage.

D. Maintenance of Control Hardware: The Control System Contractor shall inspect, repair, replace, adjust, and calibrate, as required, the controllers, control devices and associated peripheral units during the warranty period. The Control System Contractor shall then furnish a report describing the status of the equipment, problem areas (if any) noticed during service work, and description of the corrective actions taken. The report shall clearly certify that all hardware is functioning correctly.

E. Service Period: Calls for service by the Owner shall be honored within 24 hours and are not to be considered as part of routine maintenance.

F. Service Documentation: A copy of the service report associated with each owner-initiated service call shall be provided to the owner.

3.08 WARRANTY ACCESS

A. The Owner shall grant to the Control System Contractor reasonable access to the BMS during the warranty period. Remote access to the BMS (for the purpose of diagnostics and troubleshooting, via the Internet, during the warranty period) will be allowed.

3.09 OPERATION & MAINTENANCE MANUALS

A. See Division 1 for requirements. O&M manuals shall include the following elements, as a minimum:

B. As a minimum, shop drawings shall contain:
   1. A table of contents.
   2. Equipment schedules.
   3. Valve and damper schedules when applicable. Valve schedules shall include GPM, valve size, calculated Cv, valve Cv, pressure drop, close-off pressure, configuration (2-way or 3-way), and valve actuator data.
   4. VAV box schedule. VAV box schedule shall include box size, K-Factor, and flow setpoints.
   5. As-built schematic diagrams of all controlled equipment.
   6. Final sequences of operation for all controlled equipment.
   7. As-built controller wiring diagrams, including terminal number identification for all control wiring.
   8. As-built wiring details for all field devices.
   9. As-built network architecture diagram showing a high-level overview of the installed system.
   10. As-built control system bus layout depicted on building floorplans.
   11. As-built control panel layout diagrams depicting all panel mounted components.
   12. Completed Performance Verification sheets.
   13. Completed Controller Checkout/Calibration Sheets.
   14. Manufacturer’s data sheets for all installed components.

3.10 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 23 09 01

SECTION 23 09 13.13
BAS ACTUATORS AND OPERATORS

PART 1 GENERAL

1.01 REFERENCES

A. Refer to Section 23 09 00 - References

1.02 ACRONYMS, ABBREVIATIONS AND DEFINITIONS

A. Refer to Section 23 09 00 - Acronyms, Abbreviations and Definitions

PART 2 PRODUCT

2.01 ACTUATORS

A. Manufacturers:
   1. Belimo
   2. Honeywell
   3. Johnson
   4. Siemens
   5. Schneider
   6. Or Approved Equal

B. For dampers, the actuators used shall be provided from a single manufacturer.

C. For valves, the actuators used shall be provided from a single manufacturer.

D. Actuators shall be provided from a manufacturer registered under ISO9001:2000.

E. Electronic Damper Actuators.
   1. Size for torque required for damper seal at load conditions.
   2. Coupling: V-bolt dual nut clamp with a V-shaped, toothed cradle.
   3. Mounting: Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required.
   4. Overload Protection: Electronic overload or digital rotation-sensing circuitry without the use of end switches to prevent any damage to the actuator during a stall condition.
   5. Fail-Safe Operation: Mechanical, spring-return mechanism. Internal chemical storage systems, capacitors, or other internal non-mechanical forms of fail-safe operation are not acceptable.
   6. Power Requirements (Two-Position Spring Return): 24 or 120 VAC as required.
   7. Power Requirements (Proportional): Maximum 10 VA at 24 VAC or 8 W at 24 VDC.
   8. Temperature Rating: -22 to +122°F (-30 to +50°C)
   9. Housing:
      a. Minimum requirement NEMA type 2 / IP54 mounted in any orientation.
      b. In outdoor locations, provide NEMA 3R
   10. Agency Listing: ISO 9001, UL, UL(C) and CSA C22.2 No. 24-93.

F. Electronic Valve Actuators.
   1. Size for torque required for valve close off at 150% of total system (head) pressure for 2-way valves; and 100% of pressure differential across the valve or 100% of total system (pump) head differential pressure for 3-way valves.
   2. Coupling: Directly couple end mount to stem, shaft, or ISO-style direct-coupled mounting pad.
   3. Mounting: Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required.
   4. Overload Protection: Electronic overload or digital rotation-sensing circuitry without the use of end switches to deactivate the actuator at the end of rotation.
   5. Fail-Safe Operation: Mechanical, spring-return mechanism. Internal chemical storage systems, capacitors, or other internal non-mechanical forms of fail-safe operation are not acceptable.
   6. Power Requirements: Maximum 10 VA at 24 VAC or 8 W at 24 VDC.
   7. Maximum 1 VA at 24 VAC or 1 W at 24 VDC.

8. Temperature Rating: -22 to +122°F (-30 to +50°C)
9. Housing:
    a. Minimum requirement NEMA type 2 / IP54 mounted in any orientation.
    b. In outdoor locations, provide NEMA 3R
10. Agency Listing: ISO 9001, UL, UL(C) and CSA C22.2 No. 24-93.

PART 3 EXECUTION

3.01 ACTUATORS

A. General: Mount actuators and adapters according to manufacturer's recommendations.

B. Electric and Electronic Damper Actuators.
1. Mount actuators directly on damper shaft or jackshaft unless shown as a linkage installation.
2. Link actuators according to manufacturer's recommendations.
3. For low-leakage dampers with seals, mount actuator with a minimum 5° travel available for damper seal tightening.
4. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately the 5° open position, manually close the damper, and then tighten linkage.
5. Check operation of damper-actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
6. Provide necessary mounting hardware and linkages for actuator installation.

C. Valve Actuators.
1. Connect actuators to valves with adapters approved by actuator manufacturer.

END OF SECTION 23 09 13.13

SECTION 23 09 13.33
BAS CONTROL VALVES

PART 1 GENERAL

1.01 REFERENCES

A. Refer to Section 23 09 00 - References

1.02 ACRONYMS, ABBREVIATIONS AND DEFINITIONS

A. Refer to Section 23 09 00 - Acronyms, Abbreviations and Definitions

PART 2 PRODUCT

2.01 VALVES

A. Acceptable Manufacturers:
   1. Belimo
   2. Bell & Gossett
   3. Danfoss
   4. Griswold
   5. Siemens
   6. Or Approved Equal

B. Ball-style body automatic control valves shall adhere to the following:
   1. NPS 4 and Smaller: Nickel-plated forged brass body rated at no less than 400 psi, stainless steel ball and blowout proof stem, NPT female end fittings, with a dual EPDM O-ring packing design, fiberglass reinforced Teflon seats, and a Tefzel flow characterizing disc.
   2. Sizing:
      a. Two-Position: Line size or size using a pressure differential of 1 psi.
      b. 2-way Modulating: 5 psig or twice the load pressure drop, whichever is greater.
      c. 3-way Modulating: Twice the load pressure drop, but not more than 5 psig.
   3. Close-off Pressure Rating: 100 psi. [NPS 3/4” and Smaller for Terminal Units: 200 psi.]
   4. The actuator shall be the same manufacturer as the valve, integrally mounted to the valve at the factory with a single screw on a four-way DIN mounting-base.
   5. All control ball valves shall feature characterized flow guides when used for modulating applications.

PART 3 EXECUTION

3.01 APPLICATIONS

A. Hydronic control valves 6" and smaller shall be ball-style.

B. All VAV and other terminal unit control valve actuators shall be fully modulating and controlled by 0-10V or 4-20mA analog signal. Using floating type actuators with dual digital output for control will NOT be acceptable.

3.02 CO-ORDINATION

A. Coordinate delivery of control valves to site.

B. Clearly tag and mark valves for their purpose and location.

C. Supervise Mechanical Contractor in the installation of the control valves ensuring proper valve(s) are located and installed in proper location(s)

END OF SECTION 23 09 13.33

SECTION 23 09 13.43
BAS CONTROL DAMPERS

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ANSI/AMCA Standard 500-D, Laboratory Methods of Testing Dampers for Rating.

1.02 ACRONYMS, ABBREVIATIONS AND DEFINITIONS

A. Refer to Section 23 09 00 - Acronyms, Abbreviations and Definitions

1.03 QUALITY ASSURANCE

A. All dampers shall be certified to bear the AMCA Certified Ratings Program seal for Air Performance, Efficiency, and Air Leakage.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's product data.
   1. Include leakage, velocity, pressure drop, maximum pressure data and energy efficiency performance.
   2. Indicate materials, construction, and dimensions.
   3. Include pressure drop data for all damper sizes in accordance with AMCA 500-D test figures 5.2 (Ducted Inlet, Free Outlet), 5.3 (Ducted Inlet, Ducted Outlet) and 5.5 (Free Inlet, Free Outlet).
   4. Include a copy of Installation Instructions.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer, material, and location of installation.

B. Storage: Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer's instructions.

C. Handling: Handle and lift dampers in accordance with manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage.

PART 2 PRODUCT

2.01 AUTOMATIC CONTROL DAMPERS

A. Manufacturers:
   1. Tamco
   2. Ruskin
   3. Johnson
   4. Greenheck
   5. Nailor
   6. Or Approved Equal

B. Dampers shall be minimum leakage type to conserve energy and the temperature control manufacturer shall submit leakage data for all control dampers with the temperature control submittal.

C. Damper leakage ratings shall be certified in accordance with AMCA Standard 500-D.

D. Provide any automatic control dampers not specified to be integral with other equipment.

2.02 RECTANGULAR LOW LEAKAGE CONTROL DAMPER

A. Dampers shall have a maximum leakage of Class 1 @ 4 in. wg or Class 1A @ 1 in. wg as defined by AMCA (Leakage class 1 is defined as 8 cfm/ sq. ft. @ 4 in. wg and class 1A is defined as 3 cfm/ sq. ft. @ 1 in. wg. at -40°F).

B. Dampers shall meet or exceed the IECC (International Energy Conservation Code) requirements for damper leakage ratings of 3 cfm/ sq. ft. @ 1 in. wg or 8 cfm/sq. ft. @ 4in. wg or less when integral to the building envelope.

C. Dampers shall have a maximum differential pressure rating of 6 in. wg.

D. Dampers shall have a maximum velocity rating of 6000 fpm.

E. The Damper manufacturer's submittal data shall certify that all pressure drop data is licensed in accordance with the AMCA Certified Ratings Program for Test Figures 5.2, 5.3, and 5.5. Damper air performance data shall be developed in accordance with the latest edition of AMCA Standard 500-D. Dampers shall be labeled with the AMCA Air Performance Seal. AMCA certified pressure drop for a 24 in. wide x 24 in. high damper shall not exceed 0.06 in. wg when subjected to an airflow velocity of 1500 fpm according to AMCA Test Figure 5.3.

F. Blade Action:Opposed

G. Frame:
   1. Damper frame shall be 16 ga. galvanized steel formed into a 5 in. x 1 in. structural hat channel. Top and bottom frame members on dampers less than 17 in. high shall be low profile design to maximize the free area of these smaller dampers. Frame shall be 4-piece construction with 1 ½ in. (minimum) integral overlapping gusset reinforcements in each corner to assure square corners and provide maximum resistance to racking.
   2. Blades:
      a. Damper blades shall be heavy gauge extruded aluminum airfoil shape with metal blade to blade overlap. Each blade shall be symmetrical relative to its axle pivot point, presenting identical performance characteristics with air flowing in either direction through the damper. Provide symmetrical blades of varying size as required to completely fill the damper opening. Blade orientation is horizontal.
   3. Seals:
      a. Shall be TEP mechanically fastened to each blade.
      b. Jamb: Flexible stainless steel compression type.
   4. Blade Stops:
      a. Dampers of whole inch height increments shall not require blade stops. When required, individual blade stops shall occupy no more than ½ in. of the damper opening to provide maximum free area and minimal pressure loss.
   5. Linkage: Plated steel.
   6. Axles: Minimum ½ in. dia. Plated steel
   7. Bearings:
      a. Axle bearings shall be synthetic (acetal) sleeve rotating in polished extruded holes in the damper frame.
   8. Finish: Mill galvanized finish

2.03 ROUND LOW LEAKAGE CONTROL DAMPER

A. Dampers shall have a rating of 4 cfm /sq. ft. @ 1 in wg.

B. Dampers shall have a minimum differential pressure rating of 4 in. wg.

C. Dampers shall have a minimum velocity rating of 3000 fpm.

D. Construction:
   1. Frame and Sleeve: The damper frame and sleeve shall be of one piece design, made with 20 ga. galvanized steel and a groove for added strength.
   2. Blades: galvanized steel
   3. Blade Seals: Silicone mechanically secured to the blades.
   4. Axles: Minimum ½ in. dia., material isplated steel
   5. Bearings: Axle bearings shall be bronze.
   6. Mounting: Vertical or horizontal

PART 3 EXECUTION

3.01 INSTALLATION

A. Install dampers in accordance with manufacturer’s Installation Instructions.

B. Dampers must be accessible to allow inspection, adjustment, and replacement of components. The sheet metal contractor shall furnish any access doors or removable section of duct in ductwork or plenums required to provide this access. The mechanical contractor shall

furnish any access doors required in walls, ceilings, or other general building construction.

C. Install dampers square and free from racking.

D. The installing contractor shall provide and install bracing for multiple section assemblies to support assembly weight and to hold against system pressure.

E. Do not compress or stretch the damper frame into the duct or opening.

F. Attach multiple damper section assemblies together in accordance with manufacturer's instructions. Install support mullions as reinforcement between assemblies as required.

G. Handle dampers using the frame or sleeve. Do not lift or move dampers using blades, actuator or jackshaft.

3.02 CO-ORDINATION

A. Coordinate delivery of dampers to site.

B. Clearly tag and mark dampers for their purpose and location.

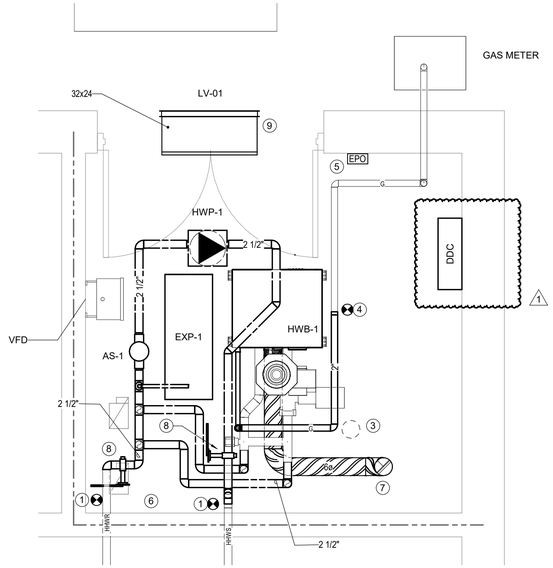
C. Supervise Mechanical Contractor in the installation of the dampers ensuring proper dampers(s) are located and installed in proper location(s)

END OF SECTION 23 09 13.43

WALL RATINGS LEGEND	
	1 HR RATED WALL
	2 HR RATED WALL
	4 HR RATED WALL

EXISTING BOILER FLUE, PIPING, PUMP, EXPANSION TANK TO BE DISCONNECTED AND REMOVED

EXISTING DOMESTIC WATER MAKEUP LINE. PROVIDE RPZ AND REPLACE EXISTING PRV. REFER TO DETAIL.



1 ENLARGED BOILER ROOM PLAN

1/2" = 1'-0"

DISCONNECT EXISTING BOILER AND BURNER FROM FUEL SOURCE, ELECTRICAL, AND PIPING CONNECTIONS AND REMOVE.HOUSEKEEPING PAD MAY BE REUSED.

KEYNOTES:

1. RECONNECT TO EXISTING HOT WATER SUPPLY AND RETURN PIPING.
2. PROVIDE VALVES FOR ISOLATION.
3. ROUTE DRAIN PIPING TO FLOOR DRAIN.
4. RECONNECT TO EXISTING GAS PIPING AND EXTEND TO EACH BOILER. PROVIDE REGULATOR AND EACH AND MAKE FINAL CONNECTION.
5. EMERGENCY STOP BUTTON FOR BOILER.
6. CONNECT TO EXISTING DOMESTIC WATER LINE AND PROVIDE RPZ AND PRV PER DETAIL.
7. ROUTE BOILER FLUE TO ROOF. REUSE EXISTING ROOF OPENING AND TERMINATE ABOVE ROOF AT CODE MINIMUM HEIGHT.
8. ISOLATION VALVE.
9. PROVIDE LOUVER FOR COMBUSTION AIR. ENLARGE EXISTING OPENING WITHIN 12" OF CEILING.

Progressive Design Collaborative, Ltd.

3101 Poplarwood Court, Suite 320
Raleigh, North Carolina 27604
919-790-9989

License# C-0183
pdcengineers.com

NORTH CAROLINA PROFESSIONAL SEAL 025020 ENGINEER STEVE W. CAMPBELL

06/27/2023

SCAMPBELL@PDCENGINEERS.COM

DRAWN BY: Author CHECKED BY: Checker

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1311 US Hwy 301 South,
Wilson, NC 27893

SCO# 22-24313-01A

ENLARGED PLANS

M3.01

RTU SEQUENCE OF OPERATIONS - DX COOLING, HOT WATER HEAT

RUN CONDITIONS - SCHEDULED:
SEQUENCES WILL BE INITIATED 30 MINUTES (ADJ.) OR MORE PRIOR TO BUILDING OCCUPANCY SCHEDULE BASED ON OPTIMIZED START PARAMETERS. THE ASSOCIATED OUTSIDE AIR DAMPER SHALL BE OPEN IN OCCUPIED MODE AND CLOSED IN MORNING WARM-UP, COOL-DOWN, OR UNOCCUPIED MODES.

THE UNIT SHALL RUN ACCORDING TO A USER DEFINABLE TIME SCHEDULE IN THE FOLLOWING MODES:
- OCCUPIED MODE: THE UNIT SHALL MAINTAIN
  - 75°F (ADJ.) COOLING SETPOINT
  - 70°F (ADJ.) HEATING SETPOINT.
- UNOCCUPIED MODE (NIGHT SETBACK): THE UNIT SHALL MAINTAIN
  - 80°F (ADJ.) COOLING SETPOINT.
  - 65°F (ADJ.) HEATING SETPOINT.

ALARMS SHALL BE PROVIDED AS FOLLOWS:
- HIGH ZONE TEMP: IF THE ZONE TEMPERATURE IS GREATER THAN THE COOLING SETPOINT BY A USER DEFINABLE AMOUNT (ADJ.).
- LOW ZONE TEMP: IF THE ZONE TEMPERATURE IS LESS THAN THE HEATING SETPOINT BY A USER DEFINABLE AMOUNT (ADJ.).

ZONE SETPOINT ADJUST:
THE OCCUPANTS SHALL BE ABLE TO ADJUST THE ZONE TEMPERATURE HEATING AND COOLING SETPOINTS AT THE ZONE SENSOR (OPERATOR SHALL HAVE ABILITY TO LOCK OUT LOCAL ADJUSTMENT). THE ZONE SENSOR MAY BE OVERRIDDEN AT THE BAS OPERATOR WORKSTATION.

ZONE OPTIMAL START:
THE UNIT SHALL USE AN OPTIMAL START ALGORITHM FOR MORNING START-UP. THIS ALGORITHM SHALL MINIMIZE THE UNOCCUPIED WARM-UP OR COOL-DOWN PERIOD WHILE STILL ACHIEVING COMFORT CONDITIONS BY THE START OF SCHEDULED OCCUPIED PERIOD.

ZONE UNOCCUPIED OVERRIDE:
A TIMED LOCAL OVERRIDE CONTROL SHALL ALLOW AN OCCUPANT TO OVERRIDE THE SCHEDULE AND PLACE THE UNIT INTO AN OCCUPIED MODE FOR AN ADJUSTABLE PERIOD OF TIME (DEFAULT, 2 HOURS, ADJ.). AT THE EXPIRATION OF THIS TIME, CONTROL OF THE UNIT SHALL AUTOMATICALLY RETURN TO THE SCHEDULE.

SUPPLY FAN:
THE SUPPLY FAN SHALL RUN ANYTIME THE UNIT IS COMMANDED TO RUN, UNLESS SHUTDOWN ON SAFETIES. TO PREVENT SHORT CYCLING, THE SUPPLY FAN SHALL HAVE A USER DEFINABLE (ADJ.) MINIMUM RUNTIME.

ALARMS SHALL BE PROVIDED AS FOLLOWS:
- SUPPLY FAN FAILURE: COMMANDED ON, BUT THE STATUS IS OFF.
- SUPPLY FAN IN HAND: COMMANDED OFF, BUT THE STATUS IS ON.
- SUPPLY FAN RUNTIME EXCEEDED: STATUS RUNTIME EXCEEDS A USER DEFINABLE LIMIT (ADJ.).
- DRAIN PAN FLOAT SWITCH HAS BEEN ACTIVATED (HARDWIRE TO FAN SHUTDOWN)

ZONE TEMPERATURE CONTROL:
ON A CALL FOR COOLING, THE DX UNIT SHALL BE ENABLED AND SHALL PROVIDE COOLING.

THE COOLING LOOP SHALL BE ENABLED WHENEVER:
- OUTSIDE AIR TEMPERATURE IS GREATER THAN 65°F (ADJ.).
- AND THE ZONE TEMPERATURE IS ABOVE COOLING SETPOINT.
- AND THE SUPPLY FAN STATUS IS ON.
- AND THE HEATING LOOP IS NOT ACTIVE.
- AND THE ECONOMIZER LOOP IS NOT ACTIVE.

ON A CALL FOR HEATING, THE UNIT SHALL ENABLE ITS HOT WATER COIL AND MODULATE THE HOT WATER CONTROL VALVE TO PROVIDE HEAT TO THE ZONE.

THE HEATING LOOP SHALL BE ENABLED WHENEVER:
- OUTSIDE AIR TEMPERATURE IS LESS THAN 60°F (ADJ.).
- AND THE ZONE TEMPERATURE IS BELOW COOLING SETPOINT.
- AND THE SUPPLY FAN STATUS IS ON.
- AND THE COOLING LOOP IS NOT ACTIVE.
- AND THE ECONOMIZER LOOP IS NOT ACTIVE.

THE UNIT SHALL RUN ACCORDING TO ITS OWN PACKAGED CONTROLS AND SAFETIES. IT SHALL STAGE ITS COMPRESSORS AND CAPACITY INTERNALLY. WHEN THE CALL FOR COOLING OR HEATING HAS BEEN SATISFIED, THE UNIT SHALL BE DISABLED. A SHORT CYCLE TIMER SHALL PREVENT THE UNIT FROM STARTING AND STOPPING MORE THAN FIVE (5) TIMES PER HOUR.

MINIMUM OUTSIDE AIR VENTILATION:
THE OUTSIDE AIR DAMPERS SHALL BE OPEN DURING BUILDING OCCUPIED HOURS. OUTSIDE AIR DAMPER SHALL BE FULLY CLOSED DURING UNOCCUPIED HOURS.

ECONOMIZER MODE:
IF THE OUTSIDE AIR TEMPERATURE IS BELOW 70 DEG F (ADJ) AND THE OUTSIDE AIR ENTHALPY IS BELOW 28 BTU/LB, ECONOMIZER MODE SHALL BE ENABLED. THE UNIT SHALL ALLOW THE OUTSIDE AIR DAMPER TO MODULATE UP TO THE 100% POSITION TO PROVIDE FREE COOLING - EITHER IN CONJUNCTION WITH MECHANICAL COOLING OR ALONE. THE RETURN AIR DAMPER SHALL MODULATE INVERSELY TO THE OUTSIDE AIR DAMPER. THE GRAVITY RELIEF DAMPER REQUIRES NO BAS CONTROL. THE UNIT SHALL EXIT ECONOMIZER MODE IF THE OUTSIDE AIR ENTHALPY RISES ABOVE 28 BTU/LB, IF THE OUTSIDE AIR TEMPERATURE DROPS BELOW 45 DEG F (ADJ), OR IF THE ECONOMIZER LOOP IS AT 100% AND THE SPACE SETPOINT IS NOT BEING MAINTAINED.

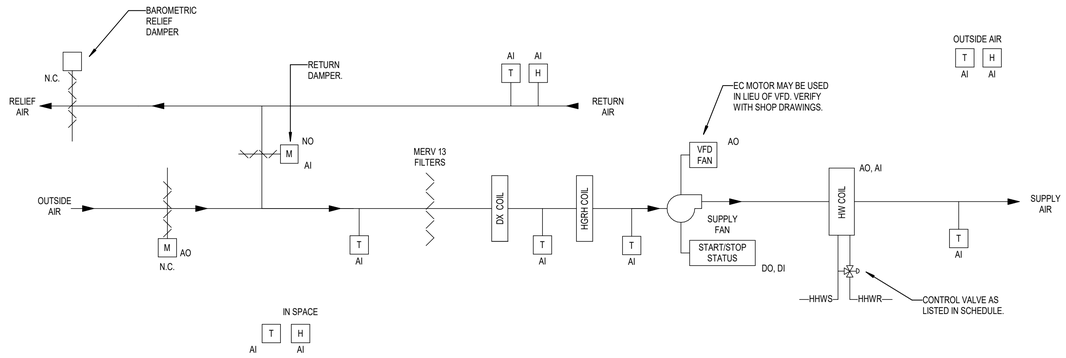
DEHUMIDIFICATION:
THE CONTROLLER SHALL MEASURE THE RETURN AIR RELATIVE HUMIDITY AND OVERRIDE THE COOLING SEQUENCE TO MAINTAIN RETURN AIR HUMIDITY AT OR BELOW 60% RH (ADJ.). DURING DEHUMIDIFICATION MODE, THE COOLING COIL DISCHARGE AIR TEMPERATURE SHALL BE RESET TO 53 DEG F (ADJ), AND THE HOT GAS REHEAT COIL SHALL MODULATE TO MAINTAIN A SUPPLY AIR SETPOINT 2°F (ADJ.) LESS THAN THE ZONE COOLING SETPOINT.

DEHUMIDIFICATION SHALL BE ENABLED WHENEVER:
- THE SUPPLY FAN STATUS IS ON.
- AND THE OUTSIDE AIR TEMPERATURE IS GREATER THAN 50 DEG F (ADJ)

RETURN AIR HUMIDITY:
THE CONTROLLER SHALL MONITOR THE RETURN AIR HUMIDITY AND USE AS REQUIRED FOR HUMIDITY CONTROL.
ALARMS SHALL BE PROVIDED AS FOLLOWS:
- HIGH RETURN AIR HUMIDITY: IF THE RETURN AIR HUMIDITY IS GREATER THAN 65% (ADJ.).

RETURN AIR TEMPERATURE:
THE CONTROLLER SHALL MONITOR THE RETURN AIR TEMPERATURE.
ALARMS SHALL BE PROVIDED AS FOLLOWS:
- HIGH RETURN AIR TEMP: IF THE RETURN AIR TEMPERATURE IS GREATER THAN 85°F (ADJ.).
- LOW RETURN AIR TEMP: IF THE RETURN AIR TEMPERATURE IS LESS THAN 55°F (ADJ.).

SUPPLY AIR TEMPERATURE:
THE CONTROLLER SHALL MONITOR THE SUPPLY AIR TEMPERATURE.
ALARMS SHALL BE PROVIDED AS FOLLOWS:
- HIGH SUPPLY AIR TEMP: IF THE SUPPLY AIR TEMPERATURE IS GREATER THAN 110°F (ADJ.).
- LOW SUPPLY AIR TEMP: IF THE SUPPLY AIR TEMPERATURE IS LESS THAN 45°F (ADJ.).



PACKAGED DX UNIT SCHEMATIC

BACNET INTEGRATION POINTS LIST

RETURN AIR TEMP	AI
SPACE TEMPERATURE	AI
SPACE HUMIDITY	AI
SPACE DEW POINT	AI
OUTDOOR AIR DAMPER COMMAND	AI
UNOCCUPIED HEATING SETPOINT	AO
UNOCCUPIED COOLING SETPOINT	AO
OCCUPIED HEATING SETPOINT	AO
OCCUPIED COOLING SETPOINT	AO
ECONOMIZER OUTDOOR AIR ENTHALPY ENABLE SETPOINT	AO
CONDENSATE OVERFLOW	DI
SUPPLT FAN STATUS	DI
ECONOMIZER STATUS	DI
ALARM INDICATOR STATUS	DI

1

Progressive Design Collaborative, Ltd.
3101 Poplarwood Court, Suite 320
Raleigh, North Carolina 27604
919-790-9989
License# C-0183
pdcengineers.com

NORTH CAROLINA PROFESSIONAL SEAL 025020 ENGINEER STEVEN W. CAMPBELL

06/27/2023

SCAMPBELL@PDCENGINEERS.COM

DRAWN BY: JAV CHECKED BY: SWC

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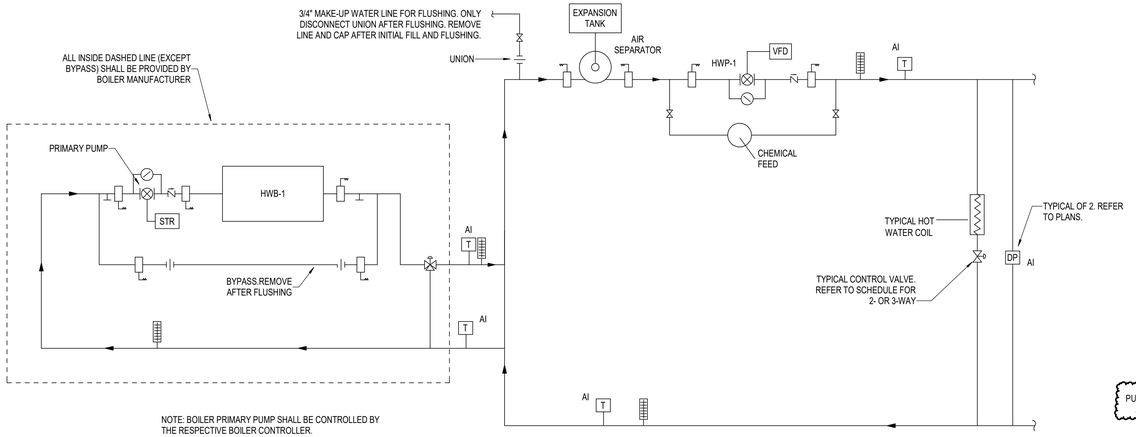
RTU WITH HW HEAT

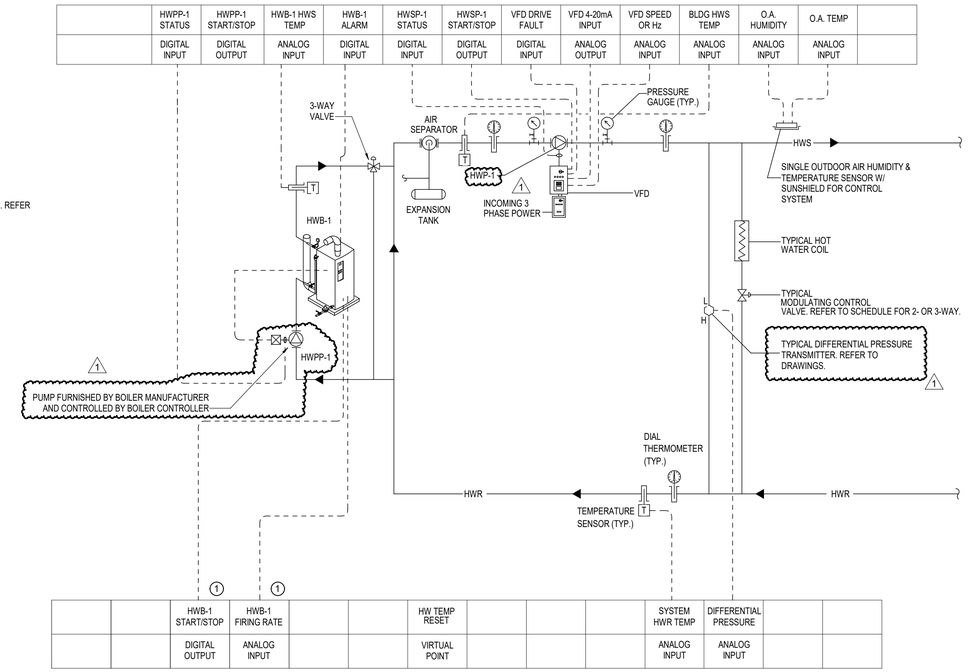
M6.01



NOTE: BOILER PRIMARY PUMP SHALL BE CONTROLLED BY THE RESPECTIVE BOILER CONTROLLER.

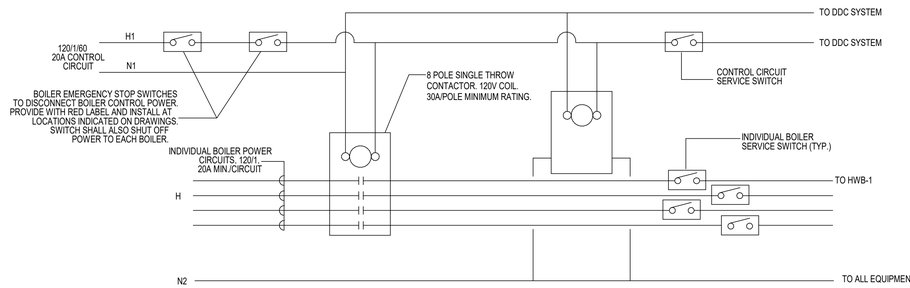
CONTRACTOR SHALL CONFIRM DURING SUBMITTAL PROCESS WHETHER MANUFACTURER REQUIRES PRIMARY PUMP ON INLET OR OUTLET SIDE OF BOILER AND COORDINATE APPROPRIATELY.

HOT WATER PIPING SCHEMATIC



BOILER PLANT SCHEMATIC

1. BOILER STAGING AND FIRING RATE SHALL BE CONTROLLED BY BOILER MANUFACTURER'S FACTORY SUPPLIED CONTROLLER. BAS SHALL ENABLE AND MONITOR THE SYSTEM ONLY.



BOILER EMERGENCY OFF - TYPICAL

HOT WATER PLANT SEQUENCE OF OPERATIONS

THE HOT WATER SYSTEM SHALL BE ENABLED TO OPERATE WHEN:

1. THE OUTSIDE AIR TEMPERATURE IS BELOW 60°F (ADJ)

THE HOT WATER SYSTEM PUMP IS A VARIABLE FLOW PUMP WITH VARIABLE FREQUENCY DRIVE. WHEN THE BOILER PLANT IS ENABLED, THE VARIABLE FREQUENCY DRIVE OF THE PUMP SHALL START AT MINIMUM SPEED AND RAMP UP TO THE MAXIMUM SPEED COMMAND ESTABLISHED BY THE TAB CONTRACTOR DURING TEST AND BALANCING..

THE BOILER START SEQUENCE, BOILER PRIMARY PUMP, 3-WAY VALVE, BOILER DISCHARGE TEMPERATURE, BOILER FIRING RATE, AND BOILER STAGING/SEQUENCING SHALL BE CONTROLLED BY THE MANUFACTURER'S BOILER CONTROL PANEL. ONCE PROOF OF FLOW IS ESTABLISHED IN THE PRIMARY LOOP, THE BOILER SHALL ENABLED THE SECONDARY PUMP.

THE HEATING WATER SUPPLY TEMPERATURE SETPOINT SHALL BE RESET FROM 180°F HEATING SUPPLY WATER TEMPERATURE AT 35°F OUTSIDE AIR TEMPERATURE OR BELOW TO 130°F HEATING SUPPLY WATER TEMPERATURE AT 60°F OUTSIDE AIR TEMPERATURE OR ABOVE. THE INITIAL FIXED SETPOINT FOR THE HEATING SUPPLY WATER TEMPERATURE SHALL BE 180°F. AN ALARM SIGNAL SHALL BE SENT TO THE BAS IF THE BOILER PLANT IS ENABLED AND THE HEATING SUPPLY WATER TEMPERATURE DROPS BELOW 120°F (ADJ) FOR 10 MINUTES (ADJ). WHEN BOILER IS SHUTDOWN, ITS ASSOCIATED PRIMARY PUMP SHALL CONTINUE TO RUN FOR 5 MINUTES AFTER THE BOILER HAS STOPPED FIRING.

THE 3-WAY VALVE AT THE BOILER SHALL MODULATE TO PREVENT WATER LESS THAN 130 DEG F FROM ENTERING THE BOILER DURING COLD STARTUP AND AT ALL TIMES.

BOILER SHALL BE DISABLED (REMOVAL OF POWER FROM THE CONTROLLER) IF THE EMERGENCY PUSH BUTTON AT THE BOILER ROOM EXIT DOOR IS PUSHED.

VARIABLE FREQUENCY DRIVE INTERFACE POINTS LIST TABLE

POINT NAME	HARDWIRED	INTERFACE COM CARD	GUI DISPLAY
VFD COMMAND START/STOP	X	X	HARDWIRED
VFD SPEED COMMAND (%)	X	X	HARDWIRED
PUMP STATUS (VIA VFD)	X	X	HARDWIRED
VFD SPEED FEEDBACK (Hz)		X	COM
PUMP ALARM (COMMAND/STATUS MISMATCH)		X	COM
VFD FAULT STATUS		X	COM
VFD FAULT RESET		X	COM
VFD POWER (KW)		X	COM
TIMESTAMP		X	COM

Progressive Design Collaborative, Ltd.
3101 Poplarwood Court, Suite 320
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License# C-0183
pdcengineers.com

NORTH CAROLINA PROFESSIONAL SEAL 025020 ENGINEER STEVE W. CAMPBELL
06/27/2023

SCAMPBELL@PDCENGINEERS.COM

DRAWN BY: Author CHECKED BY: Checker

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HW BOILER SCHEMATIC

M6.02

HOT WATER UNIT HEATER SCHEDULE (HWUH-1,2)

MODINE HC HORIZONTAL UNIT HEATER. 180°F ENTERING WATER TEMPERATURE. 45.6 MBH. 4.7 GPM. 0.6 ft PRESSURE DROP. 1120 CFM.1/12 HP. 60°F EAT, 97°F LAT. EQUIVALENTS BY REZNOR, TRANE, OR AS LISTED IN THE SPECIFICATIONS. 115V/1PH.

PUMP SCHEDULE

MARK	MANUFACTURER	SERIES	MODEL	GPM	HEAD (FT)	EFF (%)	BHP	HP	IMP (IN)	RPM	V	PH	REMARKS
HWP-1	B&G	e-90	1.25AAB	63	55	54.1	1.26	3.0	4.75	2865	208	3	

GENERAL NOTES:

A. BAS CONTRACTOR TO PROVIDE VFD FOR PUMP
1 B. PROVIDE INVERTER DUTY MOTOR WITH AEGIS SHAFT GROUNDING RING
C. PROVIDE WITH SUCTION DIFFUSER AND TRIPLE DUTY VALVE
D. EQUIVALENTS TACO, ARMSTRONG, OR AS LISTED IN SPECIFICATIONS
E. PUMPS SHALL BE VERTICAL IN-LINE TYPE.

AIR CONTROL

HOT WATER:

AS-1 - ARMSTRONG - DAS-2.5-R AIR/DIRT SEPARATOR, WITH STRAINER, BLOWDOWN VALVE, AND AUTOMATIC AIR VENT. 63 GPM, 125 PSI. ASME STAMPED. FLANGED REMOVABLE HEAD.

EXP-1 - B&G - D-60, 35 GALLON ASME BLADDER EXPANSION TANK WITH ACCEPTANCE VOLUME = 28 GALLONS. FIELD CHARGE TO 20.0 PSI. 175 PSI. PROVIDE CALIFORNIA SIGHT GLASS. ASME STAMPED. EQUIVALENTS IN THE SPECIFICATIONS. TANK SHALL BE SUITABLE FOR HORIZONTAL INSTALLATION.

HOT WATER DUCT COIL SCHEDULE

MARK	DUCT SIZE	CFM	CAPACITY (MBH)	APD IN. WG	COIL DATA						CONTROL VALVE	REMARKS
					GPM	EWT (°F)	LWT (°F)	WPD FT WG	EAT (°F)	LAT (°F)		
HWC-1	24x14	1200	50.2	0.15	5.1	180	160	2.5	56.0	94.6	3-WAY	
HWC-2	28x16	1600	67.1	0.15	6.9	180	160	2.5	55.0	93.7	3-WAY	
HWC-3	28x16	1600	67.1	0.15	6.9	180	160	2.5	55.0	93.7	3-WAY	
HWC-4	28x16	1700	67.1	0.17	6.9	180	160	1.5	57.8	94.2	2-WAY	
HWC-5	28x16	1700	67.1	0.17	6.9	180	160	1.5	57.8	94.2	2-WAY	

GENERAL NOTES:

A. PROVIDE STAINLESS STEEL COIL CASINGS.
B. PROVIDE FLANGED INLET AND OUTLET.
C. CONTROLS CONTRACTOR SHALL PROVIDE CONTROL VALVES.
D. COIL SELECTIONS INCLUDE 0.0001 FLUID FOULING FACTOR.
E. COILS ARE SELECTED FOR 12 FINS/INCH
F. BASIS OF DESIGN IS CAPITAL COIL. EQUIVALENTS BY GREENHECK AND LUVATA OR AS LISTED IN THE SPECIFICATIONS.

HOT WATER BOILER SCHEDULE

MARK	TYPE	INPUT (MBH)	OUTPUT (MBH)	EFF (%)	TURN DOWN	FLOW DATA					ELECTRICAL		WEIGHT (LBS)	REMARKS
						MIN GPM	GPM	EWT (°F)	LWT (°F)	WPD FT	V	PH		
HWB-1	COPPER FIN	750.0	630.0	84	60%	32	63	160	180	6	120	1	670	

BOILER SCHEDULE (HWB-1)

RAYPACK MVB BOILER, 754A, MODULATING NON-CONDENSING, LOW NOX <30 PPM ALL FIRING RATES TYPE, 63 GPM AT 20 DEG DELTA T. 750.0 MBH INPUT, 630.0 MBH OUTPUT. ELECTRONIC MODULAION, 60% MINIMUM FIRE. FM CONTROLS AND ALARM CONTACTS. PROVIDE 75 PSI RELIEF VALVE. NATURAL GAS FIRED. 115V/1PH, 12 FLA, 20 MOCP, 30"W X 50"D X 49"H, 670 LBS. SUPPLY WATER TEMPERATURE 180°F, RETURN TEMPERATURE 160°F. PROVIDE SINGLE POINT POWER CONNECTION. COORDINATE FINAL SIZE, VOLTAGE AND PHASE OF THE ELECTRICAL REQUIREMENTS OF THE BOILER WITH THE ELECTRICIAN. PROVIDE GAS PRESSURE REGULATORS FOR EACH BOILER TO PROVIDE 4" WC, MIN. @ FULL INPUT LOAD, 2 PSI MAXIMUM. PROVIDE SYSTEM CONTROLLER WITH MODBUS COMMUNICATIONS. BOILER SHALL CONTROL ITS RESPECTIVE PRIMARY PUMP. EQUIVALENTS BY LOCHINVAR, LAARS, AND AS LISTED IN THE SPECIFICATIONS. COORDINATE WITH CONTROLS CONTRACTOR.

PROVIDE BACNET GATEWAY. PROVIDE FACTORY COLD WATER START OPTION WITH BRONZE PRIMARY PUMP AND 3-WAY CONTROL VALVE TO MAINTAIN INLET TEMPERATURE TO BOILER.

PROVIDE COMBUSTION AIR FILTER.

BOILER STACKS

10" DOUBLE WALL STACK ALL STAINLESS STEEL (AL29-4C) CONSTRUCTION, U.L LISTED, CATEGORY IV BY HEATFAB, VAN-PACKER, OR SELKIRK, SUITABLE FOR USE WITH BOILER SPECIFIED. PROVIDE COMPLETE EXHAUST AND INTAKE DUCTING, INCLUDING ALL DUCTS, ELBOWS, FLANGES, TRIM RING FOR WALL PENETRATION AND WALL CAPS. PROVIDE TEST PORT IN EXHAUST FLUE FOR EACH BOILER.

LOUVER SCHEDULE

MARK	PURPOSE	DESCRIPTION	CFM	MIN. FREE AREA (sf)	MAX VELOCITY (fpm)	REMARKS
LV-01	COMBUSTION AIR	BOILER	32x24	2.30	600	

GENERAL NOTES:

A. PROVIDE MILLED ALUMINUM FINISH.
B. AMCA 540 AND AMCA 550 CERTIFIED.
C. PROVIDE ALUMINUM BIRSCREEN.
D. BASIS OF DESIGN IS RUSKIN EME6625. EQUIVALENTS BY GREENHECK, AIROLITE, OR AS LISTED IN THE SPECIFICATIONS.

ROOFTOP UNIT SCHEDULE

MARK	MANUFACTURER	MODEL	OUTSIDE AIR (CFM)	SUPPLY FAN						COOLING COIL							COMPRESSOR		REHEAT COIL			ELECTRICAL				WEIGHT (LBS)	REMARKS
				CFM	ESP IN. WG	QTY	HP	BHP	TSP IN. WG	EER	EDB (°F)	EWB (°F)	LDB (°F)	LWB (°F)	TOTAL (MBH)	SENSIBLE (MBH)	QTY	RLA	EDB (°F)	LDB (°F)	HEATING (MBH)	V	PH	MCA	MFS		
RTU-4	TRANE	THC060E3R0A	225	1700	0.8	1	1.0	0.75	1.08	11.9	76.1	66.1	55.7	54.2	57.8	34.9	1	15.9	55.7	75.6	36.7	208	3	26	40	1,200	
RTU-5	TRANE	THC060E3R0A	200	1700	0.9	1	1.0	0.82	1.18	11.9	75.9	65.8	55.4	53.9	57.3	35.0	1	15.9	55.4	75.4	36.9	208	3	26	40	1,200	

GENERAL NOTES:

A. EQUIVALENTS BY CARRIER, YORK, OR AAON.
B. PROVIDE ROOF CURB WITH 2" INSULATION.
C. PROVIDE 0-100% ECONOMIZER WITH REFERENCE ENTHALPY AND BAROMETRIC RELIEF
D. PROVIDE TEMPERATURE/HUMIDITY SENSOR AND BACNET CARD
E. PROVIDE WITH FACTORY NEMA 3R CIRCUIT BREAKER
F. PROVIDE FROSTAT AND/OR LOW AMBIENT COOLING TO 0 DEG F
G. PROVIDE HINGED ACCESS PANELS AND HAILGUARDS
H. PROVIDE PHASE MONITORING PROTECTION
I. PROVIDE CONVENIENCE OUTLET. TO BE FIELD POWERED ON SEPARATE CIRCUIT
J. PROVIDE CONDENSATE OVERFLOW SWITCH
K. PROVIDE FAN FAILURE SWITCH
L. PROVIDE 2" MERV 13 FILTERS
M. PROVIDE HUMAN INTERFACE OPTION
N. PROVIDE 65 kA SCCR

A.C. UNIT SCHEDULE:

UNIT NO.	TYPE	NOMINAL CAPACITY TONS	CFM	VOLTS	PH	ACCESSORIES	TYPICAL CAT. NO. (CARRIER)
1	SINGLE PACKAGE ROOF TOP	3	1200	208	3	ROOF CURB ECONOMIZER KIT CONCENTRIC DUCT PKG CONCEN-SUP.RET. DIFF.	50YH036
2	DO	4	1600	208	3	DO	50YH048
3	DO	4	1600	208	3	DO	50YH048

EXISTING RTU SCHEDULE - FOR INFORMATION AND TAB ONLY

VENTILATION CALCS

Building:
System Tag/Name: RTU-4
Operating Condition Description:
Units (select from pull-down list): IP

Design primary supply fan airflow rate	Vpsd	cfm	1,700	100%	1,700	
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf	0.02			
OA req'd per person for system area (Weighted average)	Rps	cfm/p	7.5			
Percent increase in Vbz over minimum required			0%			

Inputs for Potentially Critical zones

			Potentially Critical Zones		
Zone Name			Home Ec	Classroom	Corridor
Zone Tag	Show Values per Zone	Zone title turns purple italic for critical zone(s)	118	117	119
Occupancy Category		Select from pull-down list:	Classrooms (age 9 plus)	Classrooms (age 9 plus)	Corridors
Floor Area of zone	Az	sf	976	717	663
Design population of zone	Pz	P (default value listed; may be overridden)	10	10	0
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm	675	610	215
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?		Select from pull-down list or leave blank if N/A:			
Frac. of local recirc. air that is representative of system RA	Er				

Inputs for Operating Condition Analyzed

Percent of total design airflow rate at conditioned analyzed	Ds	%		100%	100%	100%
Air distribution type at conditioned analyzed		Select from pull-down list: Show codes for Ez		CSCRH	CSCRH	CSCRH
Zone air distribution effectiveness at conditioned analyzed	Ez			0.80	0.80	0.80
Primary air fraction of supply air at conditioned analyzed	Ep					

Results

System Ventilation Efficiency	Ev		0.88
Outdoor air intake required for system	Vot	cfm	216
Outdoor air per unit floor area	Vot /As	cfm/sf	0.09
Outdoor air per person served by system (including diversity)	Vot /Ps	cfm/p	10.8
Outdoor air as a % of design primary supply air	Ypd	%	13%

Detailed Calculations
Initial Calculations for the System as a whole

System primary supply air flow at conditioned analyzed	Vps	cfm	= Vpsd Ds	=	1700
Uncorrected OA intake flow req'd for system	Vou	cfm	= Rps Ps + Ras As	=	190
Uncorrected OA req'd as a fraction of primary SA	Xs		= Vou / Vps	=	0.11

VENTILATION CALCS

Building:
System Tag/Name: RTU-5
Operating Condition Description:
Units (select from pull-down list): IP

			w/o diversity System		Diversity	w/ diversity System
Inputs for System						
Floor area served by system	As	sf	2173			
Population of area served by system	Ps	P	17	D	100%	17
Design primary supply fan airflow rate	Vpsd	cfm	1,700		100%	1,700
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf	0.04			
OA req'd per person for system area (Weighted average)	Rps	cfm/p	6.5			
Percent increase in Vbz over minimum required			0%			

Inputs for Potentially Critical zones

			Potentially Critical Zones				
Zone Name			Computer	Office	Office	Office	Corridor
Zone Tag	Show Values per Zone	Zone title turns purple italic for critical zone(s)	116	113	114	115	119
Occupancy Category		Select from pull-down list:	Computer lab	Office space	Office space	Office space	Corridors
Floor Area of zone	Az	sf	895	310	134	171	663
Design population of zone	Pz	P (default value listed; may be overridden)	10	3	2	2	0
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm	675	240	155	220	410
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?		Select from pull-down list or leave blank if N/A:					
Frac. of local recirc. air that is representative of system RA	Er						

Inputs for Operating Condition Analyzed

Percent of total design airflow rate at conditioned analyzed	Ds	%	100%	100%	100%	100%	100%	100%	
Air distribution type at conditioned analyzed		Select from pull-down list: Show codes for Ez		CSCRH	CSCRH	CSCRH	CSCRH	CSCRH	
Zone air distribution effectiveness at conditioned analyzed	Ez			0.80	0.80	0.80	0.80	0.80	
Primary air fraction of supply air at conditioned analyzed	Ep								

Results

System Ventilation Efficiency	Ev		0.93
Outdoor air intake required for system	Vot	cfm	200
Outdoor air per unit floor area	Vot /As	cfm/sf	0.09
Outdoor air per person served by system (including diversity)	Vot /Ps	cfm/p	11.7
Outdoor air as a % of design primary supply air	Ypd	%	12%

VENTILATION CALCS

Progressive Design Collaborative, ltd.
3101 Poplarwood Court, Suite 320
Raleigh, North Carolina 27604
919-790-9989
License# C-0183
pdcengineers.com

NORTH CAROLINA PROFESSIONAL SEAL 025020 ENGINEER STEVE W. CAMPBELL
06/27/2023

SCAMPBELL@PDCENGINEERS.COM

DRAWN BY: JAV CHECKED BY: SWC

PDC 22034 06/09/2023

REVISIONS

NUMBER	DATE	DESCRIPTION
1	06/27/23	Addendum 01

BID/PERMIT

ENCSD Alford Hall HVAC

NORTH CAROLINA DEPARTMENT OF PUBLIC INSTRUCTION
1311 US Hwy 301 South,
Wilson, NC 27893

SCO# 22-24313-01A

MECHANICAL SCHEDULES

M7.01