ADDENDUM NO. 01

October 31, 2025

Pentwater Public Schools – Renovations & Improvements
600 E. Park Street
Pentwater, MI 49449

TO: ALL BIDDERS OF RECORD

This Addendum forms a part of and modifies the Bidding Requirements, Contract Forms, Contract Conditions, the Specifications and the Drawings dated September 22, 2025, by C2AE. Acknowledge receipt of the Addendum in the space provided on the Bid Form. Failure to do so may subject the Bidder to disqualification.

This Addendum consists of Pages ADD 1-1 through ADD 1-1 and C2AE Addendum No. 01, dated October 31, 2025, consisting of 68 pages.

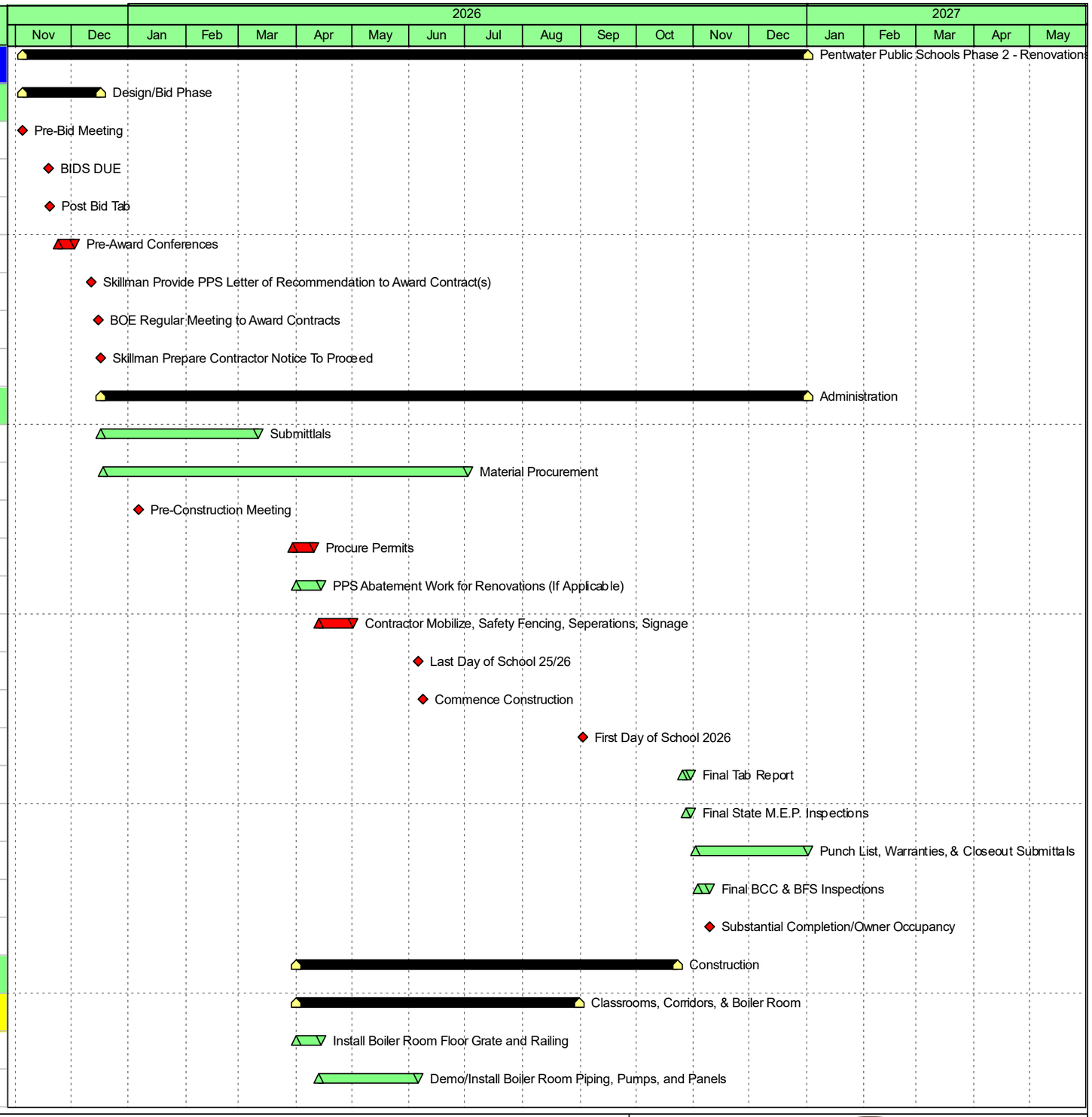
A. **SPECIFICATION SECTION 01 32 00 – SCHEDULES AND REPORTS**

a. 1**.03 GUIDELINE SCHEUDLE.**

Add:

1. See Guideline Schedule attached.
2. See Phasing Plan attached.

Activity Name	Original Duration	Start	Finish
Pentwater Public Schools Phase 2 - Renovations and Improve	300	04-Nov-25	01-Jan-27
Design/Bid Phase	28	04-Nov-25	16-Dec-25
Pre-Bid Meeting	0		04-Nov-25
BIDS DUE	0		18-Nov-25
Post Bid Tab	0		19-Nov-25
Pre-Award Conferences	5	24-Nov-25	02-Dec-25
Skillman Provide PPS Letter of Recommendation to Award Contract(s)	0		11-Dec-25
BOE Regular Meeting to Award Contracts	0		15-Dec-25
Skillman Prepare Contractor Notice To Proceed	0		16-Dec-25
Administration	272	17-Dec-25	01-Jan-27
Submittlals	60	17-Dec-25*	11-Mar-26
Material Procurement	140	18-Dec-25	02-Jul-26
Pre-Construction Meeting	0		06-Jan-26
Procure Permits	10	30-Mar-26	10-Apr-26
PPS Abatement Work for Renovations (If Applicable)	10	01-Apr-26	14-Apr-26
Contractor Mobilize, Safety Fencing, Seperations, Signage	15	13-Apr-26	01-May-26
Last Day of School 25/26	0		05-Jun-26
Commence Construction	0	08-Jun-26	
First Day of School 2026	0	02-Sep-26	
Final Tab Report	5	26-Oct-26	30-Oct-26
Final State M.E.P. Inspections	3	28-Oct-26*	30-Oct-26
Punch List, Warranties, & Closeout Submittals	45	02-Nov-26	01-Jan-27
Final BCC & BFS Inspections	5	03-Nov-26	09-Nov-26
Substantial Completion/Owner Occupancy	0		09-Nov-26
Construction	148	01-Apr-26	23-Oct-26
Classrooms, Corridors, & Boiler Room	109	01-Apr-26	31-Aug-26
Install Boiler Room Floor Grate and Railing	10	01-Apr-26	14-Apr-26
Demo/Install Boiler Room Piping, Pumps, and Panels	40	13-Apr-26	05-Jun-26

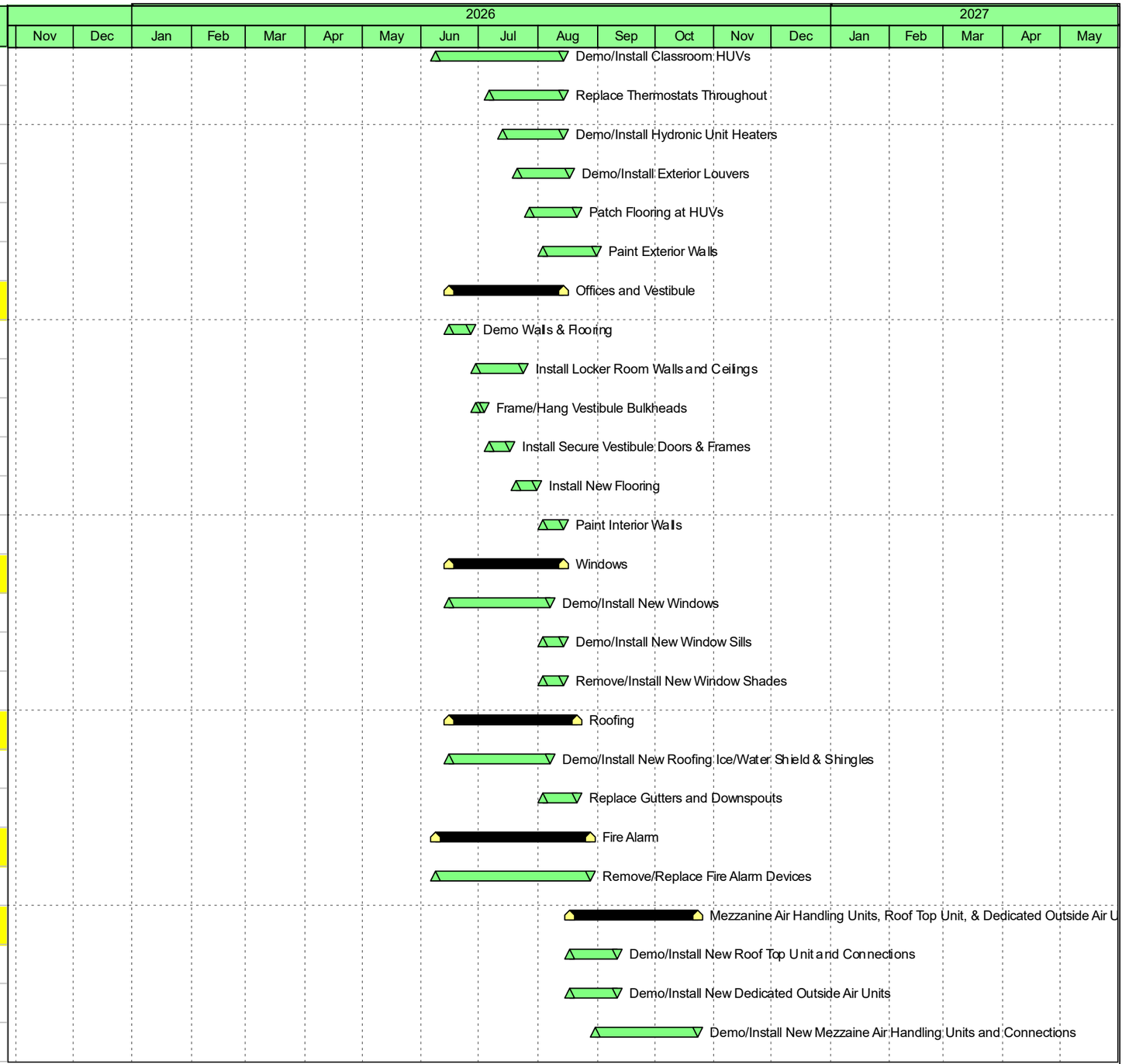


Actual Work
Remaining Work
Critical Remaining Work
Milestone
Summary

223040.02 - Pentwater Public Schools Phase 2 - Renovations and Improvements
Guideline Schedule - 13-Oct-25

SKILLMAN

Activity Name	Original Duration	Start	Finish
Demo/Install Classroom HUVs	50	08-Jun-26	14-Aug-26
Replace Thermostats Throughout	30	06-Jul-26	14-Aug-26
Demo/Install Hydronic Unit Heaters	25	13-Jul-26	14-Aug-26
Demo/Install Exterior Louvers	20	21-Jul-26	17-Aug-26
Patch Flooring at HUVs	20	27-Jul-26	21-Aug-26
Paint Exterior Walls	20	03-Aug-26	31-Aug-26
Offices and Vestibule	45	15-Jun-26	14-Aug-26
Demo Walls & Flooring	10	15-Jun-26	26-Jun-26
Install Locker Room Walls and Ceilings	20	29-Jun-26	24-Jul-26
Frame/Hang Vestibule Bulkheads	5	29-Jun-26	03-Jul-26
Install Secure Vestibule Doors & Frames	10	06-Jul-26	17-Jul-26
Install New Flooring	10	20-Jul-26	31-Jul-26
Paint Interior Walls	10	03-Aug-26	14-Aug-26
Windows	45	15-Jun-26	14-Aug-26
Demo/Install New Windows	40	15-Jun-26	07-Aug-26
Demo/Install New Window Sills	10	03-Aug-26	14-Aug-26
Remove/Install New Window Shades	10	03-Aug-26	14-Aug-26
Roofing	50	15-Jun-26	21-Aug-26
Demo/Install New Roofing Ice/Water Shield & Shingles	40	15-Jun-26	07-Aug-26
Replace Gutters and Downspouts	15	03-Aug-26	21-Aug-26
Fire Alarm	60	08-Jun-26	28-Aug-26
Remove/Replace Fire Alarm Devices	60	08-Jun-26	28-Aug-26
Mezzanine Air Handling Units, Roof Top Unit, & Dedicated Outside Air Units	50	17-Aug-26	23-Oct-26
Demo/Install New Roof Top Unit and Connections	20	17-Aug-26	11-Sep-26
Demo/Install New Dedicated Outside Air Units	20	17-Aug-26	11-Sep-26
Demo/Install New Mezzaine Air Handling Units and Connections	40	31-Aug-26	23-Oct-26



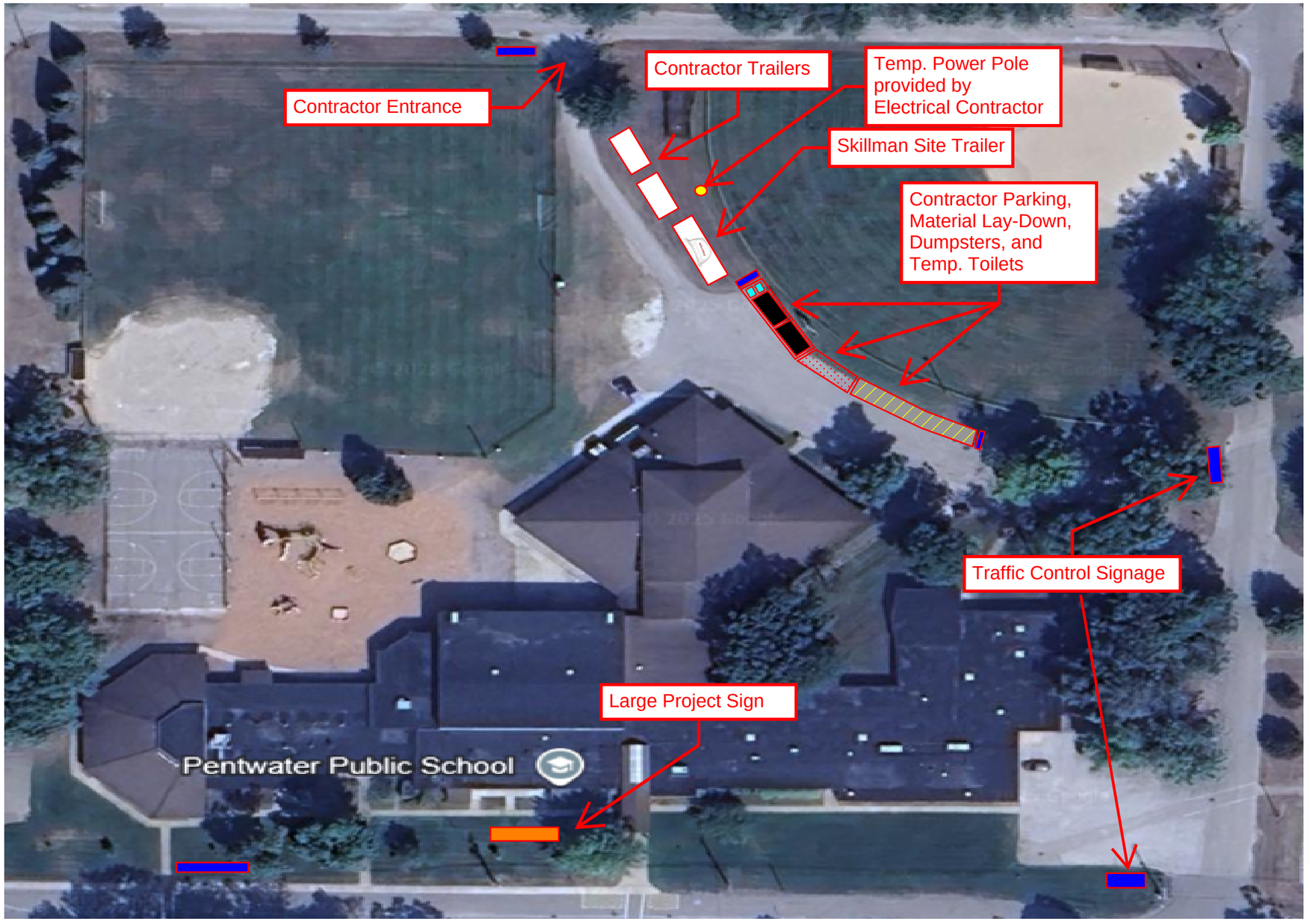
Actual Work
Remaining Work
Critical Remaining Work
Milestone
Summary

223040.02 - Pentwater Public Schools Phase 2 - Renovations and Improvements
Guideline Schedule - 13-Oct-25

SKILLMAN

Pentwater Public Schools

Renovations and Improvements



LEGEND:

Skillman Site Trailer =

Material Lay-Down Area =

Contractor Parking Area =

Dumpsters =

Large Project Sign =

Project Traffic and
Contractor Entrance Signage =

Temporary Toilets =

The SKILLMAN Corporation
Construction Management

PENTWATER FALCONS

c2ae

Site Logistics Plan - 10/15/25

50 Louis St., NW, Suite 200
Grand Rapids, MI 49503
616.454.9414
www.c2ae.com

Addendum #1

Project No.:	24-0301	**Date:**	October 31, 2025
Project:	Pentwater Public Schools 2024 Bond Implementation – Bid Package #2	**A/E Firm:**	C2AE
		Project Manager:	Anthony Seifritz
Owner:	Pentwater Public Schools 600 East Park Street Pentwater, MI 49449		

The following changes, revisions, modifications, etc. shall be incorporated into the contract documents, specifications, and plans.

ACKNOWLEDGEMENTS

A1.1 The Bidder shall acknowledge receipt of Addenda #1 by indicating so in the spaces provided on the Bid Form.

SPECIFICATIONS

A1.2 **Refer To Section 09 6813 – Tile Carpeting (reissued)**
Reissue section in its entirety. Refer to Article 2.1 Materials, paragraph A. for revisions.

A1.3 **Refer To Section 23 0923 – Direct Digital Control (DDC) System for HVAC (reissued)**
Reissue section in its entirety. Refer to Article 1.1 Summary, paragraph A. (pages 1 and 2), and Article 2.1, paragraphs A. and B. (page 12) for revisions.

DRAWINGS

A1.4 **Refer to Sheet 2M-601 (reissued):**
Updated schedule note 1 in the "AIRHANDLING UNIT SCHEDULE" to require refrigerant detection capability.

A1.5 **Refer to Sheet 2M-801 (reissued):**
Added hydronic heating zone tables for each pump, including equipment flow rates and total pressure drop.

APPENDIX

A1.6 **Refer To Appendix (not reissued)**
Add Tarkett Art Work Approval 984933B, issued herein.

SECTION 09 6813 - TILE CARPETING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Carpet tile, fully adhered.

1.2 REFERENCE STANDARDS

A. ASTM D2859 - Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials; 2016 (Reapproved 2021).

B. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source; 2025.

C. CRI 104 - Standard for Installation of Commercial Carpet; 2015.

D. NFPA 253 - Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source; 2023.

1.3 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.

C. Shop Drawings: Indicate layout of joints, direction of carpet pile, and location of edge moldings.

D. Verification Samples:
   1. Carpet Tile: Submit 3 samples, full size, for each color and pattern specified.

E. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning.

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.
   2. Extra Carpet Tiles: Quantity equal to 2 percent of total installed, but not less than one box for each type and color.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing specified carpet tile with minimum 5 years documented experience.

B. Installer Qualifications: Company specializing in installing carpet tile with minimum 5 years documented experience.

1.5 FIELD CONDITIONS

A. Store materials in area of installation for minimum period of 24 hours prior to installation.

1.6 EXTRA MATERIALS

A. Deliver stock of maintenance materials to Owner. Furnish maintenance materials from same manufactured lot as materials installed and enclosed in protective packaging with appropriate identifying labels.
   1. Carpet Tile Flooring: Furnish not less than one box for each 50 boxes or fraction thereof, for each type, color, pattern, and size installed.

PART 2 PRODUCTS

2.1 MATERIALS

A. CPT1 Tile Carpeting:
   1. Product:
      a. Tarkett; Assertive Action 04837: https://commercial.tarkett.com/.
      b. *Tarket, Plexus Colour IV 02875:https://commercial Tarkett.com/.**(ADM1)***
      c. Substitutions: Not permitted.
         *1) Plexus Colour IV to be applied at logo only. **(ADM1)***
      d. *Substitutions: Not Permitted. (ADM1)*
      e. Manufacturer's Representative: Paul Brown, Paul.Brown@tarkett.com, 810.908.4344.
   2. Construction: Fusion bonded, manufactured in one color dye lot.
      a. Field color (CPT1A) for logo and adjacent spaces must be from same dye lot.
   3. Tile Size: 24 x 24 inch, nominal.
   4. Color:
      a. CPT1A *Assertive Action,* 26202 Steelwork.***(ADM1)***
      b. CPT1B ~~Custom Color to be Selected~~ *Plexus Colours IV, Dark Shadow. **(ADM1)***
      c. CPT1C ~~Custom Color to be Selected~~ *Plexus Colours IV, Gold Rush. **(ADM1)***
      d. CPT1D ~~Custom Color to be Selected~~ *Plexus Colours IV, Milky Opal **(ADM1)***
      e. *CPT 1E Plexus Colours IV, Purple Haze **(ADM1)***
   5. Installation Pattern: Monolithic.
      a. Includes custom 4'-0" x 4'-0" logo, as indicated on drawings. Artwork to match district logo. ~~Up to 3 colors to be selected.~~ *Approved Manufacturer artwork #984933B. **(ADM1)***
   6. Critical Radiant Flux: Minimum of 0.22 watts/sq cm, when tested in accordance with ASTM E648 or NFPA 253.
   7. Surface Flammability Ignition: Pass ASTM D2859 (the "pill test").
   8. Fiber Content: TDX Nylon.
   9. Dye Method: Solution Dyed.
   10. Density Factor: 10,989 oz/cu yd.
   11. Secondary Backing Material: ethos Modular with Omnicoat Technology.

B. CPT2 Tile Carpeting:
   1. Product:
      a. Shaw; In the Groove 2545971.
      b. Substitutions: Not permitted.
   2. Construction: Tufted, manufactured in one color dye lot.
   3. Tile Size: 24 x 24 inch, nominal.
   4. Color: Luck of the Draw.
   5. Installation Pattern: Monolithic.
   6. Critical Radiant Flux: Minimum of 0.22 watts/sq cm, when tested in accordance with ASTM E648 or NFPA 253.
   7. Surface Flammability Ignition: Pass ASTM D2859 (the "pill test").
   8. Fiber Content: 100% Eco Solution Q Nylon.
   9. Secondary Backing Material: EcoWorx.

C. CPT3 Tile Carpeting:
   1. Product:
      a. Interface; Aireal Flying Colors, AE315: www.interface.com.
      b. Substitutions: Not permitted.
      c. Manufacturer's Representative: Cara Bogosian, 248.214.2707, Cara.Bogosian@interface.com.
   2. Construction: Tufted, manufactured in one color dye lot.
   3. Tile Size: 25 cm x 1 m, nominal.
   4. Color: 105815 Smoke / Iris.
   5. Installation Pattern: Ashlar.
   6. Critical Radiant Flux: Minimum of 0.22 watts/sq cm, when tested in accordance with ASTM E648 or NFPA 253.
   7. Surface Flammability Ignition: Pass ASTM D2859 (the "pill test").
   8. Fiber Content: 100% Recycled Content Nylon.
   9. Dye Method: 100 percent solution dyed.
   10. Density Factor: 6,400 oz/cu yd.
   11. Secondary Backing Material: GlasBac.

2.2 ACCESSORIES

A. Subfloor Filler: White premix latex; type recommended by flooring material manufacturer.

B. Carpet Tile Adhesive: Recommended by carpet tile manufacturer; releasable type.

C. Floor Moldings, Stair Coverings, and Resilient Base: Refer to Section 09 6513 - Resilient Bases and Accessories.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that subfloor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive carpet tile.

B. Verify that subfloor surfaces are dust-free and free of substances that could impair bonding of adhesive materials to subfloor surfaces.

C. Cementitious Subfloor Surfaces: Verify that substrates are ready for flooring installation by testing for moisture and alkalinity (pH).
   1. Test in accordance with Section 09 0561 - Common Work Results for Flooring Preparation.

3.2 PREPARATION

A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.

B. Remove subfloor ridges and bumps. Fill minor or local low spots, cracks, joints, holes, and other defects with subfloor filler.

C. Apply, trowel, and float filler to achieve smooth, flat, hard surface. Prohibit traffic until filler is cured.

D. Vacuum clean substrate.

3.3 INSTALLATION

A. Starting installation constitutes acceptance of subfloor conditions.

B. Install carpet tile in accordance with manufacturer's instructions and CRI 104 (Commercial).

C. Blend carpet from different cartons to ensure minimal variation in color match.

D. Cut carpet tile clean. Fit carpet tight to intersection with vertical surfaces without gaps.

E. Install carpet tile in floor patterns indicated.

F. Locate change of color or pattern between rooms under door centerline.

G. Trim carpet tile neatly at walls and around interruptions.

H. Coordinate with Section 09 6513 - Resilient Bases and Accessories for installation of floor moldings, stair coverings, and resilient base.

3.4 CLEANING

A. Remove excess adhesive without damage, from floor, base, and wall surfaces.

B. Clean and vacuum carpet surfaces.

C. Complete final cleaning of floor not more than 5 days prior to Substantial Completion.

3.5 PROTECTION

A. After cleaning, protect finish floors from damage until Date of Substantial Completion.

END OF SECTION 09 6813

SECTION 23 0923 - DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Direct digital control (DDC) system equipment and components for monitoring and controlling of HVAC systems and equipment.

1. It is Pentwater School's goal to implement a new "open/non-proprietary" Building Management System (BMS) for both the Pentwater *school* ~~Secondary and Elementary~~ buildings that will allow products from various suppliers to be integrated into a unified system to provide flexibility for expansion, maintenance, and service of the system. ***(ADM1****)*

a. The new BMS for this project shall monitor and control all HVAC systems and equipment associated with this project as indicated in the Drawings and as noted within this specification section.

b. The new BMS for this project shall also be expandable to include ~~sufficient~~ capacity to allow for future DDC upgrades. *This project scope* ~~that will~~ includes ALL *(new and existing)* the building's HVAC systems and equipment. ***(ADM1)***

2. The new BMS as provided in this specification shall be based on Tridium's Niagara Framework and adhere to the open NCIS licensing.

a. The BMS shall be comprised of Java Application Control Engine of Controllers (JACE-8000 expandable) and shall connect to the District's local area network.

b. Access to the BMS, either locally, or remotely from a central site, shall be accomplished through standard Web browsers via the internet and/or local area network.

c. Each JACE shall communicate to LonMark/LonTalk, BACnet, ModBus listed controllers, and other open and legacy protocol systems/devices.

d. The District shall be the named license holder of all software associated with any and all incremental work on the project. No exceptions allowed.

3. The existing temperature controls for the ~~Secondary~~ Building's HVAC systems are comprised of original pneumatic devices and controllers, several packaged rooftop units with factory DDC controllers, and *stand alone boiler manufacturer controls* ~~a newer Johnson Controls Metasys was~~ installed for the recent boiler replacements. ~~Other upgraded equipment includes stand-alone Johnson Controls thermostats and electronic actuators~~ ***(ADM1)***

a. The Controls Contractor shall take due care to ensure the existing ~~existing Johnson Controls~~ DDC devices remain active and fully functional during the work of this project. ***(ADM1)***

4. ~~The existing temperature controls for the Elementary Building's HVAC systems are comprised primarily of original pneumatic devices and control panels. A newer Johnson Controls Metasys was installed for the recent boiler replacements.~~

~~a. The Controls Contractor shall take due care to ensure the existing Johnson Controls DDC devices remain active and fully functional during the work of this project.~~

5. ~~It is the responsibility of the Controls Contractor to provide any hardware, software, control devices, or supplementary and miscellaneous items not mentioned in this specification that are necessary for a fully functional and integrated system of temperature controls, graphic interfaces, monitoring, and management.~~
6. ~~Depict floor plans and each mechanical system, components, and data points on point-and-click graphics that will allow operators to perform all normal functions through Web Browser interface.~~ ***(ADM1)***

B. Remove controls which will not remain as part of the building automation system, including all associated wiring and conduit, and all associated pneumatic tubing. The Owner will inform the Contractor of any equipment which is to be removed that will remain the property of the Owner. All other equipment which is removed will be disposed of by the Contractor. Demolition will include removing existing control panels, existing control devices, existing wire/cable raceways and all pneumatic control tubing and raceways. All demolished components will be properly disposed of offsite. ABANDONMENT OF ANY EXISTING CONTROL PANELS, RACEWAYS, WIRES/CABLES, PNEUMATIC TUBING/RACEWAYS IS NOT PERMITTED – THIS WILL BE STRICTLY ENFORCED.

C. Related Requirements:
1. Section 23 0800 “Commissioning” for controls verification and testing.
2. Section 23 0923.11 “Control Valves” for control valves and electronic actuators.
3. Section 23 0923.12 “Control Dampers” for control dampers and electronic actuators.
4. Section 23 0993.11 "Sequence of Operations for HVAC DDC" for control sequences in DDC systems.
5. Section 26 0553 "Identification for Electrical Systems" for identification requirements for electrical power and communications components

1.2 DEFINITIONS

A. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data and services over a network.

B. BAS: Building Automation System, often considered a subset of a BMS, a network of various DDC controllers that automate specific building system operations typically related to HVAC and lighting controls.

C. BMS: Building Management System, a computer-based system focused on overall building management and optimization that can integrate various building systems to allow operators to monitor and control system performance, manage energy consumption, improve indoor air quality and occupant comfort, etc.

D. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are indicated: network controllers, programmable application controllers, and application-specific controllers.

E. Control System Integrator: An entity that assists in expansion of existing enterprise system and support of additional operator interfaces to I/O being added to existing enterprise system.

F. DDC System Provider: Authorized representative of, and trained by, DDC system manufacturer and responsible for execution of DDC system Work indicated.

G. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.

H. LON Specific Definitions:
1. FTT-10: Echelon Transmitter-Free Topology Transceiver.
2. LonMark International: Association comprising suppliers and installers of LonTalk products. Association provides guidelines for implementing LonTalk protocol to ensure interoperability through a standard or consistent implementation.
3. LonTalk: An open standard protocol developed by Echelon Corporation that uses a "Neuron Chip" for communication. LonTalk is a register trademark of Echelon.
4. LonWorks: Network technology developed by Echelon.

I. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

J. Modbus TCP/IP: An open protocol for exchange of process data.

K. MS/TP: Master-slave/token-passing, ISO/IEC/IEEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.

L. Network Controller: Digital controller, which supports a family of programmable application controllers and application-specific controllers, that communicates on peer-to-peer network for transmission of global data.

M. Peer to Peer: Networking architecture that treats all network stations as equal partners.

N. Server: Computer used to maintain system configuration, historical and programming database.

O. TCP/IP: Transport control protocol/Internet protocol.

P. UPS: Uninterruptible power supply.

1.3 SYSTEM DESCRIPTION

A. In accordance to the scope of work, the system shall also provide a graphical, web-based, operator interface that allows for instant access to any system through a standard browser. Microcomputer controllers of modular design providing distributed processing capability and allowing future expansion of both input/output points and processing/control functions will be provided by the Controls Contractor.

B. For this project, the system shall consist of the following components:
   1. Administration and Programming Workstation(s): operation software and architecture as described in Part 2 of the specification. These workstations must be running the standard workstation software developed and tested by the manufacturer of the network server controllers and the standalone controllers. No third party front-end workstation software will be acceptable. Workstations must conform to the B-OWS BACnet device profile. All field level controllers must have the ability to be programmed by site personnel from a BAS contractor supplied and licensed programming tool or N4 embedded programming tool jar file.
   2. Web-Based Operator Workstations: furnish licenses for web connection to the BAS system. Web-based users shall have access to all system points and graphics, shall be able to receive and acknowledge alarms, and shall be able to control setpoints and other parameters. All engineering work, such as trends, reports, graphics, etc. that are accomplished from the WorkStation shall be available for viewing through the web browser interface without additional changes. The web-based interface must conform to the B-OWS BACnet device profile. There will be no need for any additional computer based hardware to support the web-based user interface.
   3. Ethernet-based Network Router and/or Network Server Controller(s): furnish needed quantity of Ethernet-based Network Server Controllers as described in Part 2 of the specification. These controllers will connect directly to the Operator Workstation over Ethernet at a minimum of 100mbps, and provide communication to the Standalone Digital Control Units and/or other Input/Output Modules. All field level controllers must have the ability to be programmed by site personnel from a BAS contractor supplied and licensed programming tool or N4 embedded programming tool jar file. Network Server Controllers shall conform to BACnet device profile B-BC. Network controllers that utilize RS232 serial communications to communicate with the workstations will not be accepted. Network Controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Building Controllers (B-BC).
   4. Standalone Digital Control Units (SDCUs): Provide the necessary quantity and types of SDCUs to meet the requirements of the project for mechanical equipment control including air handlers, central plant control, and terminal unit control. Each SDCU will operate completely standalone, containing all of the I/O and programs to control its associated equipment. All field level controllers must have the ability to be programmed by site personnel from a BAS contractor supplied and licensed programming tool or N4 embedded programming tool jar file. Each BACnet protocol SDCU shall conform to the BACnet device profile B-AAC. BACnet SDCUs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Advanced Application Controllers (B-AAC).

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

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

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

F. The AAC shall be capable of communicating as a BACnet IP device communicating at 10/100 Mbps on a TCP/IP trunk. The ANSI / ASHRAE™ Standard 135-2004, BACnet protocol is required to assure that the project is fully supported by the leading HVAC open protocol to reduce future building maintenance, upgrade, and expansion costs.

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

H. Complete temperature control system to be DDC with electronic sensors and electronic/electric actuation of Mechanical Equipment Room (MER) valves and dampers and electronic actuation of terminal equipment valves and actuators as specified herein. The BMS is intended to seamlessly connect devices throughout the building regardless of subsystem type, i.e. variable frequency drives and power metering should easily coexist on the same network channel.
   1. The supplied system must incorporate the ability to access all data using HTML5 enabled browsers without requiring proprietary operator interface and configuration programs. The system shall not require JAVA to be enabled in the browser.
   2. Data shall reside on a supplier-installed server for all database access.
   3. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer’s internal Intranet network.

I. All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the regular employment of the approved manufacturer's local field office. The approved manufacturer's local field office shall have a minimum of 5 years of installation experience with the manufacturer and shall provide documentation in the bid and submittal package verifying longevity of the installing company's relationship with the manufacturer when requested. Supervision, hardware and software engineering, calibration and checkout of the system shall be by the employees of the approved manufacturer's local field office and shall not be subcontracted. The control contractor shall have an in-place support facility within 120 miles of the site with factory certified technicians and engineers, spare parts inventory and all necessary test and diagnostic equipment for the installed system, and the control contractor shall have 24 hours/day, 7 days/week emergency service available.

1.2 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:
   1. Graphic Display: Display graphic with minimum 30 dynamic points with current data within 5 seconds.
   2. Graphic Refresh: Update graphic with minimum 30 dynamic points with current data within 2 seconds.

3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
5. Alarm Response Time: Annunciate alarm at workstation within 15 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
    a. Water Temperature: Plus or minus 1-degree F.
    b. Water Flow: Plus or minus 5 percent of full scale.
    c. Water Pressure: Plus or minus 2 percent of full scale.
    d. Space Temperature: Plus or minus 1-degree F.
    e. Ducted Air Temperature: Plus or minus 1-degree F.
    f. Outside Air Temperature: Plus or minus 2-degrees F.
    g. Averaging Air Temperature: Plus or minus 2-degrees F.
    h. Dew Point Temperature: Plus or minus 2.7-degrees F.
    i. Temperature Differential: Plus or minus 0.27-degrees F.
    j. Relative Humidity: Plus or minus 5-percent relative humidity (% RH).
    k. Airflow (Terminal): Plus or minus 5-% FS.
    l. Air Pressure (Space): Plus or minus 0.0005-inches wg.
    m. Air Pressure (Ducts): Plus or minus 0.02-inches wg.
    n. Carbon Dioxide: Plus or minus 50-ppm CO2.
    o. Electrical: Plus or minus 2-percent of reading (volts/amps/watts).

1.3 SEQUENCE OF OPERATION

A. Sequences of Operation are included on the temperature control drawings (plans).

1.4 SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
    1. Building Automation System: Include technical data for operator workstation, operating system software, color graphics; editors for graphics, point database, and programming; software licensing, software updates during construction, and other third-party applications.
    2. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for remote operator’s terminal, operator display menus, interface equipment to BAS, DDC Controllers, Unitary Controllers, Application Specific Controllers (e.g. Air Terminal Controller), transducers/transmitters, sensors, control dampers, damper actuators, control valves, valve actuators, relays/switches, auxiliary control panels.

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

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
   2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
   3. Wiring Diagrams: Power, signal, and control wiring.
   4. Details of control panel faces, including controls, instruments, and labeling.
   5. Written description of sequence of operation.
   6. Schedule of dampers including size, leakage, and flow characteristics.
      a. Coordinate dampers sizes with sheet metal and/or mechanical contractor before submitting.
   7. Schedule of valves including flow characteristics.
   8. Schedule of Terminal Equipment Controllers, e.g. air terminals, unit ventilators, etc.
   9. DDC System Hardware:
      a. Wiring diagrams for control units with termination numbers.
      b. Schematic diagrams and floor plans for field sensors and control hardware.
      c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
   10. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
   11. Controlled Systems:
      a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
      b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
      c. Written description of sequence of operation including schematic diagram.
      d. Points list.

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

D. Samples for Initial Selection: For each color required, of each type of thermostat or sensor cover with factory-applied color finishes.

E. Samples for Verification: For each color required, of each type of thermostat or sensor cover.

F. Software and Firmware Operational Documentation: Include the following:
   1. Software operating and upgrade manuals
   2. Program Software Backup: On a USB Drive.
   3. Device address list

4. Printout of software application and graphic screens
5. Software licenses required by and installed for DDC workstations and control systems

G. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

H. Field quality control test reports

I. Installing contractor's commissioning reports

J. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. Include the following:
1. Maintenance instructions and list of spare parts for each type of control device and the compressed air station.
2. Interconnection wiring diagrams with identified and numbered system components and devices.
3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
4. Inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.
5. Calibration records and list of set points.

1.5 QUALITY ASSURANCE

A. All bidders must be building automation contractors in the business of installing direct digital control building automation systems for a minimum of 5 years.
1. The Building Management System contractor shall have a full service facility within 120 miles of the project that is staffed with engineers trained and certified by the manufacturer in the configuration, programming and service of the automation system. The contractor's technicians shall be fully capable of providing instructions and routine emergency maintenance service on all system components.
2. Any installing contractor, not listed as prequalified in the Approved Manufacturer's section, shall submit credentials as detailed in the Pre-bid Submittal section for the engineer's review 2 weeks prior to bid date. Failure to follow the attached formats shall disqualify potential alternate bidders. Credentials must attest that the contractor meets all requirements of the specification and the Engineers judgment regarding approval to bid as an acceptable installer after reviewing the data will be final.

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

C. Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BAS will be tested against the appropriate sequence of operation specified herein. Successful completion of the system test shall constitute the beginning of the warranty period. A written report will be submitted to the owner indicating that the installed system functions in accordance with the plans and specifications.

D. The BAS system supplier shall commission and set in operating condition all major equipment and systems, such as the hot water heating and all air handling systems, in the presence of the equipment manufacturer's representatives, as applicable, and the Owner and Architect's representatives. If the vendor is providing an AFDD/CC system, use of the analytics shall be used to help commission the system.

E. Startup Testing shall be performed for each task on the startup test checklist, which shall be initialed by the technician and dated upon test was completion along with any recorded data such as voltages, offsets or tuning parameters. Any deviations from the submitted installation plan shall also be recorded.

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

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

H. A Startup Testing Report and a Performance Verification Testing Report shall be provided upon test completion.

1.6 DELIVERY, STORAGE, AND HANDLING

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

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

1.7 COORDINATION

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

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

C. Coordinate equipment with Division 26 to achieve compatibility with starter coils and annunciation devices.

D. Coordinate installation of control dampers, smoke dampers, HVAC equipment isolation dampers, and pipe-mounted sensors and instruments with the mechanical and/or plumbing contractor.

E. Coordinate installation of duct, space, outdoor, or building static pressure sensors with the finished surfaces, installing contractor and the Architect prior to installation.

F. Coordinate installation of any exterior wall or roof-mounted sensors, instruments, or controllers required for the temperature control system with the General Contractor and the Architect prior to installation.

G. Coordinate the color selection process of any sensor or device intended to be mounted on finished surfaces with the Architect prior to installation.

1.8 OWNERSHIP

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

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

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

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

1.9 WARRANTY

A. The control system shall be guaranteed for a period of two years after final approval by the Owner. The guarantee shall be provided for a completely installed system, including all components, parts, and assemblies of the control system. The guarantee shall cover parts, materials, and labor to locate and correct any defects in materials or workmanship.

B. The Contractor shall initiate the warranty period by formally transmitting to the Owner commencement notification of the period for the system and devices accepted. The warranty period begins when these devices are formally accepted by the Owner (refer to ACCEPTANCE PROCEDURE below).

C. Contact information shall be provided for quick service engineering assistance concerning hardware and software problems. There shall be provisions made for getting manufacturer certified diagnostic and repair personnel on the scene quickly should the need arise. There shall also be a software expert familiar with the software of this machine who can be easily contacted.

D. This system shall be inspected by the control system Contractor for a four-hour period once each quarter during the warranty period to run diagnostic tests and also provide maintenance instructions to the operating personnel.

E. The control system Contractor shall give the Owner 24 hours prior notification of each maintenance trip during the contract guarantee period. In addition, the Contractor shall furnish the Owner and Engineer a written record of each maintenance trip, number of employees present, time involved and work accomplished.

F. The Owner shall be able to make changes to database, when prior database is stored on disk in case of error in change, without affecting or voiding warranty.

1.10 MAINTENANCE

A. The control system Contractor shall provide and maintain on site working spare parts for the control system during the warranty period including DDC Controllers, power supplies, modules, sensors, floor level (subnet) devices, transformers, etc. The owner will be custodian of these spare parts and shall be authorized to utilize them in performing first level maintenance. The control contractor shall refurbish/replace spare parts in exchange for failed items.

PART 2 - PRODUCTS

2.1 DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. *Honeywell WEBs N4 Building Control Systems (Optimizer Suite of products – BASIS OF DESIGN)* ***(ADM1)***
   2. Alerton Inc.
   3. Automated Logic Corporation
   4. Delta Controls Inc
   5. Distech Controls
   6. Honeywell International Inc.
   7. Johnson Controls, Inc.
   8. Schneider Electric USA, Inc.
   9. Trane

B. Contractors: Subject to compliance with requirements, work to be performed by one of the following:

   a. ControlNET LLC- (Basis of Design) Contact: Jeff Tibbs jtibbs@control-net.com
   b. Control Resource-(Voluntary Alternate)
   c. Temperature Control, Inc.- (Voluntary Alternate)
   d. Grand Valley Automation - (Voluntary Alternate) ***(ADM1)***

2.2 DDC SYSTEM DESCRIPTION

A. Microprocessor-based monitoring and control including analog/digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices to achieve a set of predefined conditions.
   1. DDC system consisting of high-speed, peer-to-peer network of distributed DDC controllers, operator interfaces, and software.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 WEB ACCESS

A. DDC system to be web based.
   1. Web-Based Access to DDC System:
      a. DDC system software based on server thin-client architecture, designed around open standards of web technology. DDC system server accessed using a web browser over DDC system network, using Owner's LAN, and remotely over Internet.
      b. Intent of thin-client architecture is to provide operators complete access to DDC system via a web browser. No special software other than a web browser is required to access graphics, point displays, and trends; to configure trends, points, and controllers; and to edit programming.
      c. Password-protected web access.

2.4 SYSTEM ARCHITECTURE

A. General
   1. The Building Automation System (BAS) shall consist of Network Server/Controllers (NSCs) and a family of Standalone Digital Control Units (SDCUs). Administration and Programming Workstations (APWs) and Web-based Operator Workstations (WOWs) are provided by SI. Alarm notifications, scheduling, reporting and information management for the entire facility, and Wide Area Network (WAN) if applicable will be provided by SI. All field level controllers must have the ability to be programmed by site personnel from a BAS contractor supplied and licensed programming tool or N4 embedded programming tool jar file.
   2. An Enterprise Level BAS provided by SI shall consist of an Enterprise Server, which enables multiple NSCs (including all graphics, alarms, schedules, trends, programming, and configuration) to be accessible from a single Workstation simultaneously for operations and engineering tasks.
   3. The Enterprise Level BAS shall support built-in reporting functionality without dependency on other software.
   4. The Enterprise Level BAS shall support standard accessing of data for third party reporting or analytics software.
   5. The Enterprise Level BAS shall be able to host up to 250 servers, or NSCs, beneath it.
   6. The system shall be designed with a top-level 10/100bT Ethernet network, using the BACnet/IP, and/or Modbus TCP protocol.

B. Modbus RTU/ASCII (and J-bus), Modbus TCP, BACnet MS/TP, BACnet IP, and WebServices shall be native to the NSCs. There shall not be a need to provide multiple NSCs to support all the network protocols, nor should there be a need to supply additional software to allow all three protocols to be natively supported.

C. A sub-network of SDCUs using the BACnet IP, BACnet MS/TP protocol shall connect the local, stand-alone controllers with Ethernet-level Network Server Controllers/IP Routers.

D. The fieldbus layer shall support all of the following types of SDCUs:
   1. BACnet IP SDCU requirements: The system shall consist of one or more BACnet/IP field buses managed by the Network Server Controller.
   2. BACnet MS/TP SDCU requirements: (Only where shown on the control architecture drawings)

E. The system shall consist of one or more BACnet MS/TP field buses managed by the Network Server Controller. Minimum speed shall be 38.4 kbps. The field bus layer consists of an RS485, token passing bus that supports Standalone Digital Control Units (SDCUs) for operation of HVAC. These devices shall conform to BACnet standard 135-2004. The NSCs shall be capable of at least two BACnet MS/TP field buses per NSC.

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

G. All NSCs, Workstation(s) and Servers shall be capable of residing directly on the owner's Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the NSC's, Workstation(s), and Server(s) shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches and hubs. With this design the owner may utilize the investment of an existing or new enterprise network or structured cabling system. This also allows the option of the maintenance of the LAN/WAN to be performed by the owner's Information Systems Department as all devices utilize standard TCP/IP components. All added BAS supplied switches and routers must be approved by the Owner's Information Systems Department.

H. System Expansion
   1. The BAS system shall be scalable and expandable at all levels of the system using the same software interface, and the same TCP/IP level and fieldbus level controllers. Systems that require replacement of either the workstation software or field controllers in order to expand the system shall not be acceptable.
   2. Web-based operation shall be supported directly by the NSCs and require no additional software.
   3. The system shall be capable of using graphical and/or line application programming language for the Network Server Controllers.
   4. The system shall be able to operate normally and without restriction at multiple software version levels with the only requirement that each element of the hierarchy be at least as new a version as the newest version in the level below it. In other words, Enterprise Servers will be able to manage NSCs of different version provided that the Enterprise Server was the same or more recent version than the most recent NSC version.

I. All Network Server Controllers must natively support the BACnet IP, BACnet MS/TP, Modbus TCP, Modbus RTU (RS-485 and RS-232), and Modbus ASCII protocols.

2.5 OPERATOR WORKSTATION REQUIREMENTS

A. General
1. The operator workstation portion of the BAS shall consist of one or more full-powered configuration and programming workstations, and one or more web-based operator workstations. For this project provide a minimum of 3 concurrent client licenses at the enterprise level. Client licenses are licenses that can be used for variable designations of the users choosing; i.e. operator, engineering, or web capabilities.
2. The programming and configuration workstation software shall allow any user with adequate permission to create and/or modify any or all parts of the NSC and/or Enterprise Server database. All field level controllers must have the ability to be programmed by site personnel from a BAS contractor supplied and licensed programming tool or N4 embedded programming tool jar file.
3. At the NSC level, there shall be no cap on concurrent web-based workstations (webstations) other than what the CPU capacity can support.
4. All configuration workstations shall be desktop personal computers operating under the Microsoft Windows operating system. The application software shall be capable of communication to all Network Server Controllers and shall feature high-resolution color graphics, alarming, trend charting. It shall be user configurable for all data collection and data presentation functions.
5. A minimum of 1 physical Workstation shall be allowed on the Ethernet network. In this client/server configuration, any changes or additions made from one workstation will automatically appear on all other workstations since the changes are accomplished to the databases within the NSC. Systems with a central database will not be acceptable.

B. N4 Supervisor, Administration/Programming Workstation, and Webstation requirements
1. The N4 Supervisor shall consist of the following:
    a. Processor
        1) Minimum: Intel Xeon CPU E5-2640 x64 (or better) compatible with dual and quad core processors
    b. Memory
        1) 64GB or higher recommended
    c. Operating systems:
        1) Microsoft Windows 10 64-bit
        2) Microsoft Windows 11 64-bit
        3) Microsoft Windows Server 2016
        4) Microsoft Windows Server 2019
    d. 10/100MBPS Ethernet NIC
    e. Storage
        1) Minimum: 1TB or higher
        2) Solid State Drive recommended
    f. Required additional software:
        1) Microsoft .Net 4.7.2 and later
    g. License agreement for all applicable software

2. The Workstation shall consist of the following:
    a. Processor
        1) Minimum: Intel Core i5 @ 2.0 GHz or equivalent

2) Recommended: Intel Core i5 @ 3.0 GHz or better
b. Memory
1) Minimum: 8GB or higher
c. Operating systems:
1) Microsoft Windows 10 64-bit
2) Microsoft Windows 11 64-bit
3) Microsoft Windows Server 2016
4) Microsoft Windows Server 2019
d. 10/100MBPS Ethernet NIC
e. Storage
1) Minimum: 20GB
2) Recommended: 1TB
3) Solid State Drive recommended
f. Required additional software:
1) Microsoft .Net 4.7.2 and later
g. License agreement for all applicable software

3. Web-Based Operator PC Requirements
a. Any user on the network can access the system, using the following software:
b. Minimum:
1) Google Chrome 61 or higher
2) Mozilla Firefox 60 or higher
3) Microsoft Edge (EdgeHTML) 16 or higher
4) Safari 11.1 or higher
c. Recommended:
1) Google Chrome 71 or higher
2) Mozilla Firefox 64 or higher
3) Microsoft Edge (EdgeHTML) 17 or higher
4) Safari 11.4 or higher

C. General Administration and Programming Workstation Software
1. System architecture shall be truly client server in that the Workstation shall operate as the client while the NSCs shall operate as the servers. The client is responsible for the data presentation and validation of inputs while the server is responsible for data gathering and delivery.
2. The workstation functions shall include monitoring and programming of all DDC controllers. All field level controllers must have the ability to be programmed from the N4 workstation software.
3. Monitoring consists of alarming, reporting, graphic displays, long term data storage, automatic data collection, and operator-initiated control actions such as schedule and setpoint adjustments.
4. Programming of SDCUs shall be capable of being done either off-line or on-line from any operator workstation. All information will be available in graphic or text displays stored at the NSC. Graphic displays will feature animation effects to enhance the presentation of the data, to alert operators of problems, and to facilitate location of information throughout the DDC system. All operator functions shall be selectable through a mouse.

D. User Interface:
   1. The BAS workstation software shall allow the creation of a custom, browser-style interface linked to the user when logging into any workstation. Additionally, it shall be possible to create customized workspaces that can be assigned to user groups. This interface shall support the creation of “hot-spots” that the user may link to view/edit any object in the system or run any object editor or configuration tool contained in the software. Furthermore, this interface must be able to be configured to become a user’s “PC Desktop” – with all the links that a user needs to run other applications. This, along with the Windows user security capabilities, will enable a system administrator to setup workstation accounts that not only limit the capabilities of the user within the BAS software, but may also limit what a user can do on the PC and/or LAN/WAN. This might be used to ensure, for example, that the user of an alarm monitoring workstation is unable to shutdown the active alarm viewer and/or unable to load software onto the PC.
   2. System shall be able to automatically switch between displayed metric vs. imperial units based on the workstation/webstations localization.
   3. The BMS workstation/webstations shall be capable of multiple language display, including English, Spanish, German, French, Japanese, Italian, Finnish, Portuguese, Swedish, Russian, and traditional and simplified Chinese. The multiple languages shall not require additional add on software from the standard workstation installer and shall be selectable within said workstation.
   4. Webstations shall have the capability to automatically re-direct to an HTTPS connection to ensure more secure communications.
   5. Personalized layouts and panels within workstations shall be extended to webstations to ensure consistent user experiences between the two user interfaces.
   6. Webstations shall give the user the same capabilities within the graphics pages as are given within the workstation but shall be mobile responsive for use on smaller devices.
   7. Servers and clients shall have the ability to be located in different time zones, which are then synchronized via the NTP server.
   8. Workstation shall indicate at all times the communication status between it and the server.
   9. The BMS web interface shall enable presentation mode whereby any functionality for interactivity shall be disabled.
   10. The BMS web interface shall automatically detect light mode and dark mode settings in the operating system and adapt accordingly.
   11. The BMS web interface shall allow override of the operating systems light/dark mode settings so that the setting can be enabled independent of the operating system’s setting.
   12. The BMS web interface shall automatically respond and adapt to different screen sizes and orientations from smart phone to smart televisions of any size.
   13. The BMS web interface shall support slideshow functionality.
   14. The BMS web interface shall support full screen mode displaying Alarm views / graphics / dashboards / Custom Reports.

E. User Access and Permissions
   1. The BMS system shall allow for creation of one account per user.

2. The BMS shall support Groups where User Accounts associated with the group can inherit group permissions.
3. The BMS shall be able to specify each user account / group accessibility to each object in the system.
4. The BMS permission system shall be possible to integrate with Windows Active directory.
5. The BMS shall be able to report on the permission level across account / group for review / archiving / audit.
6. This username/password combination shall be linked to a set of capabilities within the software, set and editable only by user with system administrator privileges. The sets of capabilities shall include: edit or View only, Acknowledge alarms, Enable/disable Program and change values.
7. The system shall allow the above capabilities to be applied independently to each and every class of object in the system.
8. The BMS shall support integration with Windows Active Directory for user log on credentials.
9. The BMS shall support configurable reminder for “Days until password expires”.
10. The BMS shall support configurable password policy across:
    a. Minimum number of characters
    b. Minimum number of lowercase characters
    c. Minimum number of numeric characters
    d. Minimum number of special characters
    e. Number of consecutive unique passwords before reuse
    f. No more than three repeating identical characters
11. The BMS user account management shall support password policy with the following components:
    a. Mandatory change of password at first logon with default credentials
    a. Disabling of all imported user accounts by default
    b. Custom password complexity rules and its enforcement
    c. Custom password reuse and its enforcement
    d. Configurable black listing of passwords to limit the use of common known passwords (e.g. password)
    e. Password aging rules
12. The BMS shall be capable of enabling an anonymous access (guest account) to previously engineered views such as dashboards, graphics, etc. with configurable permissions and without username or password.
13. It shall be possible to configure the BMS system so that the guest account is used by default to simplify presentation of Kiosk Mode across multiple screens
14. The BMS shall provide time configurability to logout the user and to revert to a preconfigured presentation view, such as offered by the Guest account functionality.
15. The BMS shall provide configurability in managing access and permission levels based on location, IP addresses and address ranges, Schedule and Time of day and combination thereof.

F. System Security
    1. The BMS system supplier shall be subjected to regular and verifiable best practice cyber security testing by the system supplier. Results of this testing shall be made available upon request prior to deployment of the system.

2. The BMS system supplier shall provide cyber security service incident escalation through help desk on a 7/24/365 basis.
3. The BMS shall support configuration for inactivity auto log-off of logged clients
4. The BMS system shall support Self-Signed Certificates, Default Certificates and/or Certification Authority (CA) certificates.
5. The BMS client communications (web access or rich client access) shall support TLS 1.2 encryption or higher
6. The BMS shall allow configuration in disabling all devices and software that support HTTP and require access via HTTPS.
7. The BMS must be able to Alarm or generate notification on failed access attempts
8. The BMS Servers shall support SNMP V3 monitoring of network performance and stack statistics for the purpose of managing denial of service attacks
9. The Integrated Control Platform shall support the feature to alarm on a predetermined period of time until the default password for each device is changed from the default factory setting.
10. The Integrated Control Platform shall support encrypted password authentication for all web services whether serving or consuming.
11. The BMS shall have the capability to use blacklisted and whitelisted IPs/MAC addresses to gate access
12. The BMS shall have the capability to differentiate, limit or enable, user access depending on Client's IP address/range (where) and time of day (when) the user is accessing the system.

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

H. Color Graphic Displays
1. The system shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems or building schematics. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition, operators shall be able to command equipment or change setpoints from a graphic through the use of the mouse.

2. Requirements of the color graphic subsystem include:
   a. At a minimum, the user shall have the ability to import .gif, .png, .bmp, .jpeg, .tif, and CAD generated picture files as background displays, and layering shall be possible.
   b. The system shall support HTML5 enabled graphics.
   c. It shall be possible for the user to use JavaScript to customize the behavior of each graphic.
   d. The editor shall use Scalable Vector Graphics (SVG) technology.
   e. A built-in library of animated objects such as dampers, fans, pumps, buttons, knobs, gauges, ad graphs which can be “dropped” on a graphic through the use of a software configuration “wizard”. These objects shall enable operators to interact with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels.
   f. Support for high DPI icons shall be included and automatically chosen if viewing on a high definition display such as Retina or 4K displays.
   g. Using the mouse, operators shall be able to adjust setpoints, start or stop equipment, modify PID loop parameters, or change schedules.
   h. Status changes or alarm conditions must be able to be highlighted by objects changing screen location, size, color, text, blinking or changing from one display to another.
   i. Ability to link graphic displays through user defined objects, alarm testing, or the result of a mathematical expression. Operators must be able to change from one graphic to another by selecting an object with a mouse - no menus will be required.
   j. It shall be possible to create and save graphical components and JavaScript code in reusable and transferrable, customized libraries.
   k. Graphics should rescale based on whatever monitor or viewing device is being used.
   l. Be able to create graphics on varying layers that can be moved and repeated.
   m. Be able to create graphics within varying window panes that can be moved and/or re-referenced. For example, creating the graphical menu within a pane and referencing it on every graphics page, therefore not rebuilding thus allowing for a single spot for updates that get pushed to all the pages that reference it.
   n. The ability to create re-usable cascading menus.
   o. The ability to have multiple instances of a graphic and edit one instance to change all.
3. Additionally, the Graphics Editor portion of the Engineering Software shall provide the following capabilities:
   a. Create and save pages.
   b. Group and ungroup symbols.
   c. Modify an existing symbol.
   d. Modify an existing graphic page.
   e. Rotate and mirror a symbol.
   f. Place a symbol on a page.
   g. Place analog dynamic data in decimal format on a page.
   h. Place binary dynamic data using state descriptors on a page.
   i. Create motion through the use of animated .gif files or JavaScript.

j. Place test mode indication on a page.
k. Place manual mode indication on a page.
l. Place links using a fixed symbol or flyover on a page.
m. Links to other graphics.
n. Links to web sites.
o. Links to notes.
p. Links to time schedules.
q. Links to any .exe file on the operator work station.
r. Links to .doc files.
s. Assign a background color.
t. Assign a foreground color.
u. Place alarm indicators on a page.
v. Change symbol/text/value color as a function of an analog variable.
w. Change a symbol/text/value color as a function of a binary state.
x. Change symbol/text/value as a function of a binary state.

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

J. Alarm Management
1. The software shall be capable of accepting alarms directly from NSCs or controllers, or generating alarms based on evaluation of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm (regardless of its origination) will be integrated into the overall alarm management system and will appear in all standard alarm reports, be available for operator acknowledgment, and have the option for displaying graphics, or reports.
2. Alarm management features shall include:
a. A minimum of 1000 alarm notification levels at the NSC, workstation, and webstation levels.
b. Each notification level will establish a unique set of parameters for controlling alarm display, distribution, acknowledgment, keyboard annunciation, and record keeping.
c. At the N4 Supervisor level the minimum number of active and viewable alarms shall be 10,000.
d. It shall be possible for the user to sort, filter and search on any available criteria such as priority, category, origin, alarm type, etc.
e. An active alarm viewer shall be included which can be customized for each user or user type to a hide or display any alarm attributes.
f. It shall be possible to present alarms with configurable colors based on priority, category, origin, alarm type, etc.
g. It shall be possible to linking files/documents/hyperlinks/navigation links/graphics link to an alarm for easy access upon occurrence
h. Automatic logging in the database of the alarm message, point name, point value, source device, timestamp of alarm, username and time of acknowledgement, username and time of alarm silence (soft acknowledgement).
i. Alarm notifications must support multiple distribution methods within one notification

j. On alarm, it shall be possible to notify via email to a preconfigured list of recipients. through a Simple Mail Transfer Protocol (SMTP) or secure email using Simple Mail Transfer Protocol Secure (SMTPS). No special software interfaces shall be required and no email client software must be running in order for email to be distributed. The email notification shall be able to be sent to an individual user or a user group.
k. On alarm, it shall be possible to notify via SNMP
l. On alarm, it shall be possible to notify via file (on disk) that would be consumable by other alarm management services
m. An operator shall have the capability to assign an alarm to another user of the system.
n. Individual alarms shall be able to be assigned to a user automatically via a preconfigured list of users and date/time. For example, a critical high temp alarm can be configured to be assigned to a Facilities Dept or to a Central Alarming workstation depending on time/date.
o. Playing an audible sound on alarm initiation or return to normal.
p. It shall be possible assigning a custom audio sound to each alarm / alarm-criteria (priority, category, origin, alarm type, etc.)
q. The active alarm viewer can be configured such that an operator must confirm that all of the steps in a check list have been accomplished prior to acknowledging the alarm.
r. The active alarm viewer shall, if filtered, show the quantity of visible and total number of alarms that are not equal to ‘normal’ and the quantity of disabled and hidden alarms.
s. The alarm viewer can be configured to auto hide alarms when triggered.
t. An operator shall have the capability to save and apply alarm favorites.
u. Alarms shall be configurable such that an operator must type in text in an alarm entry and/or pick from a drop-down list of user actions for certain alarms.
v. Alarms shall be configurable such that an operator must type in text in an alarm entry and/or pick from a drop-down list of causes for certain alarms. This ensures accountability (audit trail) for the response to critical alarms.
w. It shall be possible to configure user-actions via user/group permissions when responding to an alarm
x. All operator actions responding to an alarm must be audit trailed.

K. Static Paginated Reporting / Custom Reporting
1. The BMS Software and Network Servers shall support built-in native reporting capability without dependency on any external software
2. It shall be possible to generate custom reports manually, via Schedule, Alarm triggered or custom conditions (e.g. program/schedule/etc.)
3. The Custom Reporting shall have no dependency on external database
4. The Custom Reporting shall have the capability of reporting on the full range of available data, most recent to historical data.
5. It shall be possible to generate reports containing current active alarms
6. The Building Management System software shall natively be capable of producing custom repots in txt, xlxs and pdf file formats.
7. The Custom Report capability at the BMS software shall support digital signing of pdf for traceability and authenticity.

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

M. Programmer's Environment
1. Programming in the NSC shall be in graphical block format.
2. Programming of the NSC shall be available offline from system prior to deployment into the field. All engineering tasks shall be possible, except, of course, the viewing of live tasks or values.
3. The programmer's environment will include access to a superset of the same programming language supported in the SDCUs.
4. NSC devices will support a graphical function block programming language.
5. It shall be possible to save custom programs as libraries for reuse throughout the system. A wizard tool shall be available for loading programs from a library file in the program editor.
6. It shall be possible to view graphical programming live and real-time from the Workstation.
7. Key terms should appear when typing (IntelliType).
8. Applications should be able to be assigned different priorities and cycle times for a prioritized execution of different function.
9. The system shall be able to create objects that allow common objects such as power meters, VFD drives, etc. to be integrated into the system with simple import actions without the need of complicated programming or configuration setups.

N. Saving/Reloading
1. The workstation software shall have an application to save and restore NSC and field controller memory files.

2. For the NSC, this application shall not be limited to saving and reloading an entire controller – it must also be able to save/reload individual objects in the controller. This allows off-line debugging of control programs, for example, and then reloading of just the modified information.

O. Audit Trail
1. The workstation software shall automatically log and timestamp every operation that a user performs at a workstation, from logging on and off a workstation to changing a point value, modifying a program, enabling/disabling an object, viewing a graphic display, running a report, modifying a schedule, etc.
2. It shall be possible to view a history of alarms, user actions, and commands for any system object individually or at least the last 5000 records of all events for the entire system from Workstation.
3. The N4 Supervisor shall be able to store up to 5 million events.
4. The event view shall support viewing of up to 100,000 events.
5. It shall be possible to save custom filtered views of event information that are viewable and configurable in Workstation.
6. It shall be capable to search and view all forced values within the system.

P. Fault Tolerant N4 Supervisor Operation (Top level NSC)
1. A single component failure in the system shall not cause the entire system to fail. All system users shall be informed of any detectable component failure via an alarm event. System users shall not be logged off as a result of a system failure or switchover.

Q. Web-based Operator Software
1. General:
   a. Day-to-day operation of the system shall be accessible through a standard web browser interface, allowing technicians and operators to view any part of the system from anywhere on the network.
   b. The system shall be able to be accessed on site via a mobile device environment with, at a minimum, access to overwrite and view system values.
   c. Through the browser interface, operators must be able to view pre-defined groups of points, with their values updated automatically.
2. Graphic Displays
   a. The browser-based interface must share the same graphical displays as the Administration and Programming Workstations, presenting dynamic data on site layouts, floor plans, and equipment graphics. The browser's graphics shall support commands to change setpoints, enable/disable equipment and start/stop equipment.
   b. Through the browser-based interface, operators must be able to navigate through the entire system, and change the value or status of any point in any controller. Changes are effective immediately to the controller, with a record of the change stored in the system database.
   c. System shall have out-of-the-box dashboards that enable customizable views of live data which can be public to all users or capable to make them specific to a user based on log in credentials.
   d. The user shall have the ability to create custom dashboards.

e. The dashboards shall have a kiosk mode which allows for occupant level data display on monitors or tablets throughout the building.

3. Alarm Management
   a. Systems requiring additional client software to be installed on a PC for viewing the webstation from that PC will not be considered.
   b. Through the browser interface, a live alarm viewer identical to the alarm viewer on the Administration and Programming workstation shall be presented, if the user's password allows it. Users must be able to receive alarms, silence alarms, and acknowledge alarms through a browser. If desired, specific operator text must be able to be added to the alarm record before acknowledgement, attachments shall be viewable, and alarm checklists shall be available.

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

S. User Accounts and Audit Trail
   1. The same user accounts shall be used for the browser interface and for the operator workstations. Operators must not be forced to memorize multiple passwords.

T. All commands and user activity through the browser interface shall be recorded in the system's activity log, which can be later searched and retrieved by user, date, or both.

2.6 NETWORK SERVER CONTROLLERS (NSC: ALSO KNOWN AS JACE-8000)

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

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

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

D. The NSCs shall be capable of whitelisting IPs to restrict access to a pre-defined list of hosts or devices.

E. Whitelisting of file extensions for documents shall be capable.

F. Encrypted and authenticated communication shall be configurable for non-open protocol communications using TLS 1.2.

G. The NSCs shall support Simple Network Management Protocol version 3 (SNMPv3) for monitoring of the NSCs using a Network Management Tool.

H. The NSCs shall support remote system logging for used by System Information and Event Monitoring (SIEM) software.

I. They shall also be responsible for monitoring and controlling their own HVAC equipment such as an AHU or boiler.

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

K. It shall be capable of executing application control programs to provide:
1. Calendar functions
2. Scheduling
3. Trending
4. Alarm monitoring and routing
5. Time synchronization by means of an Internet site including automatic synchronization
6. Native integration of LonWorks controller data and Modbus controller data or BACnet controller data and Modbus controller data
7. Network Management functions for all LonWorks based devices

L. Hardware Specifications
1. Memory:
    a. The operating system of the controller, application programs, and all other portions of the configuration database, shall be stored in non-volatile, FLASH memory. Servers/Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory.
2. Each JACE-8000 shall provide the following on-board hardware for communication:
    a. Two 10/100b Ethernet for communication to Workstations, other NRCs, IP field bus controllers, other SDCUs, and onto the internet.
        1) The two Ethernet ports shall support active switch and BACnet/IP communication protocols.
        2) Support IPv4 addressing
        3) Ethernet port 1 shall support static or DHCP client configuration for communication to Workstation or other NSCs
        4) Ethernet port 2 shall support switch mode or DHCP server to set addressing of DHCP client devices
        5) It shall be possible to disable Ethernet port 2
        6) In DHCP server mode, the Ethernet port 2 shall support 50 BACnet/IP field controllers in daisy chain configuration directly from the port
        7) Where a switch is needed, use an approved model from owner’s information technology dept.

b. Two RS-485 ports for communication to BACnet MSTP bus or serial Modbus (software configurable)
c. One device USB port
d. One host USB port

3. The NSC shall conform to a small footprint no larger than 100W x 125H x 75D mm (3.94W x 4.92H x 2.95D in).

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

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

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

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

Q. Real Time Clock (RTC):
   1. Each NSC shall include a real time clock, accurate to 10 seconds per day. The RTC shall provide the following: time of day, day, month, year, and day of week. Each NSC will allow for its own UTC offset, depending upon the time zone. When the time zone is set, the NSC will also store the appropriate times for daylight savings time.
   2. The RTC date and time shall also be accurate, up to 10 days, when the NSC is powerless.
   3. No batteries may be used to for the backup of the RTC.

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

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

T. Data Retention:
   1. During a power failure, the NSC shall retain all programs, configuration data, historical data, and all other data that is configured to be retained. There shall be no time restriction for this retention and it must not use batteries to achieve it.

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

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

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

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

Y. NSCs shall have the ability to perform any or all of the following energy management routines:
   1. Time of Day Scheduling
   2. Calendar Based Scheduling
   3. Holiday Scheduling
   4. Temporary Schedule Overrides
   5. Optimal Start
   6. Optimal Stop
   7. Night Setback Control
   8. Enthalpy Switchover (Economizer)
   9. Peak Demand Limiting
   10. Temperature Compensated Duty Cycling
   11. CFM Tracking
   12. Heating/Cooling Interlock
   13. Hot Water Reset

Z. History Logging:
1. Each NSC controller shall be capable of LOCALLY logging any input, output, calculated value or other system variable either over user defined time intervals ranging from 1 second to 1440 minutes or based upon a user configurable change of value. A minimum of 1000 logs, with a minimum of 100,000 records, shall be stored. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to a higher level NSC long term archiving based upon user-defined time intervals, or manual command.
2. For extended trend logging a minimum of 1500 trends shall be capable, with a minimum number of 600,000 records within.
3. Management of a power meter replacement to ensure meter log data is accurate shall be possible in the NSC.
4. Every hardware input and output point, hosted within the NSC and attached I/O modules, shall be trended automatically without the requirement for manual creation, and each of these logs shall log values based upon a change of value and store at least 500 trend samples before replacing the oldest sample with new data.
5. The presentation of logged data shall be built into the server capabilities of the NSC. Presentation can be in time stamped list formats or in a chart format with fully configurable pen colors, weights, scales and time spans.
6. Tooltips shall be present, magnetic, and visible based on users preference.
7. Comments shall be visible whenever viewing the trend log list.
8. System shall give indication of memory usage and be able to alert the user if too many logs are allocated.
9. The BMS software and Network Servers shall support recording of all historical data, independent of any limitation in its local memory, which will be readily available for reporting and analysis without additional configurations or actions.
10. All historical data shall be available for use by the operator to access in BMS or a third-party reporting systems.

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

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

BB. Embedded Web Server
1. Each NSC must have the ability to serve out web pages containing the same information that is available from the WorkStation. The development of the screens to accomplish shall not require any additional engineering labor over that required to show them at the WorkStation itself.
2. The NSC shall be configurable to logging all Embedded Web Server access attempts
3. The NSC shall have the option to redirect HTTP based Embedded Web Server connections to secure, HTTPS connections.
4. The NSC shall authenticate and authorize all users connecting to the Embedded Web Server
5. The NSC shall provide to ability to configure an automatic logoff for Embedded Web Server users that have not had any activity for an adjustable time period.

CC. The NSC controller shall comply with the following regulatory certifications
1. CE – EN 61000-6-3
2. CE – EN 61000-6-2
3. CE – EN 61010-1
4. CE – EN 61326-1
5. FCC CFR 47 Part 15 Class A
6. RCM
7. RoHS 2011/65/EU
8. China RoHS SJ/T 11364-2014
9. UL916 Energy Management equipment

DD. HMI
1. The NSC shall have an option for a tablet display
2. The tablet display shall be an industrial grade Human Machine Interface (HMI) that can be locked to the building management application to create a dedicated tool for local operation and maintenance.
3. The tablet display shall provide an easy-to-use interface through which users and engineers can locally access NSC’s
4. The tablet display shall always start in a kiosk mode ensuring the end user can only use the device using the installed integration with the NSC.
5. The tablet display shall always require a password on start up
6. The tablet display shall require a password after a defined period of inactivity
7. The tablet display shall support being handheld or being installed on a control cabinet.
8. The tablet display user interface shall provide touchscreen navigation making it easy to operate and maintain the system.
9. The tablet display shall support robust physical panel mounting mechanisms provided with the product.
10. The tablet display shall have a screen size of 255mm or 10.1 inches
11. The tablet display shall support a screen resolution of 1280 by 800 pixels
12. The tablet display shall have a 16:10 aspect ratio
13. The tablet display shall be based on the Android platform

14. The tablet display shall have an IP54 rated frame that helps protect against dust and moisture.
15. The tablet display shall be powered by a 24 VDC power supply
16. The tablet display can be powered by a 24 VDC through the Y-shaped cable
17. The tablet display shall be able to communicate with the NSC over a wired (USB) connection running BACnet IP over USB.
18. The tablet display shall have an accessory Wi-Fi Module is an option instead of using USB for communication.
    a. Through the Wi-Fi module, you can establish wireless communication between the tablet display and the NCS connected to a wireless access point.
    b. The Wi-Fi module shall have an adhesive mount Wi-Fi antenna.
    c. The Wi-Fi module shall be compliant with IEEE 802.11 b/g/n
    d. The Wi-Fi module shall support enhanced wireless security using 64-bit and 128-bit WEP encryption
19. The tablet display shall connect to the NSC using only secure, HTTPS connections via the WebStation functionality of the NSC
20. The tablet display shall connect using a specific user and password combination defined as part of the NSC configuration

2.7 BACNET IP FIELDBUS CONTROLLERS

A. Controllers – BACnet/IP Protocol
   1. All BACnet/IP Fieldbus controllers shall be BACnet Testing Laboratory listed (v12 or later) as specified BACnet Advanced Application Controller (B-AAC)
   2. All BACnet/IP Fieldbus controllers shall use the following communication specifications and achieve performance as specified herein:
      a. All controllers shall be able to communicate peer-to-peer without the need for a NSC
      b. Any BACnet/IP Fieldbus controllers on the Ethernet Data Link/Physical layer shall be able to act as a Master to allow for the exchange and sharing of data variables and messages with any other controller connected on the same communication cabling. Slave controllers are not acceptable.

B. The BACnet/IP Fieldbus controllers shall be equipped with 2x 10/100bT Ethernet communication ports with active switch and will support BACnet/IP communication protocols with the following configurations:
   1. Supporting IPv4 addressing
   2. Supporting Static IP setting, DHCP client and Auto-IP address acquisition
   3. It shall be possible to disable Ethernet port 2

C. Topologies
   1. BACnet/IP Fieldbus controllers shall support daisy chain topology of up to 50 controllers. In case of any disruption to the communication, a system alarm shall notify the NSC/BMS of the point disruption has occurred.
   2. BACnet/IP Fieldbus Controllers shall support RSTP loop whereby up to 39 controllers are supported.
      a. In case of any disruption there shall be no communication interruption
      b. In case of any disruption there shall be system alarms that will inform the operator of the disruption

D. Performance
   1. Each BACnet/IP Fieldbus Controllers shall have a 32-bit microprocessor operating at 500 MHz and support a BACnet protocol stack in accordance with the ANSI/ASHRAE Standard 135-2008 and the BACnet Device Profile supported.
   2. They shall be multi-tasking, real-time digital control processors consisting of communication controllers, controls processing, power supplies with built-in inputs and outputs.

E. Programmability
   1. The BACnet/IP Fieldbus controllers shall support both script programming language and graphical that will be consistent with the NSC.
   2. The control program will reside within the same enclosure as the input/output circuitry, that reads inputs and controls outputs
   3. All control sequences programmed into the BACnet/IP Fieldbus Controllers shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.
   4. BACnet/IP Fieldbus controllers shall communicate with the Network Server Controller (NSC) via a BACnet/IP connection at a baud rate of not less than 100 Mbps
   5. BACnet/IP Fieldbus controllers shall support a dedicated communications port for connecting and supplying power to a matching room temperature and/or humidity sensor and/or CO2 and/or presence detector that does not utilize any of the I/O points of the controller.
   6. BACnet/IP Fieldbus controllers (Excluding VAV) shall support an add-on display to supply and provide access in real-time for monitoring inputs and overriding of outputs
   7. The override functionality must be supported by a dedicated processor to assure reliable operation (overriding of output)
   8. Each BACnet/IP Fieldbus controller shall have sufficient memory, to support its own operating system and databases, including:
      a. Control processes
      b. Energy management applications
      c. Alarm management
      d. Historical/trend data
      e. Maintenance support applications
      f. Custom processes
      g. Manal override monitoring
   9. Each BACnet/IP Fieldbus controller shall support local trend data up to 2x the built-in I/O and at a minimum be capable of holding 5 days @ 15 min intervals locally.
   10. The BACnet/IP Fieldbus controller analog or universal input shall use a 16 bit A/D converter.
   11. The BACnet/IP Fieldbus controller analog or universal output shall use a 10 bit D/A converter.

12. Built-in I/O: each BACnet/IP Fieldbus controllers shall support:
    a. At minimum 8 and up to 20 configurable IO channels to monitor and to control the following types of inputs and outputs without the addition of equipment inside or outside the DDC Controller cabinet.
        1) Universal Inputs – the following thermistors for use in the system without any external converters needed.
            a) 10 kohm Type I
            b) 10 kohm Type II
            c) 10 kohm Type III
            d) 10 kohm Type IV
            e) Linearized 10 kohm Type V (FD w/11k shunt)
            f) Linearized 10 kohm
            g) 1.8 kohm
            h) 1 kohm
            i) 20 kohm
            j) 2.2 kohm
            k) PT100
            l) PT1000
            m) Ni1000
        2) Analog inputs
            a) Current Input - 0-20 mA
            b) Voltage Input 0-10 Vdc
        3) Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
        4) Digital outputs
        5) Analog outputs of 4-20 mA and/or 0-10 Vdc
13. Real Time Clock (RTC):
    a. Provide internal clocks for all BACnet Controllers (B-AAC) using BACnet time synchronization services.
        1) Automatically synchronize system clocks daily from an operator-designated controller.
        2) The system shall automatically adjust for daylight saving time.
    b. Each BACnet/IP Fieldbus controller shall include a real time clock, accurate to +/-1 minute per month.
    c. The RTC shall provide the following: time of day, day, month, year, and day of week.
    d. The RTC date and time shall also be accurate up to 7 days, from when the BACnet/IP Fieldbus controller has lost power with no reliance on.
14. The BACnet/IP Fieldbus controller for Variable Air Volume (VAV) applications
    a. The BACnet/IP Fieldbus controller for VAV applications shall include a built-in ‘flow thru’ differential pressure transducer
    b. The VAV differential pressure transducer shall have a measurement range of 0 to 1 in. W.C. and measurement accuracy of ±5% at 0.001 to 1 in. W.C. and a minimum resolution of 0.001 in. W.C., insuring primary air flow conditions shall be controlled and maintained to within ±5% of setpoint at the specified minimum and maximum air flow parameters
    c. The BACnet/IP FieldBus controller for VAV applications shall support a dedicated commissioning tool for air flow balancing

d. The BACnet/IP Fieldbus controller for VAV applications shall require no programing for air balancing algorithm
e. All balancing parameters shall be synchronized in NSC

15. Each BACnet/IP Fieldbus controller shall have a minimum of 10% spare capacity for each point type represented on the controller for future point connection
16. Power Requirements. 24VDC (21 to 33 VDC) and 24 VAC +/-20% with local transformer power
17. The BACnet/IP Fieldbus controller shall comply with the following regulatory certifications
    a. CE - EMCD 2014/30/EU
    b. CE LVD 2014/35/EU
    c. FCC CFR 47 Part 15 Class B
    d. RCM
    e. RoHS 2011/65/EU
    f. China RoHS SJ/T 11364-2014
    g. UL2043 (Plenum space mounting)
    h. UL916 Open-Energy Management equipment
    i. UL916 Energy Management equipment
18. Intelligent Space Sensor Interface –
    a. The BACnet/IP Fieldbus controllers shall support a dedicated RJ45 communication port to communicate and power up to 4 intelligent wall mount sensors without the use of on-board inputs or outputs
    b. It shall be possible to disable the RJ45 communication port.
19. The BACnet/IP Fieldbus controller for Connected Room solutions
    a. All BACnet/IP Fieldbus controllers shall be BACnet Testing Laboratory listed (v14 or later) as specified BACnet Advanced Application Controller (B-AAC)
    b. All BACnet/IP Fieldbus controllers shall use the following communication specifications and achieve performance as specified herein:
        1) All controllers shall be able to communicate peer-to-peer without the need for an NSC
        2) Any BACnet/IP Fieldbus controllers on the Ethernet Data Link/Physical layer shall be able to act as a Master to allow for the exchange and sharing of data variables and messages with any other controller connected on the same communication cabling. Slave controllers are not acceptable.
    c. The BACnet/IP Fieldbus controllers shall be equipped with 2x 10/100bT Ethernet communication ports with active switch and will support BACnet/IP communication protocols with the following configurations:
        1) Supporting IPv4 addressing
        2) Supporting Static IP setting, DHCP client and Auto-IP address acquisition
        3) It shall be possible to disable Ethernet port 2
        4) Each BACnet/IP controller shall be configurable to restrict communications to only whitelisted IP addresses.

d. Topologies
   1) BACnet/IP Fieldbus controllers shall support daisy chain topology of up to 50 controllers. In case of any disruption to the communication, a system alarm shall notify the NSC/BMS of the point disruption has occurred.
   2) BACnet/IP Fieldbus Controllers shall support RSTP loop whereby up to 39 controllers are supported.
      a) In case of any disruption there shall be no communication interruption
      b) In case of any disruption there shall be system alarms that will inform the operator of the disruption

e. Performance
   1) Each BACnet/IP Fieldbus Controllers shall have a 32-bit microprocessor operating at 500 MHz and support a BACnet protocol stack in accordance with the ANSI/ASHRAE Standard 135-2012 and the BACnet Device Profile supported.
   2) They shall be multi-tasking, real-time digital control processors consisting of communication controllers, controls processing, power supplies with built-in inputs and outputs.
   3) Each BACnet/IP Fieldbus Controllers shall support upgrade of its firmware with no impact to its operation

f. Programmability
   1) The BACnet/IP Fieldbus controllers shall support graphical programming that will be consistent with the NSC.
   2) The control program will reside within the same enclosure as the input/output circuitry, that reads inputs and controls outputs
   3) All control sequences programmed into the BACnet/IP Fieldbus Controllers shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.
   4) The BACnet/IP Fieldbus controllers shall communicate with the Network Server Controller (NSC) via a BACnet/IP connection at a baud rate of not less than 100 Mbps
   5) The BACnet/IP Fieldbus controllers shall support two RS485 communication ports for connecting and supplying power to a range of protocol types
      a) BACnet/IP Fieldbus controllers shall support configurable selection of the supported protocol on the RS485 communications ports,
      b) BACnet/IP Fieldbus controllers shall support a communications capability for connecting and supplying power to a matching room temperature and/or humidity sensor and/or CO2 and/or presence detector that does not utilize any of the I/O points of the controller.
      c) BACnet/IP Fieldbus controllers shall support a communications capability for connecting and supplying power to a matching connected module for the purpose of control of lights and blinds that do not utilize any of the I/O points of the controller
      d) BACnet/IP Fieldbus controllers shall support a communications capability for connecting to open market Modbus devices

g. Each BACnet/IP Fieldbus controller shall have sufficient memory, to support its own operating system and databases, including:
   1) Control processes
   2) Energy management applications
   3) Alarm management
   4) Historical/trend data
   5) Maintenance support applications
   6) Custom processes

h. In the case of communication disruption between the BACnet/IP Fieldbus controller and NSC/BMS, each BACnet/IP Fieldbus controller shall support storage of local trend data up to 2x the number of its built-in I/O at the collection rate of 5 min for 5 days.

i. The BACnet/IP Fieldbus controller analog or universal input shall use a 16-bit A/D converter.

j. The BACnet/IP Fieldbus controller analog or universal output shall use a 10-bit D/A converter.

k. Built-in I/O: each BACnet/IP Fieldbus controllers shall support:
   1) Up to 8 configurable IO channels to monitor and to control the following types of inputs and outputs without the addition of equipment inside or outside the DDC Controller cabinet.
      a) Universal Inputs – the following thermistors for use in the system without any external converters needed.
      b) 10K Ohm Type I
      c) 10K Ohm Type II
      d) 10K Ohm Type III
      e) 10K Ohm Type IV
      f) Linearized 10K Ohm Type V (FD w/11k shunt)
      g) Linearized 10K Ohm
      h) 1.8K Ohm
      i) 1K Ohm
      j) 20K Ohm
      k) 2.2K Ohm
      l) PT100
      m) PT1000
      n) Ni1000 ,
      o) Voltage Input - 0-10 Vdc
      p) Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
      q) Digital outputs
      r) Analog outputs 0-10 Vdc

l. Internal Clock
   1) Provide internal clocks for all BACnet Controllers (B-AAC) using BACnet time synchronization services.
      a) Automatically synchronize system clocks daily from an operator-designated controller.
      b) The system shall automatically adjust for daylight saving time.
   2) Each BACnet/IP Fieldbus controller shall include a real time clock, accurate to +/-1 minute per month.

3) The RTC shall provide the following: time of day, day, month, year, and day of week.
4) The RTC date and time shall also be accurate up to 7 days, from when the BACnet/IP Fieldbus controller has lost power with no reliance on batteries.

m. Each BACnet/IP Fieldbus controller shall have a minimum of 10% spare capacity for each point type represented on the controller for future point connection.

n. Power Requirements. 24VDC (21 to 33 VDC) and 24 VAC +/-20% with local transformer power.
o. Power Requirements. A line voltage version shall be available 230 VAC
p. In the case of power disruption, each BACnet/IP Fieldbus controller shall support power failure recovery within 10 seconds and resume operation from where the disruption had occurred.
q. The BACnet/IP Fieldbus controller shall be able to be plenum mounted (UL2043 compliant).
r. The BACnet/IP Fieldbus controller shall meet the open class standard of UL916 permitting its installation without secondary enclosure where appropriate.
s. The BACnet/IP Fieldbus controller shall comply with the following regulatory certifications:
1) CE - EMCD 2014/30/EU
2) CE LVD 2014/35/EU
3) FCC CFR 47 Part 15 Class B
4) RCM
5) RoHS 2011/65/EU
6) China RoHS SJ/T 11364-2014
7) UL2043 (Plenum space mounting)
8) UL916 Open-Energy Management equipment
9) UL916 Energy Management equipment
t. Intelligent Space Sensor Interface - The BACnet/IP Fieldbus controllers shall support an RJ45 communication port to communicate and power up to 4 intelligent wall mount sensors without the use of on-board inputs or outputs.
1) It shall be possible to disable the RJ45 communication port

20. The BACnet/IP Fieldbus controller for remote IO
a. It shall be possible to extend Inputs / Outputs required in NSC or BACnet/IP Fieldbus Controllers over the IP network
b. The BACnet/IP IO expansion device shall be equipped with 2x 10/100bT Ethernet communication ports with active switch supporting the following configurations:
1) Supporting IPv4 addressing
2) Supporting Static IP setting, DHCP client and Auto-IP address acquisition
3) It shall be possible to disable Ethernet port 2
c. The BACnet/IP IO expansion device shall support daisy and RSTP topologies.

d. The BACnet/IP I/O expansion device shall be capable of sharing its local I/O resources with one or multiple applications distributed across one or multiple NSCs or BACnet/IP Fieldbus Controllers.
e. The BACnet/IP I/O expansion device shall support BACnet Alarm and Trend locally.
f. Outputs of the BACnet/IP I/O expansion device shall support user configurable fallback value that is triggered in case of communication disruption.

F. The Intelligent Space Sensor shall be capable of displaying measured space temperature from 0 to 50 °C (32 to 122 °F) with accuracy of ±0.2 °C (±0.4 °F) selectable for 0.1 or 1 degree display resolution of °F or °C
1. Sensing Element: 10k Type 3 Thermistor
2. Accuracy of ±0.2 °C (±0.4 °F)
3. Resolution: 0.1 or 1 degree display resolution
4. Range: 0 to 50 °C (32 to 122 °F)

G. The Intelligent Space Sensor shall have the option for humidity sensor support sensing humidity from 0 % RH to 100 % RH Digital humidity indication (selectable for 0.1 or 1% RH with selectable display resolution of 0.1 or 1 % RH
1. Accuracy: ±2 % RH
2. Resolution: 0.1 or 1 % RH
3. Range: 0 % RH to 100 % RH

H. The Intelligent Space Sensor shall have the option for support of CO2 sensor with display resolution with 0 to 2000 ppm resolution
1. Accuracy: ±30 ppm ±2% of measured value
2. Range: 0 to 2,000 ppm
3. Operating elevation: 0 to 16,000 ft.
4. Temperature dependence: 0.11% FS per ˚F
5. Stability: <2% of FS over life of sensor (15 years)
6. Sensing method: Non-dispersive infrared (NDIR), diffusion sampling

I. The Intelligent Space Sensor shall have the option for motion sensor

J. Display options: The Intelligent Space Sensor shall be capable of displaying the following elements:
1. Space temperature
2. Cooling space temperature set point
3. Heating space temperature set point
4. Current heating or cooling mode
5. Current occupancy mode
6. Fan speed
7. Current time

2.8 BACNET FIELDBUS AND BACNET SDCUS

A. Networking
1. IP Network: All devices that connect to the WAN shall be capable of operating at 10 megabits per second or 100 megabits per second.

2. IP To Field Bus Routing Devices
    a. A Network Server Controller shall be used to provide this functionality.
    b. These devices shall be configurable locally with IP crossover cable and configurable via the IP network.
    c. The routing configuration shall be such that only data packets from the field bus devices that need to travel over the IP level of the architecture are forwarded.

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

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

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

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

2) Support alarm acknowledgement from any BACnet OWS that supports the BACnet service for executing alarm/event acknowledgement,

g. Shall support the reading of analog and binary data from any BACnet OWS or Building Controller that supports the BACnet service for the reading of data.
h. Shall support the control of the out of service property and assignment of value or state to analog and binary objects from any BACnet OWS that supports writing to the out of service property and the value property of analog and binary objects.
i. Shall support the receipt and response to Time Synchronization commands from a BACnet Building Controller.
j. Shall support the “Who is” and “I am.” BACnet services.
k. Shall support the “Who has” and “I have.” BACnet services.

2. Analog Input Circuits
   a. The resolution of the A/D chip shall not be greater than 0.01 Volts per increment. For an A/D converter that has a measurement range of 0 to 10 VDC and is 10 bit, the resolution is 10/1024 or 0.00976 Volts per increment.
   b. For non-flow sensors, the control logic shall provide support for the use of a calibration offset such that the raw measured value is added to the (+/-) offset to create a calibration value to be used by the control logic and reported to the Operator Workstation (OWS).
   c. For flow sensors, the control logic shall provide support for the use of an adjustable gain and an adjustable offset such that a two-point calibration concept can be executed (both a low range value and a high range value are adjusted to match values determined by a calibration instrument).
   d. For non-linear sensors such as thermistors and flow sensors the B-AAC shall provide software support for the linearization of the input signal.
3. Binary Input Circuits
   a. Dry contact sensors shall wire to the controller with two wires.
   b. An external power supply in the sensor circuit shall not be required.
4. Pulse Input Circuits
   a. Pulse input sensors shall wire to the controller with two wires.
   b. An external power supply in the sensor circuit shall not be required.
   c. The pulse input circuit shall be able to process up to 20 pulses per second.
5. True Analog Output Circuits
   a. The logical commands shall be processed by a digital to analog (D/A) converter chip. The 0% to 100% control signal shall be scalable to the full output range which shall be either 0 to 10 VDC, 4 to 20 milliamps or 0 to 20 milliamps or to ranges within the full output range (Example: 0 to 100% creates 3 to 6 VDC where the full output range is 0 to 10 VDC).
   b. The resolution of the D/A chip shall not be greater than 0.04 Volts per increment or 0.08 milliamps per increment.
6. Binary Output Circuits
   a. Single pole, single throw or single pole, double throw relays with support for up to 230 VAC and a maximum current of 2 amps.
   b. Voltage sourcing or externally powered triacs with support for up to 30 VAC and 0.5 amps at 24 VAC.

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

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

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

9. The controller will be capable of being programmed with customizable scripts via the open programming language Lua. It shall be equipped with at least 256KB of SRAM with 80KB configurable/reserved for Lua scripting purposes

2.9 DDC SENSORS AND POINT HARDWARE

A. Temperature Sensors
   1. Basis of design Manufacturers: Veris Industries or BAS manufacturer equivalent
   2. All temperature devices shall use thermistors or RTDs accurate to +/- 1 degree F over a range of –30 to 230 degrees F. Space temperature sensors shall be accurate to +/- .5 degrees F over a range of 40 to 100 degrees F.
   3. Room Sensor: Standard space sensors shall be available in an off white enclosure made of high impact ABS plastic for mounting on a standard electrical box. Basis of Design: Veris TW Series
      a. Where manual overrides are required, the sensor housing shall feature both an optional sliding mechanism for adjusting the space temperature setpoint, as well as a push button for selecting after hours operation.
      b. Where a local display is specified, the sensor shall incorporate an LCD display for viewing the space temperature, setpoint and other operator selectable parameters. Using built in buttons, operators shall be able to adjust setpoints directly from the sensor.
   4. Duct Probe Sensor: Sensing element shall be fully encapsulated in potting material within a stainless steel probe. Useable in air handling applications where the coil or duct area is less than 14 square feet. Basis of Design: Veris TD Series
   5. Duct Averaging Sensor: Averaging sensors shall be employed in ducts which are larger than 14 square feet. The averaging sensor tube shall contain at least one thermistor for every 3 feet, with a minimum tube length of 6 feet. The averaging sensor shall be constructed of rigid or flexible copper tubing. Basis of Design: Veris TA Series
   6. Pipe Immersion Sensor: Immersion sensors shall be employed for measurement of temperature in all chilled and hot water applications as well as refrigerant applications. Provide sensor probe length suitable for application. Provide each sensor with a corresponding pipe-mounted sensor well, unless indicated otherwise. Sensor wells shall be stainless steel for non-corrosive fluids below 250 degrees F and 300 series stainless steel for all other applications. Basis of Design: Veris TI Series
   7. Outside Air Sensor: Provide the sensing element on the building's north side. Sensing element shall be fully encapsulated in potting material within a stainless steel probe. Probe shall be encased in PVC solar radiation shield and mounted in a weatherproof enclosure. Operating range -40 to 122 F, Basis of Design: Veris TO Series
   8. A pneumatic signal shall not be allowed for sensing temperature.

B. Humidity Wall Transmitter
   1. Basis of Design Manufacturer: Veris Industries or BAS manufacturer equivalent
   2. Transmitters shall be accurate to +/- 3% at full scale.
   3. Transmitter shall have replaceable sensing element.
   4. Sensor type shall be thin-film capacitive.
   5. Sensor element shall contain multipoint calibration on-board in nonvolatile memory

6. Operating range shall be 0 - 100% RH noncondensing, 50 to 95 F
7. Output shall be field selectable 4-20 mA or 0-5/0-10 VDC.
8. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
9. Transmitter shall be available in an off white enclosure made of high impact ABS plastic for mounting on a standard electrical box.
10. Transmitter shall have option of having an LCD display
11. Transmitter shall have option of being NIST certified
12. Transmitter shall have option of an integrated temperature sensor
13. Basis of Design: Veris HWL Series

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

D. Carbon Dioxide Duct Transmitter:
1. Basis of Design Manufacturer: Veris Industries or BAS manufacturer equivalent
2. Sensor type shall be Non-dispersive infrared (NDIR).
3. Accuracy shall be ±30 ppm ±2% of measured value with annual drift of ±10 ppm. Minimum five year recommended calibration interval.
4. Repeatability shall be ±20 ppm ±1% of measured value
5. Response Time shall be <60 seconds for 90% step change
6. Outputs shall be field selectable Analog: 4-20mA or 0-5/0-10VDC with SPDT Relay 1A@30VDC
7. Transmitter shall accept 12-30 VDC or 24 VAC supply power.
8. Temperature Range: 32° to 122°F
9. Output range shall be programmable 0-2000 or 0-5000 ppm
10. Enclosure shall not require remote pickup tubes and make use of integrated H-beam probe to channel air flow to sensor.
11. Enclosure lid shall require no screws and make use of snap on features for attachment
12. Enclosure shall be made of high impact ABS plastic
13. Transmitter shall have option of an LCD display

14. Transmitter shall have option of an integrated temperature sensor and/or humidity sensor
15. Basis of Design: Veris CDL

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

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

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

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

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

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

2.10 STATUS SENSORS AND DEVICES - ELECTRIC

A. Status Input for Fan: Differential pressure switch with pilot-duty rated contacts and adjustable range of 0- to 5-inch wg.
   1. Manufacturers:
      a. Cleveland Controls.

B. Status Input for Pump: Liquid differential pressure switch with pilot-duty rated contacts and adjustable pressure range of 20- to 60-psigand differential pressure range of 5- to 30-psig, SPDT contacts pilot-duty rated or for application, ¼" female NPT pipe connections.
   1. Manufacturers:
      a. United Electric Controls.

C. Sensing Inputs for Electric Motors:
   1. Manufacturers:
      a. American Aerospace Controls.
   2. Current Transformer/Transmitter: Comply with ISA 50.00.01, current-sensing, fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current and 1 percent full-scale accuracy, for AC or DC applications.
   3. Voltage Transformer/Transmitter (100- to 600-V AC): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy, for AC or DC applications.
   4. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor, for AC and DC applications.

D. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
   1. Manufacturer's
      a. DDC equipment manufacturer's recommended product

E. Water Flow Switch: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.
   1. Manufacturers:
      a. Xylem.
      b. I.T.M. Instruments.

F. Liquid Leak Detectors
   1. Liquid detectors shall utilize microchip technology for detection of conductive liquids through one of the following types of sensors: gold-plated probes, self-adhesive sensor tape with copper electrodes and durable cotton cover, or rope type sensor. Detectors shall be selected based on the best use for the application. Power requirement shall be 11-27 VAC or VDC and have a green LED normal operation indicator. Unit shall have a SPDT pilot duty low voltage alarm contact. Unit shall be waterproof and rustproof. A red LED shall indicate the presence of liquid. Unit shall have an adjustable setpoint.

2. Approved Manufacturers:
   a. R. E. Technologies.
   b. Dorlen Products. (Water Alert)

G. Control Relay: Monitors or controls AC or DC motors or other equipment (as required), with cover, with visual indicator when energized, and two SPDT contacts rated 120/250 VAC at 8 Amps.
1. Manufacturers:
   a. Dayton.
   b. Omron.
   c. Functional Devices.

H. Damper End Switch (limit switch): Fully encapsulated, mercury-type, damper end switch with two contacts per switch; one for interlock wiring and one for DDC input.
1. Manufacturers:
   a. KELE Controls part number TS-470-2.

I. Emergency Power-Off (EPO) Push-button: ADA compliant, push-button switch with clear cover to prevent inadvertent closure. Push-to-activate push-button, key-to-reset feature, and providing two SPDT contacts rated 120/250 VAC at 10 Amps.
1. Manufacturers:
   a. Safety Technology International – model SS-2212PO.

J. Boiler EPO Contactor: Electrically operated, electrically held; provide contactor in NEMA-12 rated enclosure. Six (6) normally closed contacts rated 120/250 VAC at 20 Amps.
1. Manufacturers:
   a. Allen-Bradley.
   b. Cutler-Hammer.
   c. Square-D.

2.11 THERMOSTATS

A. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed setpoint adjustment, 55- to 85-degrees F setpoint range, and 2-degrees F maximum differential.

B. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed setpoint adjustment, 55- to 85-degrees F setpoint range, and 2-degrees F maximum differential.
1. Selector Switch: Integral, manual, On-Off-Auto.

C. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.
1. Bulbs in water lines with separate wells of same material as bulb.
2. Bulbs in air ducts with flanges and shields.
3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.

4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
5. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.
6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.

D. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable setpoint.

E. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable setpoint in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.

F. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic- reset switch that trips if temperature sensed across any 12-inches of bulb length is equal to or above setpoint.
1. Bulb Length: Minimum 20-feet.
2. Quantity: One thermostat for every 20-sq. ft. of coil surface.

G. Heating/Cooling Valve-Top Thermostats: Proportional acting for proportional flow, with molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse acting at minimum shutoff pressure of 25-psig, and cast housing with position indicator and adjusting knob.

2.12 HUMIDISTATS

A. Electric:
1. Room or Duct-Mounted Humidistats: Electric insertion, 2-position type, with adjustable 2 percent RH throttling range, 20 to 90 percent RH operating range, and single- or double-pole contacts. Calibrated for +/- 5% RH accuracy.

2.13 CONTROL CABLE

A. Electronic and fiber-optic cables for control wiring are specified in Division 26 Low Voltage Electrical Power Conductors and Cables."

B. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
1. Verify compatibility with and suitability of substrates.

B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.

C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

D. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.

E. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONTROL DEVICES FOR INSTALLATION BY INSTALLERS

A. Deliver the following to duct fabricator and Installer for installation in ductwork. Include installation instructions to Installer and supervise installation for compliance with requirements.
   1. Control dampers.
   2. Airflow sensors and switches.
   3. Pressure sensors.

B. Deliver the following to plumbing and HVAC piping installers for installation in piping. Include installation instructions to Installer and supervise installation for compliance with requirements.
   1. Control valves.
   2. Pipe-mounted sensors, switches, and transmitters.
   3. Liquid temperature sensors.
   4. Pipe- and tank-mounted thermowells.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install products to satisfy more stringent of all requirements indicated. In addition to the requirements specified herein, execution shall be in accordance with the requirements of other specifications and Drawings.

B. Examine equipment exterior and interior prior to installation. Report any damage and do not install any equipment that is structurally, moisture, or mildew damaged.

C. Beginning the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

D. Install equipment in accordance with reviewed product data, final shop drawings, manufacturer's written instructions and recommendations, and as indicated on the Drawings.

E. Install products level, plumb, parallel, and perpendicular with building construction.

F. Support products, tubing, piping wiring, and raceways. Brace products to prevent lateral movement and sway or a break in attachment when subjected to force.

G. Provide final protection and maintain conditions in a manner acceptable to the manufacturer that shall help ensure that the equipment is without damage at time of Substantial Completion.

H. Code Compliance
   1. All wiring shall be installed in accordance with all applicable electrical codes and will comply with equipment manufacturer's recommendations.
   2. If codes and referenced standards are more stringent than requirements indicated, comply with requirements in codes and referenced standards.

I. Fabricate openings and install sleeves in ceilings, floors, roof, and walls required by installation of products. Before proceeding with drilling, punching, and cutting, check for concealed work to avoid damage. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

J. Firestop Penetrations Made in Fire-Rated Assemblies

K. Seal penetrations made in acoustically rated assemblies.

L. If product locations are not indicated, install products in locations that are accessible and that will permit service and maintenance from floor, equipment platforms, or catwalks without removal of permanently installed furniture and equipment.

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

3.4 SYSTEM ACCEPTANCE TESTING

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

B. Control loops will be exercised by inducing a setpoint shift of at least 10% and observing whether the system successfully returns the process variable to setpoint. Record all test results and attach to the Test Results Sheet.

C. Test each alarm in the system and validate that the system generates the appropriate alarm message, that the message appears at all prescribed destinations (workstations or printers), and that any other related actions occur as defined (i.e. graphic panels are invoked, reports are generated, etc.). Submit a Test Results Sheet to the owner.

D. Perform an operational test of each unique graphic display and report to verify that the item exists, that the appearance and content are correct, and that any special features work as intended. Submit a Test Results Sheet to the owner.

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

3.5 INSTALLATION

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

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

C. Wiring, Conduit, and Cable
   1. All wire will be copper and meet the minimum wire size and insulation class listed below:
      a. Power - 12 Gauge - 600 Volt
      b. Class One - 14 Gauge Std. - 600 Volt
      c. Class Two - 18 Gauge Std. - 300 Volt
      d. Class Three - 18 Gauge Std. - 300 Volt
      e. Communications - Per Mfr.
   2. Power and Class One wiring may be run in the same conduit.
   3. Class Two and Three wiring and communications wiring may be run in the same conduit. (Separate from Power and Class One wiring)
   4. Where different wiring classes terminate within the same enclosure, maintain clearances, and install barriers per the National Electric Code.
   5. Where wiring is required to be installed in conduit, EMT shall be used. Conduit shall be minimum 1/2-inch galvanized EMT. Set screw fittings are acceptable for dry interior locations. Watertight compression fittings shall be used for exterior locations and interior locations subject to moisture. Provide conduit seal-off fitting where exterior conduits enter the building or between areas of high temperature/moisture differential.
   6. Flexible metallic conduit (max. 3 feet) shall be used for connections to motors, actuators, controllers, and sensors mounted on vibration producing equipment. Liquid-tight flexible conduit shall be use in exterior locations and interior locations subject to moisture.
   7. Junction boxes shall be provided at all cable splices, equipment termination, and transitions from EMT to flexible conduit. Interior dry location J-boxes shall be galvanized pressed steel, nominal four-inch square with blank cover. Exterior and damp location JH-boxes shall be cast alloy FS boxes with threaded hubs and gasketed covers.
   8. Where the space above the ceiling is a supply or return air plenum, the wiring shall be plenum rated. Teflon wiring can be run without conduit above suspended ceilings. EXCEPTION: Any wire run in suspended ceilings that is used to control outside air dampers or to connect the system to the fire management system shall be in conduit.
   9. Fiber optic cable shall include the following sizes; 50/125, 62.5/125 or 100/140.
   10. Only glass fiber is acceptable, no plastic.
   11. Fiber optic cable shall only be installed and terminated by an experienced contractor. The BAS system supplier shall submit to the Engineer the name of the intended contractor of the fiber optic cable with his submittal documents.

D. Enclosures
   1. For all I/O requiring field interface devices, these devices where practical will be mounted in a field interface panel (FIP). The Contractor shall provide an enclosure which protects the device(s) from dust, moisture, conceals integral wiring and moving parts.
   2. FIPs shall contain power supplies for sensors, interface relays and contactors, and safety circuits.
   3. The FIP enclosure shall be of steel construction with baked enamel finish; NEMA 1 rated with a hinged door and keyed lock. The enclosure will be sized for twenty percent spare mounting space. All locks will be keyed identically.

4. All wiring to and from the FIP will be to screw type terminals. Analog or communications wiring may use the FIP as a raceway without terminating. The use of wire nuts within the FIP is prohibited.
5. All outside mounted enclosures shall meet the NEMA-4 rating.
6. The wiring within all enclosures shall be run in plastic track. Wiring within controllers shall be wrapped and secured.

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

F. Existing Controls.
1. Existing controls which are to be reused and are found to be defective requiring replacement, will be noted to the Owner. The Owner will be responsible for all material and labor costs associated with their repair.

G. Location
1. The location of sensors is per mechanical and architectural drawings.

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

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

3.6 CONTROL SYSTEM SWITCH-OVER

A. Demolition of the existing control system will occur after the new temperature control system is in place including new sensors and new field interface devices.

B. Switch-over from the existing control system to the new system will be fully coordinated with the Owner. A representative of the Owner will be on site during switch-over.

C. The Contractor shall minimize control system downtime during switch-over. Sufficient installation mechanics will be on site so that the entire switch-over can be accomplished in a reasonable time frame.

D. Remove controls which will not remain as part of the building automation system, including all associated wiring and conduit, and all associated pneumatic tubing. The Owner will inform the Contractor of any equipment which is to be removed that will remain the property of the Owner. All other equipment which is removed will be disposed of by the Contractor. Demolition will include removing existing control panels, existing control devices, existing wire/cable raceways and all pneumatic control tubing and raceways. All demolished components will be properly disposed of offsite. ABANDONMENT OF ANY EXISTING CONTROL PANELS, RACEWAYS, WIRES/CABLES, PNEUMATIC TUBING/RACEWAYS IS NOT PERMITTED – THIS WILL BE STRICTLY ENFORCED.

3.7 DATABASE CONFIGURATION

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

3.8 POINT TO POINT CHECKOUT

A. Each I/O device (both field mounted as well as those located in FIPs) shall be inspected and verified for proper installation and functionality. A checkout sheet itemizing each device shall be filled out, dated and approved by the Project Manager for submission to the owner or owner's representative.

3.9 WORKSTATION CHECKOUT

A. A checkout of all front end equipment shall be conducted to verify proper operation of both hardware and software. A checkout sheet itemizing each device and a description of the associated tests shall be prepared and submitted to the owner or owner's representative by the completion of the project.

3.10 BAS FIELD CONTROLLERS CHECKOUT

A. A checkout of all field devices shall be conducted to verify proper operation of both hardware and software. A checkout sheet itemizing each device and a description of the associated tests shall be prepared and submitted to the owner or owner's representative by the completion of the project

3.11 DOCUMENTATION

A. As built software documentation will include the following:
   1. Descriptive point lists
   2. Application program listing
   3. Application programs with comments.
   4. Printouts of all reports.
   5. Alarm list.
   6. Printouts of all graphics
   7. Commissioning and System Startup

3.12 ADJUSTING

A. Calibrating and Adjusting:
   1. Calibrate installed devices and instruments, whether electric or pneumatic.
   2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
   3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
   4. Control System Inputs and Outputs:
      a. Check analog inputs at 0, 50, and 100 percent of span.
      b. Check analog outputs using milli-ampere meter at 0, 50, and 100 percent output.
      c. Check digital inputs using jumper wire.
      d. Check digital outputs using ohmmeter to test for contact making or breaking.
      e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
   5. Flow:
      a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
      b. Manually operate flow switches to verify that they make or break contact.
   6. Pressure:
      a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
      b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
   7. Temperature:
      a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
      b. Calibrate temperature switches to make or break contacts.
   8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
   9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
   10. Provide diagnostic and test instruments for calibration and adjustment of system.
   11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature, CO, CO_2, static pressure, humidity, etc., set points.

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

3.13 GRAPHIC DISPLAY GENERATION

A. Provide the following graphic displays as a minimum at the operator workstations, arranged in logical penetration paths:
   1. Overall campus layout which shows all of the buildings on the Owner's campus.
   2. Individual building layout or isometric for each building connected to the system.
   3. Floor plans for each floor within each building, with display of present values of space conditions sensed by connected space sensors, display of the name of the air handler associated with each space sensor, display of the room number in which the sensor is located and color coding to indicate whether the sensed space condition is within the acceptable range, is too high, or is too low. TC Contractor shall confirm Owner desired room names prior to graphics generation which may differ from the room names indicated on construction documents.
   4. Schematic diagram for each HVAC system. Each system schematic display shall include at least the following:
      a. Schematic arrangement of ductwork, fans, dampers, coils, valves, piping, pumps, equipment etc.
      b. System name.
      c. Area served.
      d. Present value or status of all inputs, along with present setpoint.
      e. Present percent open for each damper, valve, etc. based on commanded position.
      f. Reset schedule parameters for all points, where applicable.
      g. Present occupancy mode.
      h. Present economizer mode, where applicable.
      i. Present outside air temperature.
      j. Associated space conditions and setpoints, where applicable.
      k. Status of application programs (e.g., warm-up, night cycle, duty cycle, etc.).
      l. Color coding to indicate normal and abnormal values, alarms, etc.
   5. Manual override capability for each on/off or open/closed controlled digital output (for fans, pumps, 2-position dampers and valves, etc.) and each modulating analog output (for dampers, valves, VFD speed modulation type points, etc.) shall be provided. Graphic display of output point auto or manual override status shall be provided.
   6. Sequence of operation in written (text) format for each HVAC system.
   7. Overall BAS system schematic.
   8. System management graphic for each network device and/or DDC panel.
   9. Provide a separate page for critical alarm summary.

B. Contractor to provide graphics that are fully operational prior to commissioning.

3.14 TRAINING

A. Engage a factory-authorized service representative with complete knowledge of Project-specific system installed to train Owner's maintenance personnel to adjust, operate, and maintain DDC system.

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

C. Training Schedule:
   1. Schedule training to provide Owner with at least 20 business days of notice in advance of training.
   2. Training to occur within normal business hours at mutually agreed on time. Unless otherwise agreed to, training to occur Monday through Friday, except on U.S. Federal holidays.
   3. Provide staggered training schedule as requested by Owner.

D. On-Site Training:
   1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power, and data connectivity for instructor and each attendee.
   2. Provide training materials, projector, and other audiovisual equipment used in training.
   3. Provide as much of training located on-site as deemed feasible and practical by Owner.
   4. Include on-site training with regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration, and service requirements.

END OF SECTION 23 0923

Tarkett

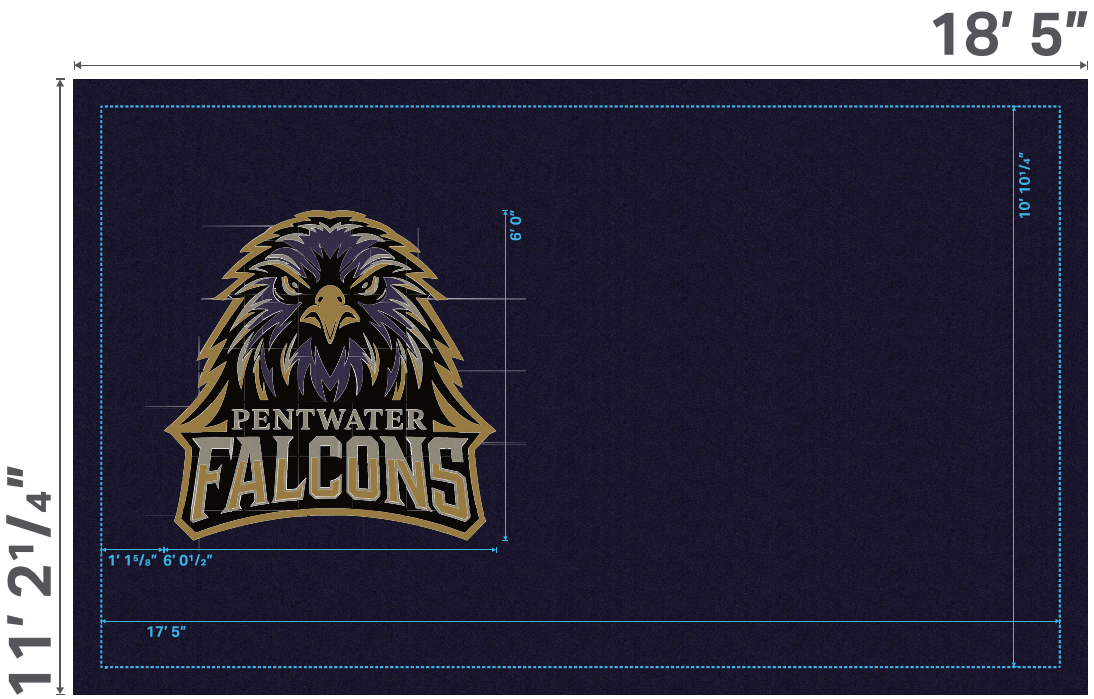
ART APPROVAL
984933B

Assertive Action

- Etch

Plexus Colours IV

- Dark Shadow
- Gold Rush
- Milky Opal
- Purple Haze



PILE DIRECTION

POWERBOND

Pentwater Public Schools

For full project details, including any disclaimers and warranty information, see page two.

IMAGINATIONS™
Custom Cutting and Design
Resilient ■ Soft Surface

Control Number:

984933B

Project Title:
Pentwater Public Schools

Date:
9/23/2025

Size:
18′ 5″ x 11′ 2¹/₄″

Quantity:
1

Product:
Powerbond® Cushion

Project Description:
A custom carpet inlay for direct, on-site cut-in and glue down; constructed out of selected colors from the Assertive Action and Plexus Colours IV collections, in Powerbond® Cushion backing.

Tarkett Representative:
Jennifer Conway
email |jennifer.conway@tarkett.com
phone | (248) 639-8161

Imaginations™ Coordinator:
Jennifer Beach
email | jennifer.beach@tarkett.com
phone | (706) 259-2683

Imaginations™ Designer:
Chase Parker
email | chase.parker@tarkett.com
phone | (706) 259-2153

Product Details:

Powerbond® Cushion is a hybrid resilient sheet product with a closed-cell, impermeable cushion. Installed with chemically-welded seams, Powerbond creates a wall-to-wall moisture barrier that allows liquids to be easily extracted.

Powerbond® features **Dynex SD®** fiber with permanent stain resistance and Eco-Ensure soil protection to inherently resist staining and dirt retention.

Powerbond® is made with 8–10% postconsumer recycled materials and, like all Tarkett North America floors, is free of all Six Classes of Harmful Chemicals as defined by the Green Science Policy Institute, including ortho-phthalates, per- and polyfluoroalkyl substances (PFAS) and antimicrobials.

For more information about **Powerbond®** and **Dynex SD®**, visit commercial.tarkett.com

POWERBOND

Powerbond® Collection | Powerbond® Cushion | Dynex SD®

Notes:

Note: Manufacturing tolerances may result in a +/- 1 inch deviation.

Note: Due to the nature of Powerbond® Cushion, it is possible to experience a variation of +/- 1.5% of the length, width, and thickness of the product in normal climates. If exposed to more extreme temperatures, such as non-climate controlled warehouses or a similar situation, a variation of +/-5% is possible.

Note: Digital renderings may not provide perfect representations of the textures or colors of carpet or resilient floor coverings. Consult a color swatch before signing off on this art approval.

Note: Pattern placement may vary between this approval and the final product.

Note: It is necessary to match the direction (noted on page one) of both the logo field and the room field. If the room field is to be installed in a different direction than shown, please notify the Imaginations™ department so that the logo field direction can be adjusted to match that of the room's direction.

Note: This option can be cut-in and glued down alongside any Tarkett Powerbond® Cushion rolled goods or FlexAire® Cushion tiled goods product for an ADA compliant transition between the two soft surfaces.

Note: The dashed lines designate the approximate locations of the walls in this space.

WARRANTY / DISCLAIMER:

This warranty disclaimer extends to any Tarkett USA, INC. product that is ordered through the Tarkett, USA INC. IMAGINATIONS™ Program, to be used to create or fabricate intricate insets and/or rugs at a local level, be it by the installation group, outside vendor, or internal fabrication team.

Manufacturing and/or fabrication defects, including variations between the signed art approval and fabricated piece(s), are warranted only to the extent that any such defect is noted and reported to the IMAGINATIONS™ team at the time of delivery.

Tarkett USA, INC. and its IMAGINATIONS™ Program are not responsible for color change or color loss due to, but not limited to, staining, crocking, or dye migration after floor installation. Implied warranties of merchantability or fitness for a particular purpose are expressly disclaimed and excluded. The cutting and/or welding of irregular pieces result in a significant change from the original monolithic configuration. As such, and being that these are “custom” products, these fabrications and the material used to create them, would be subject to a “no return” policy.

In its 25+ year history of producing high quality insets and free-standing area rugs per the customer’s approved artwork, Tarkett USA, INC., through its IMAGINATIONS™ Program, has and continues to strive to maintain the highest quality fabrication in the marketplace.

Art Approval:

By completing and signing this section of the Art Approval, you are accepting the above disclaimer; confirming that you’ve read the details provided on page 2; and approving the IMAGINATIONS™ team to fabricate the design shown on page 1.

Signature

Print Name

Company

Address

City | State | Zip Code

Email Address | Phone Number

Page 2 of 2.

AIR HANDLING UNIT SCHEDULE

MARK	MANUFACTURER	MODEL	SERVING	SUPPLY FAN AIRFLOW (CFM)	SUPPLY FAN OUTDOOR AIRFLOW (CFM)	SUPPLY FAN ESP (IN-WG)	SUPPLY FAN TSP (IN-WG)	SUPPLY FAN HP	HEATING COIL CAPACITY (MBH)	HEATING COIL EAT (°F)	HEATING COIL LAT (°F)	HEATING COIL FLOW (GPM)	HEATING COIL WPD (FT-HD)	HEATING COIL EWT (°F)	HEATING COIL LWT (°F)	HEATING COIL CONTROL VALVE	HEATING COIL FLUID	ELECTRICAL VOLTAGE	ELECTRICAL PHASE	ELECTRICAL FREQUENCY	NOTES
AHU-1	TRANE	CLIMATE CHANGER	OFFICE 212	1500	160	0.80	2.14 in-wg	1	63	59	98	2.8	0.76	180	135	THREE-WAY	WATER	230	3	60	1,2,3,4,5,6,7
AHU-1N	TRANE	CLIMATE CHANGER	GYMNASIUM 121	4000	1800	0.20	1.70 in-wg	3	217	47	97	22.0	2.60	180	160	THREE-WAY	WATER	230	3	60	2,3,4,5,6
AHU-2	TRANE	CLIMATE CHANGER	MEDIA CENTER 210	2750	1200	1.17	2.42 in-wg	3	149	38	88	15.0	6.74	180	160	TWO-WAY	WATER	230	3	60	2,3,4,5,6
AHU-2N	TRANE	CLIMATE CHANGER	GYMNASIUM 121	4000	1800	0.20	1.70 in-wg	3	217	47	97	22.0	2.60	180	160	THREE-WAY	WATER	230	3	60	2,3,4,5,6
AHU-3	TRANE	CLIMATE CHANGER	MULTI-PURPOSE 217	8400	2700	1.26	2.31 in-wg	7.5	408	40	80	41.0	3.89	180	160	TWO-WAY	WATER	230	3	60	2,3,4,5,6
AHU-4	TRANE	CLIMATE CHANGER	MUSIC 215	3200	1600	1.13	2.66 in-wg	5	191	35	90	19.1	2.73	180	160	THREE-WAY	WATER	230	3	60	2,3,4,5,6
AHU-5	TRANE	CLIMATE CHANGER	LOCKER ROOM 201/206	2067	600	0.80	2.11 in-wg	2	150	26	95	15.0	1.09	180	160	TWO-WAY	WATER	230	3	60	2,3,4,5,6

(2A1)

1. PROVIDE AND INSTALL DX COOLING COIL WITH LEAK DETECTION AND ON GRADE CONDENSING UNIT.
2. DAMPERS FOR OUTSIDE AND RETURN AIR.
3. VARIABLE FREQUENCY DRIVES FOR ALL UNIT FANS.
4. CO_2 SENSOR FOR DEMAND CONTROL VENTILATION.
5. DISCONNECT SWITCH ON UNIT.
6. PROGRAMMABLE ZONE THERMOSTAT WITH TEMPERATURE ADJUSTMENT AND DISPLAY.
7. PROVIDE DOUBLE WALLED PANELS WITH A MINIMUM OF 1.5" INSULATION.

ROOFTOP UNIT SCHEDULE

MARK	MANUFACTURER	MODEL	SERVING	SUPPLY FAN AIRFLOW (CFM)	SUPPLY FAN AIR FLOW - VENTILATION (OA CFM)	SUPPLY FAN ESP (IN-WG)	SUPPLY FAN HP	DX COOLING TOTAL CAPACITY (MBH)	DX COOLING SENSIBLE CAPACITY (MBH)	DX COOLING EDB (°F)	DX COOLING EWB (°F)	DX COOLING LDB (°F)	DX COOLING LWB (°F)	DX COOLING REFRIGERANT	GAS HEATING INPUT CAPACITY (MBH)	GAS HEATING OUTPUT CAPACITY (MBH)	GAS HEATING EAT (°F)	GAS HEATING LAT (°F)	GAS HEATING FUEL TYPE	ELECTRICAL VOLTAGE	ELECTRICAL PHASE	ELECTRICAL FREQUENCY	ELECTRICAL MCA	MOCP	WEIGHT (LBS)	NOTES
RTU-1	CARRIER	48FEFM12D3A5-8L2A0	COMPUTERS 116	4000	1200 CFM	1.00	3	123.9	92.5	80	67	58.6	57.3	R-454B	250	205	70	117.5	NG	208	3	60	63	80	985	1-12

1. HORIZONTAL DUCT CONFIGURATION.
2. FIELD INSTALLED ENTHALPY SENSING ECONOMIZER WITH RELIEF.
3. CONDENSATE OVERFLOW PROTECTION.
4. NON-FUSED DISCONNECT SWITCH.
5. 4" MERV-13 FILTERS
6. HINGED ACCESS PANELS
7. RTU-OPEN COMMUNICATING CONTROLS INTEGRATED INTO BUILDING MANAGEMENT SYSTEM.
8. THROUGH BASE UTILITY CONNECTIONS.
9. SUPPLY AIR SMOKE DETECTOR.
10. PROGRAMMABLE ZONE THERMOSTAT WITH TEMPERATURE ADJUSTMENT AND DISPLAY.
11. START-UP BY AUTHORIZED MANUFACTURER'S REPRESENTATIVE.
12. INCLUDE CO_2 SENSOR FOR DEMAND CONTROLLED VENTILATION.

DEDICATED OUTSIDE AIR UNIT SCHEDULE

MARK	MANUFACTURER	MODEL	SERVING	SUPPLY FAN AIRFLOW (CFM)	SUPPLY FAN ESP (IN-WG)	SUPPLY FAN TSP (IN-WG)	SUPPLY FAN RPM	SUPPLY FAN BHP	SUPPLY FAN MOTOR (HP)	EXHAUST FAN AIRFLOW (CFM)	EXHAUST FAN ESP (IN-WG)	EXHAUST FAN TSP (IN-WG)	EXHAUST FAN RPM	EXHAUST FAN BHP	EXHAUST FAN MOTOR (HP)	DESIGN CONDITIONS SUMMER OA DB (°F)	SUMMER OA WB (°F)	SUMMER RA DB (°F)	SUMMER RH (%)	WINTER OA DB (°F)	WINTER OA WB (°F)	WINTER RA DB (°F)	WINTER RH (%)	HEATING PERFORMANCE TYPE	FUEL TYPE	INPUT (MBH)	OUTPUT (MBH)	EDB (°F)	LDB (°F)	TURNDOWN RATIO	ENERGY RECOVERY PERFORMANCE ERV TYPE	SUMMER ENTHALPY RECOVERY RATIO (%)	WINTER ENTHALPY RECOVERY RATIO (%)	ELECTRICAL VOLTAGE	PHASE	MCA	MOCP	NO. OF MOTORS	WEIGHT (LBS)	NOTES
DOAS-1	GREENHECK	RVE-40-36D	SCIENCE 304	2400	0.50	2.09	1534	1.22	1 1/2	2400	0.50	1.43	1404	1.01	1 1/2	84	72	75	50	2	0	72	35	INDIRECT GAS	NG	100	81	48.3	79.5	16:1	POLYMER WHEEL	67.1	64.8	230	3	14.5	15	2	2410	1,2,3,4,5,6
DOAS-2	GREENHECK	RVE-40-36D	SCIENCE 306	2400	0.50	2.09	1534	1.22	1 1/2	2400	0.50	1.43	1404	1.01	1 1/2	84	72	75	50	2	0	72	35	INDIRECT GAS	NG	100	81	48.3	79.5	16:1	POLYMER WHEEL	67.1	64.8	230	3	14.5	15	2	2410	1,2,3,4,5,6

1. 2 IN. MERV 8 ENERGY WHEEL FILTERS FOR BOTH AIR STREAMS.
2. 2 IN. MESH WEATHERHOOD FILTERS.
3. AMCA CLASS 1A DAMPERS WITH LEAKAGE RATING LESS THAN 3 CFM/FT^2 @ 1 IN. WG.
4. STAINLESS STEEL DRAIN PAN SHALL BE WELDED AND SLOPED IN TWO DIRECTIONS TO MEET ASHARE 62.1 REQUIREMENTS.
5. LOW SOUND CONDENSER FANS.

UNIT VENTILATOR SCHEDULE

MARK	MANUFACTURER	MODEL	TYPE	SERVING	SUPPLY FAN NOMINAL AIRFLOW (CFM)	SUPPLY FAN OUTDOOR AIRFLOW (CFM)	SUPPLY FAN HP	HYDRONIC HEATING CAPACITY (MBH)	HYDRONIC HEATING EAT (°F)	HYDRONIC HEATING LAT (°F)	HYDRONIC HEATING FLOW (GPM)	HYDRONIC HEATING EWT (°F)	HYDRONIC HEATING LWT (°F)	HYDRONIC HEATING CONTROL VALVE	HYDRONIC HEATING FLUID	ELECTRICAL VOLTAGE	ELECTRICAL PHASE	ELECTRICAL MCA	WEIGHT (LBS)	NOTES
UV-101	TRANE	VUV 125	FLOOR MOUNTED CONSOLE CABINET	CLASSROOM 101	1250	315	1/4	70	45	116	2.6	180	125	TWO-WAY	WATER	115	1	8.75	450	1,2,3,4,5,6
UV-102	TRANE	VUV 125	FLOOR MOUNTED CONSOLE CABINET	CLASSROOM 102	1250	315	1/4	70	45	116	2.6	180	125	TWO-WAY	WATER	115	1	8.75	450	1,2,3,4,5,6
UV-103	TRANE	VUV 125	FLOOR MOUNTED CONSOLE CABINET	CLASSROOM 103	1250	315	1/4	70	45	116	2.6	180	125	TWO-WAY	WATER	115	1	8.75	450	1,2,3,4,5,6
UV-109	TRANE	VUV 125	FLOOR MOUNTED CONSOLE CABINET	CLASSROOM 109	1250	315	1/4	70	45	116	2.6	180	125	TWO-WAY	WATER	115	1	8.75	450	1,2,3,4,5,7
UV-110	TRANE	VUV 125	FLOOR MOUNTED CONSOLE CABINET	CLASSROOM 110	1250	315	1/4	70	45	116	2.6	180	125	TWO-WAY	WATER	115	1	8.75	450	1,2,3,4,5,7
UV-117	TRANE	VUV 125	FLOOR MOUNTED CONSOLE CABINET	CLASSROOM 117	1250	315	1/4	70	45	116	2.6	180	125	TWO-WAY	WATER	115	1	8.75	450	1,2,3,4,5,6
UV-118	TRANE	VUV 125	FLOOR MOUNTED CONSOLE CABINET	CLASSROOM 118	1250	315	1/4	70	45	116	2.6	180	125	TWO-WAY	WATER	115	1	8.75	450	1,2,3,4,5,7
UV-119	TRANE	VUV 125	FLOOR MOUNTED CONSOLE CABINET	CLASSROOM 119	1250	315	1/4	70	45	116	2.6	180	125	TWO-WAY	WATER	115	1	8.75	450	1,2,3,4,5,7
UV-303	TRANE	VUV 150	FLOOR MOUNTED CONSOLE CABINET	COMPUTERS 303	1500	370	1/4	90	46	117	3.2	180	125	TWO-WAY	WATER	115	1	8.75	470	1,2,3,4,5,7,8
UV-307	TRANE	VUV 125	FLOOR MOUNTED CONSOLE CABINET	CLASSROOM 307	1250	370	1/4	75	46	122	3.2	180	133	TWO-WAY	WATER	115	1	8.75	450	1,2,3,4,5,7,8
UV-309	TRANE	VUV 150	FLOOR MOUNTED CONSOLE CABINET	ART ROOM 309	1500	430	1/4	100	46	125	4.0	180	130	THREE-WAY	WATER	115	1	8.75	470	1,2,3,4,5,7,8
UV-311	TRANE	VUV 125	FLOOR MOUNTED CONSOLE CABINET	CLASSROOM 311	1250	370	1/4	75	46	122	3.2	180	133	THREE-WAY	WATER	115	1	8.75	450	1,2,3,4,5,7,8
UV-312	TRANE	VUV 125	FLOOR MOUNTED CONSOLE CABINET	CLASSROOM 312	1250	315	1/4	70	45	116	2.6	180	125	TWO-WAY	WATER	115	1	8.75	450	1,2,3,4,5,6
UV-315	TRANE	VUV 125	FLOOR MOUNTED CONSOLE CABINET	CLASSROOM 315	1250	315	1/4	70	45	116	2.6	180	125	TWO-WAY	WATER	115	1	8.75	450	1,2,3,4,5,6
UV-316	TRANE	VUV 125	FLOOR MOUNTED CONSOLE CABINET	CLASSROOM 316	1250	315	1/4	70	45	116	2.6	180	125	TWO-WAY	WATER	115	1	8.75	450	1,2,3,4,5,6
UV-317	TRANE	VUV 125	FLOOR MOUNTED CONSOLE CABINET	CLASSROOM 317	1250	315	1/4	70	45	116	2.6	180	125	TWO-WAY	WATER	115	1	8.75	450	1,2,3,4,5,6
UV-318	TRANE	VUV 125	FLOOR MOUNTED CONSOLE CABINET	CLASSROOM 318	1250	315	1/4	70	45	116	2.6	180	125	TWO-WAY	WATER	115	1	8.75	450	1,2,3,4,5,6,8

1. PROVIDE WITH FAN VFD.
2. PROVIDE WITH PROGRAMMABLE ZONE THERMOSTAT WITH TEMPERATURE ADJUSTMENT AND DISPLAY.
3. DAMPERS FOR OUTSIDE AND RETURN AIR.
4. CO_2 SENSOR FOR DEMAND CONTROL VENTILATION.
5. DISCONNECT SWITCH ON UNIT.
6. RIGHT HAND PIPE CONNECTION (FIELD VERIFY).
7. LEFT HAND PIPE CONNECTION. (FIELD VERIFY).
8. PROVIDE WITH FALSEBACK COVER AND END COVERS.

ENERGY RECOVERY VENTILATOR SCHEDULE

MARK	MANUFACTURER	MODEL	SERVING	SUPPLY FAN AIRFLOW (CFM)	SUPPLY FAN ESP (IN-WG)	SUPPLY FAN HP	EXHAUST FAN AIRFLOW (CFM)	EXHAUST FAN ESP (IN-WG)	EXHAUST FAN HP	ELECTRICAL VOLTAGE	ELECTRICAL PHASE	ELECTRICAL FLA	ELECTRICAL MCA	ELECTRICAL MOCP	NO. OF MOTORS	WEIGHT (LBS)	NOTES
ERV-1	RENEWAIRE	HE4XRTV	WEIGHT ROOM 121E	2800	0.75	3	3000	0.50	3	230	3	8.4	20.3	25	2	1279	1,2,3,4,5,6

1. INTERLOCK CONTROLS WITH EXISTING DUCT MOUNTED HYDRONIC HEATING COIL UTILIZING CAREL PREMIUM CARD FROM MANUFACTURER. SEE ERV SEQUENCE OF OPERATIONS.
2. PROVIDE STANDARD 20"x20"x2" MERV 8 FILTERS (QTY: 8)
3. PROVIDE STANDARD NON-FUSED DISCONNECT.
4. PROVIDE WITH ROOF CURB: STANDARD 14".
5. PROVIDE WITH WALL MOUNTED CO_2 SENSOR.
6. PROVIDE WITH IE3 EFFICIENCY MOTOR WITH VFD'S

EXPANSION TANK SCHEDULE

MARK	MANUFACTURER	MODEL	PERFORMANCE VOLUME (GAL)	PERFORMANCE ACCEPTANCE (GAL)
ET-1	BELL & GOSSETT	B-400	55.7	22.6

AIR SEPERATOR SCHEDULE

MARK	MANUFACTURER	MODEL	FLOW (GPM)	Notes
AS-1	BELL AND GOSSETT	RL	360 GPM	1

1. SUPPORT FROM CEILING

SIDE STREAM FILTER SCHEDULE

MARK	MANUFACTURER	MODEL	FLOW RATE	CONNECTIONS	NOTES
F-1	SHELCO FILTERS	4FOS3//5FOS3	82 GPM	2" MNPT	1

1. PROVIDE WITH HEAVY DUTY MOUNTING LEGS.

DIFFUSER, REGISTER, AND GRILLE SCHEDULE

MARK	MANUFACTURER	TYPE	DESCRIPTION	FINISH	MATERIAL	FACE SIZE	NOTES
RD-1	TITUS	PAR	RETURN DIFFUSER	PREFORATED CEILING DIFFUSER	STANDARD WHITE	STEEL	24"X24"	
SD-1	TITUS	TJD	SUPPLY DIFFUSER	PLAQUE FACE DIFFUSER	STANDARD WHITE	STEEL	24"X24"	

CONDENSING UNIT SCHEDULE

MARK	MANUFACTURER	MODEL	SERVING	MODEL NUMBER	DX COOLING NOMINAL CAPACITY (TON)	DX COOLING REFRIGERANT	ELECTRICAL VOLTAGE	ELECTRICAL PHASE	ELECTRICAL FAN HP	WEIGHT (LBS)	NOTES
CU-1	TRANE	ODESSEY	AHU-1	TTA072K*A*	6	R-454B	230	3	1/2	288	

HOOD SCHEDULE

MARK	MANUFACTURER	MODEL	SERVING	TYPE	AIRFLOW (CFM)	ESP (IN-WG)	MODEL SIZE	WEIGHT (LBS)	NOTES
RAH-1	GREENHECK	GRSR	CLASSROOM 117	RELIEF AIR HOOD	315	0.00	24	29	1,2,3
RAH-2	GREENHECK	GRSR	CLASSROOM 118	RELIEF AIR HOOD	315	0.00	24	29	1,2,3
RAH-3	GREENHECK	GRSR	CLASSROOM 119	RELIEF AIR HOOD	315	0.00	24	29	1,2,3
RAH-4	GREENHECK	GRSR	CLASSROOM 110	RELIEF AIR HOOD	315	0.00	24	29	1,2,3
RAH-5	GREENHECK	GRSR	CLASSROOM 109	RELIEF AIR HOOD	315	0.00	24	29	1,2,3
RAH-6	GREENHECK	GRSR	PASSAGE 901	RELIEF AIR HOOD	2675	0.09	24	29	1,2,3
RAH-7	GREENHECK	GRSR	LOCKER ROOM 201/206	RELIEF AIR HOOD	600	0.00	24	29	1,2,3

1. PROVIDE WITH BIRD SCREEN.
2. PROVIDE WITH MOTORIZED DAMPER AND BACKDRAFT DAMPER.
3. INSTALL ON EXISTING CURB.

HYDRONIC UNIT HEATER SCHEDULE

MARK	MANUFACTURER	MODEL	SERVING	HYDRONIC HEATING AIRFLOW (CFM)	HYDRONIC HEATING CAPACITY (MBH)	HYDRONIC HEATING EAT (°F)	HYDRONIC HEATING LAT (°F)	HYDRONIC HEATING FLOW (GPM)	HYDRONIC HEATING EWT (°F)	HYDRONIC HEATING LWT (°F)	HYDRONIC HEATING CONTROL VALVE	HYDRONIC HEATING FLUID	ELECTRICAL VOLTAGE	ELECTRICAL PHASE	ELECTRICAL MCA	FACE SIZE	AIRFLOW TYPE/MOUNTING STYLE	NOTES
CUH-112B	TRANE	FORCEFLO-1	VESTIBULE 112A	150	10	55	95	1.2	180	160	THREE-WAY	WATER	115	1	2.75	40"X30"	HORIZONTAL CEILING CONCEALED	1
CUH-115B	TRANE	FORCEFLO-1	VESTIBULE 115A	150	10	55	95	1.2	180	160	THREE-WAY	WATER	115	1	2.75	40"X30"	HORIZONTAL CEILING CONCEALED	1
CUH-116A	TRANE	FORCEFLO-1	VESTIBULE 116A	150	10	55	95	1.2	180	160	THREE-WAY	WATER	115	1	2.75	40"X28"	HORIZONTAL WALL CONCEALED	1
CUH-213A	TRANE	FORCEFLO-1	RECIEVING 213	350	30	55	95	3.0	180	160	THREE-WAY	WATER	115	1	2.75	60"X28"	VERTICAL WALL MOUNTED	1
CUH-214A	TRANE	FORCEFLO-1	KITCHEN 214	200	15	55	95	1.5	180	160	TWO-WAY	WATER	115	1	2.75	40"X25"	VERTICAL WALL MOUNTED	1
CUH-214B	TRANE	FORCEFLO-1	KITCHEN 214	200	15	55	95	1.5	180	160	TWO-WAY	WATER	115	1	2.75	40"X25"	VERTICAL WALL MOUNTED	1
CUH-900A	TRANE	FORCEFLO-1	VESTIBULE 900A	250	20	55	95	1.2	180	160	TWO-WAY	WATER	115	1	2.75	60"X25"	HORIZONTAL WALL CONCEALED	1
CUH-902	TRANE	FORCEFLO-1	PASSAGE 902	300	25	55	95	2.5	180	160	TWO-WAY	WATER	115	1	2.75	45"X25"	VERTICAL WALL MOUNTED	1
CUH-903A	TRANE	FORCEFLO-1	VESTIBULE 903A	150	10	55	95	1.2	180	160	TWO-WAY	WATER	115	1	2.75	60"X36"	HORIZONTAL FLOOR MOUNTED	1
CUH-904	TRANE	FORCEFLO-1	PASSAGE 904	200	15	55	95	1.5	180	160	THREE-WAY	WATER	115	1	2.75	60"X36"	HORIZONTAL FLOOR MOUNTED	1
CUH-905	TRANE	FORCEFLO-1	VESTIBULE 905	200	15	55	95	1.5	180	160	TWO-WAY	WATER	115	1	2.75	45"X25"	VERTICAL WALL MOUNTED	1
CUH-906	TRANE	FORCEFLO-1	VESTIBULE 906	250	20	55	95	2.0	180	160	TWO-WAY	WATER	115	1	2.75	45"X25"	VERTICAL WALL MOUNTED	1
CUH-907	TRANE	FORCEFLO-1	VESTIBULE 907	125	10	55	95	1.2	180	160	THREE-WAY	WATER	115	1	2.75	45"X25"	VERTICAL WALL MOUNTED	1
UH-104A	REZNOR	UWS	BOILER 104A	600	30	55	95	3.0	180	160	TWO-WAY	WATER	115	1	2.75	N/A	CEILING SUSPENDED	
UH-121B	REZNOR	UWS	STORAGE 121B	200	30	55	95	3.0	180	160	THREE-WAY	WATER	115	1	2.75	N/A	CEILING SUSPENDED	1,2
UH-121C	REZNOR	UWS	STORAGE 121C	200	30	55	95	3.0	180	160	THREE-WAY	WATER	115	1	2.75	N/A	CEILING SUSPENDED	1,2

1. PROVIDE REMOTE WALL MOUNTED THERMOSTAT.
2. SUPPORT A MINIMUM OF 6'-0" AFF

HYDRONIC CONVECTOR SCHEDULE

MARK	MANUFACTURER	MODEL	SERVING	HYDRONIC HEATING CAPACITY (MBH)	HYDRONIC HEATING EAT (°F)	HYDRONIC HEATING LAT (°F)	HYDRONIC HEATING FLOW (GPM)	HYDRONIC HEATING WPD (FT-HD)	HYDRONIC HEATING EWT (°F)	HYDRONIC HEATING LWT (°F)	HYDRONIC HEATING CONTROL VALVE	HYDRONIC HEATING FLUID	FACE SIZE	NOTES
CV-1	MODINE	PL	GIRLS TOILET 314	7.5	65	85	0.8	0.00	180	160	TWO-WAY	WATER	48"X30"	1,2
CV-2	MODINE	PL	BOY'S TOILET 313	7.5	65	85	0.8	0.00	180	160	TWO-WAY	WATER	48"X30"	1,2

1. WALL MOUNTED.
2. PROVIDE WITH PENCIL PROOF BAR GRILLE OPTION..

SECONDARY PUMP SCHEDULE

MARK	MANUFACTURER	SERIES	SERVING	PERFORMANCE FLOW (GPM)	PERFORMANCE WPD (FT-HD)	PERFORMANCE RPM	ELECTRICAL HP	ELECTRICAL VOLTAGE	ELECTRICAL PHASE	NOTES
P-3	BELL & GOSSETT	E-80	BUILDING CIRCULATION	183	49	1800	5	208	3	1,2,3
P-4	BELL & GOSSETT	E-80	BUILDING CIRCULATION	183	49	1800	5	208	3	1,2,3
P-5	BELL & GOSSETT	E-80	NORTH ADDITION	91	58	1730	3	208	3	1,2,3
P-6	BELL & GOSSETT	E-80	NORTH ADDITION	91	58	1730	3	208	3	1,2,3
P-11	BELL & GOSSETT	PL-75	HYDRONIC FILTER	30	15	3400	1/6	115	1	

1. PROVIDE WITH VFD.
2. PUMP INLET AND OUTLET PRESSURE GAUGES.
3. INCLUDE ELASTOMER TYPE FLEXIBLE CONNECTORS.

LOUVER SCHEDULE

MARK	MANUFACTURER	MODEL	DESCRIPTION	FINISH	MATERIAL	NECK SIZE	NOTES
L-1	TRANE	WALL BOX	INTAKE LOUVER	DARK BRONZE	ALUMINUM	SEE DWG	1,2,3
L-2	GREENHECK	ESD-403	INTAKE LOUVER	DARK BRONZE	ALUMINUM	SEE DWG	1,2,3
L-3	GREENHECK	ESD-403	INTAKE LOUVER	DARK BRONZE	ALUMINUM	SEE DWG	1,2,3
L-4	GREENHECK	ESD-635	INTAKE LOUVER	DARK BRONZE	ALUMINUM	SEE DWG	1,2,3

1. PROVIDE BIRD SCREEN INSIDE OF LOUVER.
2. FLANGED FRAME.
3. INSTALL INTO EXISTING OPENING. FIELD VERIFY REQUIRED SIZES PRIOR TO SUBMITTALS.

FAN COIL UNIT SCHEDULE

MARK	MANUFACTURER	MODEL	SERVING	SUPPLY FAN AIRFLOW (CFM)	HYDRONIC HEATING CAPACITY (MBH)	HYDRONIC HEATING FLOW (GPM)	HYDRONIC HEATING WPD (FT-HD)	HYDRONIC HEATING EWT (°F)	HYDRONIC HEATING LWT (°F)	HYDRONIC HEATING CONTROL VALVE	HYDRONIC HEATING FLUID	ELECTRICAL VOLTAGE	ELECTRICAL PHASE	ELECTRICAL MCA	FACE SIZE	NOTES
FCU-1	TRANE	UNITRANE	STAFF 209	100	8.5	0.8	2.00	180	140	TWO-WAY	WATER	115	1	2.75	45"X25"	1

1. HEATING ONLY.

c2ae
(866) 454-3923 | WWW.C2AE.COM
TMP ARCHITECTURE

GENERAL TAB SCOPE

1. A RECENT TEST AND BALANCE OF THE FOUR NEW BOILER CIRCULATION PUMPS ONLY WILL BE PROVIDED.
2. PERFORM PREWORK WATERSIDE TAB FOR ALL EXISTING EQUIPMENT AND PROVIDE REPORT TO ENGINEER. THIS WILL ESTABLISH BASELINE FOR EXISTING SYSTEM PERFORMANCE AND FINAL TAB VERIFICATION.
3. A COMPLETE AIR AND WATERSIDE TEST AND BALANCE IS REQUIRED FOR ALL EQUIPMENT AND ASSOCIATED SYSTEMS CONTROLLED BY THE BMS AT PROJECT COMPLETION.
4. REFER TO SPECIFICATION SECTION 230593 TESTING, ADJUSTING, AND BALANCING FOR HVAC.

GENERAL COMMISSIONING SCOPE

1. OWNER WILL OBTAIN THIRD PARTY COMMISSIONING OF ALL NEW EQUIPMENT AND SYSTEMS DEFINED IN THIS PROJECT SCOPE OF WORK. THIS INCLUDES HYDRONINC HEATING SYSTEM AS WELL AS BOILERS.
2. REFER TO COMMISSIONING SPECIFICATION FOR REQUIRED CONTRACTOR COORDINATION WITH COMMISSIONING AGENT.

HYDRONIC SYSTEM PIPING CLEANING

1. FLUSH AND CLEAN ALL EXISTING HYDRONIC PIPING PRIOR TO NEW EQUIPMENT INSTALLATION. UTILIZE EXISTING LOW POINT DRAINS AS NEEDED. THERE IS LIMITED DRAWINGS OF HYDRONIC PIPING SYSTEM WHICH WILL BE PROVIDED TO THE CONTRACTOR.
2. FLUSH AND CLEAN ALL EXISTING EQUIPMENT HYDRONIC COILS (FIN TUBE ETC) SHOWN TO REMAIN INDIVIDUALLY. PROVIDE TEMPORARY PIPING AROUND EXISTING EQUIPMENT TO REMAIN AS REQUIRED WHEN CLEANING HYDRONIC MAINS SO THAT EQUIPMENT/COILS WILL NOT ACCUMULATE DEBRIS/SEDIMENT DURING CLEANING/FLUSHING OF MAINS.

MECHANICAL SCHEDULES

RENOVATIONS AND IMPROVEMENTS
600 E. PARK ST, PENTWATER, MI 49449

PHASE

ISSUED FOR BIDS

ISSUANCES

#	DESCRIPTION	DATE
0	ISSUED FOR BIDS	22SEP2025
2AI	ADDENDUM 1	31OCT2025

PROJ. #: 24-0301

2M-601

Addendum #1

10/31/2025 9:27:23 AM
Autodesk Docs://24030_PS 20/24 Bond Implementation/24030_MEP.rvt
DESIGNED BY: MR
CHECKED BY: DTD APPROVED BY: Approver

WE RECYCLE

THE BAR BELOW SHOWS GRAYSCALE FROM WHITE TO SOLID BLACK

THE BAR BELOW SHOWS PRIMARY COLORS WHITE

EXISTING FINNED TUBE RADIATOR...

GENERAL	HYDRONIC HEATING		NOTE
MARK	FLOW (GPM)	FLUID	
EX-RAD-102A	2.5	WATER	1
EX-RAD-103A	2.1	WATER	1
EX-RAD-106	1.5	WATER	1
EX-RAD-108A	0.5	WATER	1
EX-RAD-109B	2.5	WATER	1
EX-RAD-112	1.7	WATER	1
EX-RAD-113	1.6	WATER	1
EX-RAD-115	2.0	WATER	1
EX-RAD-116	0.4	WATER	1
EX-RAD-116B	0.4	WATER	1
EX-RAD-117B	2.8	WATER	1
EX-RAD-201	1.2	WATER	1
EX-RAD-203	0.2	WATER	1
EX-RAD-205	0.2	WATER	1
EX-RAD-206	1.2	WATER	1
EX-RAD-209	0.2	WATER	1
EX-RAD-210A	0.4	WATER	1
EX-RAD-210B	0.5	WATER	1
EX-RAD-211	0.5	WATER	1
EX-RAD-212	0.3	WATER	1
EX-RAD-212A	0.6	WATER	1
EX-RAD-212B	0.5	WATER	1
EX-RAD-214A	0.2	WATER	1
EX-RAD-215C	0.4	WATER	1
EX-RAD-215C1	0.4	WATER	1
EX-RAD-215C2	0.4	WATER	1
EX-RAD-300A	0.5	WATER	1
EX-RAD-300E	0.7	WATER	1
EX-RAD-300F	0.5	WATER	1
EX-RAD-300H	0.5	WATER	1
EX-RAD-304	5.0	WATER	1
EX-RAD-309	2.3	WATER	1
EX-RAD-902	1.2	WATER	1

1. EXISTING UNIT TO REMAIN. REMOVE AND REPLACE EXISTING PNEUMATIC CONTROLS WITH DDC HYDRONIC CONTROL VALVE AND THERMOSTAT. REWORK HYDRONIC PIPING IF NECESSARY.

2A1

NORTH ADDITION EQUIPMENT

GENERAL		HYDRONIC HEATING
MARK	ASSOCIATED PUMP(S)	FLOW (GPM)
AHU-1	P-3 & P-4	2.8
AHU-2	P-3 & P-4	15.0
AHU-3	P-3 & P-4	41.0
AHU-4	P-3 & P-4	19.1
CUH-214A	P-3 & P-4	1.5
CUH-214B	P-3 & P-4	1.5
CUH-905	P-3 & P-4	1.5
CUH-906	P-3 & P-4	2.0
CUH-907	P-3 & P-4	1.2
EX-RAD-209	P-3 & P-4	0.2
EX-RAD-210A	P-3 & P-4	0.4
EX-RAD-210B	P-3 & P-4	0.5
EX-RAD-211	P-3 & P-4	0.5
EX-RAD-212	P-3 & P-4	0.3
EX-RAD-212A	P-3 & P-4	0.6
EX-RAD-212B	P-3 & P-4	0.5
EX-RAD-214A	P-3 & P-4	0.2
EX-RAD-215C	P-3 & P-4	0.4
EX-RAD-215C1	P-3 & P-4	0.4
EX-RAD-215C2	P-3 & P-4	0.4
FCU-1	P-3 & P-4	0.8

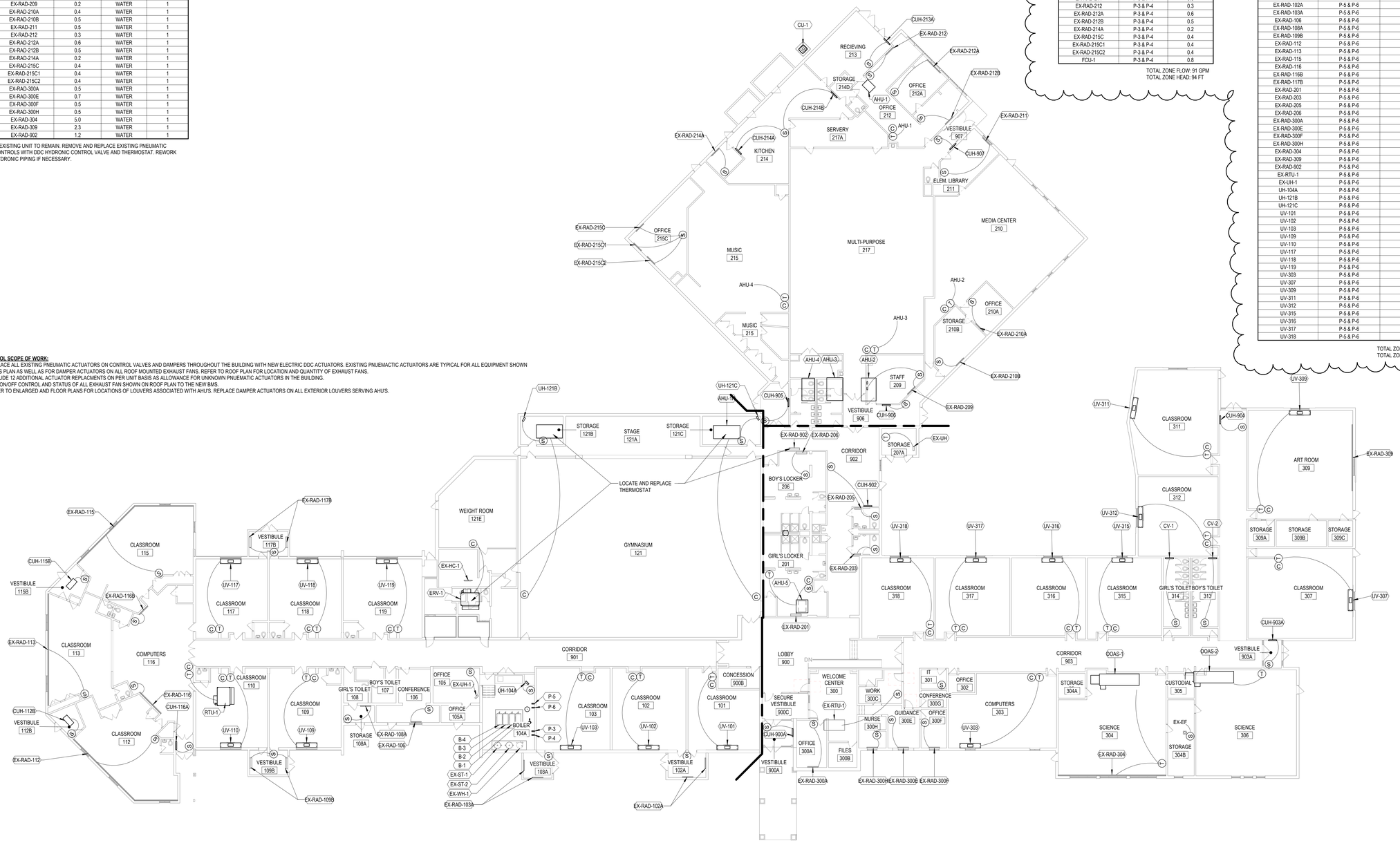
TOTAL ZONE FLOW: 91 GPM
TOTAL ZONE HEAD: 94 FT

BUILDING CIRCULATION EQUIPMENT

GENERAL		HYDRONIC HEATING
MARK	ASSOCIATED PUMP(S)	FLOW (GPM)
AHU-1N	P-5 & P-6	22.0
AHU-2N	P-5 & P-6	22.0
AHU-5	P-5 & P-6	15.0
CUH-112B	P-5 & P-6	1.2
CUH-115B	P-5 & P-6	1.2
CUH-116A	P-5 & P-6	1.2
CUH-213A	P-5 & P-6	3.0
CUH-900A	P-5 & P-6	1.2
CUH-902	P-5 & P-6	2.5
CUH-903A	P-5 & P-6	1.2
CUH-904	P-5 & P-6	1.5
CV-1	P-5 & P-6	0.8
CV-2	P-5 & P-6	0.8
EX-HC-1	P-5 & P-6	15.0
EX-RAD-102A	P-5 & P-6	2.5
EX-RAD-103A	P-5 & P-6	2.1
EX-RAD-106	P-5 & P-6	1.5
EX-RAD-108A	P-5 & P-6	0.5
EX-RAD-109B	P-5 & P-6	2.5
EX-RAD-112	P-5 & P-6	1.7
EX-RAD-113	P-5 & P-6	1.6
EX-RAD-115	P-5 & P-6	2.0
EX-RAD-116	P-5 & P-6	0.4
EX-RAD-116B	P-5 & P-6	0.4
EX-RAD-117B	P-5 & P-6	2.8
EX-RAD-201	P-5 & P-6	1.2
EX-RAD-203	P-5 & P-6	0.2
EX-RAD-205	P-5 & P-6	0.2
EX-RAD-206	P-5 & P-6	1.2
EX-RAD-300A	P-5 & P-6	0.5
EX-RAD-300E	P-5 & P-6	0.7
EX-RAD-300F	P-5 & P-6	0.5
EX-RAD-300H	P-5 & P-6	0.5
EX-RAD-304	P-5 & P-6	5.0
EX-RAD-309	P-5 & P-6	2.3
EX-RAD-902	P-5 & P-6	1.2
EX-RTU-1	P-5 & P-6	5.2
EX-UH-1	P-5 & P-6	1.7
UH-104A	P-5 & P-6	3.0
UH-121B	P-5 & P-6	3.0
UH-121C	P-5 & P-6	3.0
UV-101	P-5 & P-6	2.6
UV-102	P-5 & P-6	2.6
UV-103	P-5 & P-6	2.6
UV-109	P-5 & P-6	2.6
UV-110	P-5 & P-6	2.6
UV-117	P-5 & P-6	2.6
UV-118	P-5 & P-6	2.6
UV-119	P-5 & P-6	2.6
UV-303	P-5 & P-6	3.2
UV-307	P-5 & P-6	3.2
UV-309	P-5 & P-6	4.0
UV-311	P-5 & P-6	3.2
UV-312	P-5 & P-6	2.6
UV-315	P-5 & P-6	2.6
UV-316	P-5 & P-6	2.6
UV-317	P-5 & P-6	2.6
UV-318	P-5 & P-6	2.6

TOTAL ZONE FLOW: 183.4 GPM
TOTAL ZONE HEAD: 58 FT.

CONTROL SCOPE OF WORK:
1. REPLACE ALL EXISTING PNEUMATIC ACTUATORS ON CONTROL VALVES AND DAMPERS THROUGHOUT THE BUILDING WITH NEW ELECTRIC DDC ACTUATORS. EXISTING PNUEMACTIC ACTUATORS ARE TYPICAL FOR ALL EQUIPMENT SHOWN ON THIS PLAN AS WELL AS FOR DAMPER ACTUATORS ON ALL ROOF MOUNTED EXHAUST FANS. REFER TO ROOF PLAN FOR LOCATION AND QUANTITY OF EXHAUST FANS.
2. INCLUDE 12 ADDITIONAL ACTUATOR REPLACMENTS ON PER UNIT BASIS AS ALLOWANCE FOR UNKNOWN PNUEMATIC ACTUATORS IN THE BUILDING.
3. ADD ON/OFF CONTROL AND STATUS OF ALL EXHAUST FAN SHOWN ON ROOF PLAN TO THE NEW BMS.
4. REFER TO ENLARGED AND FLOOR PLANS FOR LOCATIONS OF LOUVERS ASSOCIATED WITH AHU'S. REPLACE DAMPER ACTUATORS ON ALL EXTERIOR LOUVERS SERVING AHU'S.



BUILDING MECHANICAL CONTROLS PLAN
1/16" = 1'-0"

(866) 454-3923 | WWW.C2AE.COM

ARCHITECTURE

MECHANICAL CONTROLS

RENOVATIONS AND IMPROVEMENTS
600 E. PARK ST, PENTWATER, MI 49449

PHASE

ISSUED FOR BIDS

ISSUANCES

#	DESCRIPTION	DATE
0	ISSUED FOR BIDS	22SEP2025
2A1	ADDENDUM 1	31OCT2025

PROJ. #: 24-0301

2M-801

Addendum #1

10/31/2025 6:27:55 AM
Autodesk Docs://24030_PPS 20/24 Bond Implementation/24030_MP.rvt

DESIGNED BY: NBI
CHECKED BY: DTD APPROVED BY: Approver