ADDENDUM NO. TWO
MAY 15, 2026

HVAC IMPROVEMENTS
SEWARD, NE
SEWARD PUBLIC SCHOOL DISTRICT
JEO PROJECT NO. 242372.01

THIS ADDENDUM IS ISSUED BY JEO CONSULTING GROUP, INC. TO ALL WHO HAVE OBTAINED OR RECEIVED BIDDING DOCUMENTS (PLANS, SPECIFICATIONS, AND/OR PROPOSED CONTRACT DOCUMENTS) FOR ABOVE LISTED PROJECT.

THIS ADDENDUM IS HEREBY MADE A PART OF THE BIDDING DOCUMENTS OR CONTRACT DOCUMENTS, AS APPROPRIATE. BIDDERS ARE REQUIRED TO ACKNOWLEDGE RECEIPT OF THIS ADDENDUM IN APPROPRIATE SPACE ON THE BID FORM.

COORDINATING PROFESSIONAL	Bryan Solko JEO Consulting Group, Inc. 2000 Q Street, Suite 500 Lincoln, NE 68503 Phone: 402.435.3080 Email: bsolko@jeo.com
SUBMITTING ORGANIZATION(S)	Architecture Organization legal name: JEO Architecture, Inc. Contact information: 1937 N Chestnut St, Wahoo, NE 68066 – 800.723.8567 Organization certificate of authorization number: CA-3929

CONSULTANT ADDENDUM:

1. Refer to attached consultant addendum, 72 pages.

All other requirements of the Plans, Specifications and Contract Documents remain in effect. This addendum shall be attached to and made a part of the Plans, Specifications and Contract Documents and receipt shall be acknowledged by the Bidder on the Proposal submitted.

END OF ADDENDUM TWO

Bryan Solko
May 15, 2026

Alvine

May 15, 2026

ADDENDUM 2

Bid Date: May 21, 2026

This addendum is hereby made a part of the contract documents to the same extent as though it were originally included therein. Specifications and drawings shall be considered modified or revised as hereinafter described. Revisions to the drawings are referenced by the drawing number.

GENERAL INFORMATION:

2GI1. Question: Who is the existing controls contractor for this project?

Answer: All of the Seward Public Schools are served by Engineered Controls.

CHANGES TO THE PROJECT MANUAL

Mechanical Specification Items:

2MS1. Specification Section 23 09 13.13 – Instrumentation and Control Devices for HVAC

1. Add this specification section in its entirety, see attached.

2MS2. Specification Section 23 09 23 – Building Management Direct Digital Control System

1. Add this specification section in its entirety, see attached.

2MS3. Specification Section 23 09 93 – Sequence of Operations for Building Management Control System

1. Add this specification section in its entirety, see attached.

2MS4. Specification Section 23 62 13 – Packaged Air or Water Cooled Refrigerant Compressor and Condenser Units

1. Page 23 62 13 – 4: Modify Article 2.10 as follows:

   "2.10 Spring Vibration Isolators"

2. Page 23 62 13 – 5: Modify Paragraph 2.10B as follows:

   "B. Not Used."

3. Page 23 62 13 – 5: Modify Paragraph 2.10C as follows:

   "C. Not Used."

4. Page 23 62 13 – 5: Add the following to the end of Subparagraph 2.10.D.1:

   "1. Restrained Spring Isolators: Freestanding, steel, housed spring isolators with seismic restraint. See drawings for locations and sizes."

2MS5. Specification Section 23 74 16 – Packaged Rooftop Air-Conditioning Units

1. Page 23 74 16 – 3: Delete Article 2.11 in its entirety.

CHANGES TO THE DRAWINGS

Mechanical Drawing Items:

2MD1. Sheet M000 P1 – Mechanical Symbols, Abbreviations, and Notes

1. Modify "Miscellaneous General Notes".
2. See attached updated sheet.

2MD2. Sheet MD102D HS P1 – Demolition Upper Floor Plan – Area D - Mechanical

1. Modify Flag Note 2.
2. Add Flag Note 5.

3. See attached updated sheet.

2MD3. Sheet M101D HS P1 – Floor Plan – Area D - Mechanical

1. Modify Flag Note 7.
2. Update gas pipe size.
3. See attached updated sheet.

2MD4. Sheet M102D HS P1 – Floor Plan – Area D - Mechanical

1. Add Flag Note 9.
2. Add section reference.
3. Update supply air duct sizes.
4. See attached updated sheet.

2MD5. Sheet M201 HS P1 – Mechanical Sections

1. Add Flag Note 1.
2. Add Flag Note 2.
3. Add Flag Note 3.
4. Add Flag Note 4.
5. Update supply air duct sizes.
6. Update gas pipe sizes.
7. Add detail reference.
8. See attached updated sheet.

2MD6. Sheet MD101A ES P1 – Demolition Floor Plan – Area A - Mechanical

1. Delete flag notes.
2. See attached updated sheet.

2MD7. Sheet M101A ES P1 – Floor Plan – Area A - Mechanical

1. Modify Flag Note 1.
2. Modify Flag Note 2 to say, “NOT USED”.
3. Modify Flag Note 3 to say, “NOT USED”.
4. See attached updated sheet.

2MD8. Sheet M102A ES P1 – Floor Plan – Area A – Mechanical

1. Add Flag Note 2.
2. Add Flag Note 3.
3. See attached updated sheet.

2MD9. Sheet M201A ES P1 – Enlarged Mechanical Plans and Sections

1. Modify Flag Note 7.
2. Add Flag Note 9.
3. Add Flag Note 10.
4. Modify HWS/R routing.

5. Add detail reference.
6. See attached updated sheet.

2MD9. Sheet M301 P1 – Mechanical Details

1. Add Notes 5 and 6 to "EXTERIOR DUCT SUPPORT 2/M301 P1".
2. Modify HWS/R routing.
3. See attached updated sheet.

2MD10. Sheet M302 P1 – Mechanical Details

1. Modify "CONDENSATE DRAIN 1/M302 P1".
2. Modify "HEATING COIL 2-WAY PIC VALVE AND CIRC. PUMP PIPING 2/M302 P1".
3. Modify "Gas Riser Diagram 5/M302 P1".
4. See attached updated sheet.

2MD11. Sheet M401 P1 – Mechanical Schedules

1. Modify "AIR COOLED CONDENSING UNIT SCHEDULE – ES P1".
2. Modify "AIR HANDLING UNIT SCHEDULE – ES P1".
3. Modify "ROOFTOP UNIT SCHEDULE (GAS HEAT) – HS P1".
4. See attached updated sheet.

Electrical Drawing Items:

2ED1. Sheet E101D HS P1 - Floor Plan – Area D – Electrical

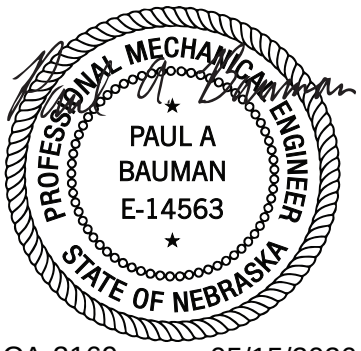
1. On the east exterior wall of Mech Rm A103, move the location for new wall pack Lighting Fixture #1 north approximately 5 feet so it is centered between existing intake louvers. Prior to any rough-in, coordinate the final location with the new mechanical ductwork to ensure no conflicts.
2. In the Auxiliary Gym A101, provide two sampling tube duct smoke detectors, one at each supply air duct location entering the Gym.
3. Modify Flag Note 4 to read as follows:

   "Provide Fire Alarm system connection to return air smoke detector furnished with AHU-7. Provide components as necessary to integrate the smoke detector with the existing Notifier system."
4. Add Flag Note 16 as follows:

   "Provide a new sampling tube duct smoke detector in the new supply air ductwork serving the gymnasium. Connect to existing Notifier fire alarm system."
5. See attached updated sheet.

END

PAB-GAN/mjh



CA-2169 05/15/2026

SECTION 23 09 13.13
INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Unitary Controllers

B. Power Supplies and Transformers.

C. Low Voltage Control Cable.

D. Control Valves:
   1. Pressure Independent Control Valves.

E. Control Dampers.

F. Damper Operators:
   1. Electric operators.

G. Input/Output Sensors:
   1. Temperature sensors.
   2. Humidity sensors.
   3. Static pressure (air pressure) sensors.
   4. Equipment operation (current) sensors.

H. Transmitters:
   1. Building static pressure transmitters.
   2. Air pressure transmitters.
   3. Thermowells.

I. Output Devices.

J. Flow Sensors:
   1. Airflow measurement system (AFMS).

1.02 REFERENCE STANDARDS

A. ANSI/FCI 70-2 - Control Valve Seat Leakage.

B. ICC (IECC)-2018 - International Energy Conservation Code.

C. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.
   1. Manufacturer's printed data sheets for all control system components clearly identify data by component.
   2. General catalog sheets, including details of construction, ratings, and dimensions for each component.

C. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.

1. Show complete details of interconnections between temperature control systems and control specified with equipment or systems.
2. Provide valve schedules indicating size, type, design flow, valve capacity, pressure drop and CV value, identification, and part number.
3. Provide dampers schedule indicating dimension and descriptions of blank-offs, installation location, arrangement, velocities, static pressure drop, damper features, identification, and part number.
4. Control panel locations indicated on plans.
5. Control panel interior layout drawings indicating the following:
    a. Overall panel size.
    b. Device loactions and labeling within panel.
    c. Spare and space locations.
    d. Power supplies and transformers.
    e. Wiring and cabeling pathways.
6. Clearly note the proposed deviations from specified sequences and equipment, and substantiate with written explanation.

D. Manufacturer's Instructions: Provide for all manufactured components.

E. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.

F. Project Record and Closeout Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.
1. Complete Index of Contents.
2. Revise shop drawings to reflect actual installation and operating sequences.
3. Red-mark "Record" control system drawings and then turn them over to the Owner's Representative.
4. Provide directions for calibration, adjustment, and maintenance instructions for each type of component.
5. Shop drawings of control system showing devices, interconnections between devices, and connections to items provided by others.
6. Specifications data sheets on each device.

G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Section 01 60 00 - Product Requirements, for additional provisions.
2. Extra Thermostats and Other Exposed Sensors: One of each type.

1.05 QUALITY ASSURANCE

A. Designer Qualifications: Design system under direct supervision of a Professional Engineer experienced in design of this work and licensed at the State in which the Project is located.

B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.

C. Installer Qualifications: Company specializing in performing the work of this section with minimum five years experience approved by manufacturer.

D. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.06 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. As indicated.

2.02 EQUIPMENT - GENERAL

A. Products Requiring Electrical and Control Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

2.03 POWER SUPPLIES AND TRANSFORMERS

A. DC Power Supplies:

B. DDC Power Supply Panel with Transformers:
   1. Transformer: 500 VA
   2. Over Current Protection: Circuit Breaker
   3. Primary: 480/277/240/120 VAC
   4. Frequency: 50/60 Hz
   5. Nominal Dimensions: 12" x 12" x 6"
   6. Approvals: Class 2 (UL Approved UL5085-3), UL916, UL508, C-UL, CE, RoHS
   7. Housing: NEMA1 Metal Enclosure, Plenum Rated
   8. Weight: 30.16 lbs.
   9. 5 Secondaries: 24 VAC, with LED Indicators
   10. 24 VAC ON/OFF: On / Off Switch & Breaker
   11. Input: 480/277/240/120 VAC, Finger-Safe Terminals
   12. Output: 5 Isolated, Floating 100 VA Class 2 24 Vac Terminals
   13. Ambient Temperature Derating: 4A up to 40 degrees C; 3A up to 50 degrees C ; 2A up to 55 degrees C (When All 5 Outputs Operated Simultaneously)
   14. Standby Wattage: 48.5 W @ 120 VAC
   15. Full Load Primary Current: 4.6 A @ 120 VAC
   16. Basis of Design: Functional Devices, Inc. Model no.: PSH500A, Enclosed Power Supply

2.04 LOW VOLTAGE CONTROL CABLE

A. All wiring materials covered by this section shall be in accordance with the latest revision of the National Electrical Code and applicable local codes and shall carry the UL label where applicable.

B. All wiring running exposed in air plenums shall be plenum cable.

C. Analog Input, Analog Output, Binary Input, Binary Output, 24 VAC, and General Purpose Cabling:
   1. Cable shall consist of copper conductors not less than #18 AWG stranded.
   2. Cable shall be two- or three-conductor twisted cable with a drain wire.
   3. Cable shall have a 100 percent overall shield.
   4. Cable shall be plenum rated.
   5. Cable shall meet or exceed NEC voltage rating of 300 volts.
   6. Cable shall be NEC type CMP.
   7. Cable shall meet or exceed UL temperature rating of +60 deg C.
   8. Cable shall be labeled at a minimum of every 18 inches with the DDC system manufacturer's name and the type of signal carried within the cable, i.e., analog input, analog output, binary input, binary output, 24 VAC.

D. Primary and Secondary Communications Network Cabling:
   1. Cable shall be of type recommended by the DDC system manufacturer.
   2. Cable shall be shielded.
   3. Cable shall be plenum rated.
   4. Cable shall meet or exceed NEC voltage rating of 150 volts.

5. Cable shall meet or exceed UL temperature rating of +60 deg C.

2.05 CONTROL VALVES

A. Control Valve General Requirements:
   1. Valve Assembly: Provide commercial-grade valve type unless otherwise indicated.
   2. Identification Tag: Custom octagon type, brass, engraved.
      a. Information: Show Cv with fail setting.
      b. Fastened: Beaded chain, brass.
   3. Valve Selection:
      a. Flow Characteristic:
         1) Equal Percentage: Water, brine and liquid service.
         2) Linear: Steam service.
      b. Sizing:
         1) Cv (Valve Coefficient): Size using expected load flow and pressure drop across branch which includes coil, pipe, and fittings.

B. Pressure Independent Control Valves (PICV):
   1. Manufactures:
      a. Delta P
      b. Bell and Gossett
      c. Belimo
      d. IMI Flow Design
      e. Griswold
   2. Valves shall be warranted for minimum of five years from date of shipment.
   3. Pressure indendent control valves shall accurately control the flow from 0 to 100% rated flow.
   4. Minimum operating pressure differential range of 5 to 50 PSI differential across the valve and equal or greater than the associated pump's design head pressure.
   5. Valve body flow accuracy of +/- 5% total assembly error incorporating differential pressure fluctuation, manufacturing tolerances and valve hysteresis.
   6. Maintain proportional and linear flow coil characteristics.
   7. Provide minimum Class 4 shut-off on all sizes and field serviceable.
   8. Valve bodies shall be Brass. All internal parts shall be Stainless Steel.
      a. NPS 2 and Smaller: Forged brass body rated at no less than 250 PSI, stainless steel ball and stem, NPT, dual EPDM lubricated O-rings and a brass or TEFZEL characterizing disc.
   9. Valves shall have minimum of two factory installed PTT ports capable of being used to measure pressure or temperature.
   10. Electronic Actuators: Direct-mounted, self-calibrating type designed for minimum 60,000 full-stroke cycles at rated force.
   11. Provide actuator with visible position indication. Fail positions on power failure to include in-place, open or closed as indicated in the controls specifications.
      a. Valves: Sized for maximum circuit flow rate and nominally, line-sized.
      b. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
      c. Fail-Safe Operation: Mechanical, spring-return mechanism or capacitance return.
      d. Provide plenum-rated actuators for service above ceilings to possess UL listings and approvals.
      e. Temperature Rating: 40 to 104 degrees F.

2.06 LOW LEAKAGE (CLASS 1A) CONTROL DAMPERS

A. Maximum Leakage Allowed: 3 cfm/sq ft at 1 in-wc.

B. Frame:
   1. Material: 20-gauge aluminum.

2. Free-area: Single cross section.
3. Blanked-off: Split frame into two free-area sections to allow a smaller free-area to be used for a minimum airflow intake or exhaust application and secondary free-area fully blanked-off.

C. Blade:
1. Type: Multi-blade such as V or 3V for low to medium pressure.
2. Operation: Parallel type for mixed air applications.
3. Maximum Individual Blade Height: 8 inches.
4. Material: 12-gauge galvanized steel.

D. Insulation: Water-resistant sound absorbing material.

E. Temperature Service Range: Minus 25 to 185 degrees F.

F. Other Requirements:
1. Provide thermally broken frame and blades.
2. Paint Finish: Standard.
3. Sleeve or Flange: Factory-mounted standard.

2.07 ELECTRIC VALVE AND DAMPER ACTUATORS

A. Manufacturers:
1. Belimo Aircontrols (USA), Inc: www.belimo.com/#sle.
2. Honeywell International, Inc: buildingcontrols.honeywell.com/#sle.
3. Johnson Controls International, PLC: www.johnsoncontrols.com/#sle.
4. Ruskin Company: www.ruskin.com/#sle.
5. Schneider Electric: www.schneider-electric.us/#sle.
6. Siemens Industry, Inc: www.siemens.com/#sle.

B. General Requirements:
1. Assembly: Products field-installed onto dampers and valves.
2. Actuator Capacity: Next torque size above calculated load requirement for single units. Increase selected capacity by 25 percent when multiple units are required.
a. Mounting: Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required.
b. Spring return, as indicated, with auxiliary end switch and minimum position potentiometer.
1) For power-failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator. Non-mechanical forms of fail-safe operation are not acceptable.
c. All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb torque capacity shall have a manual crank for this purpose.
3. Environmental Operating Range:
a. Temperature: From minus 22 to 122 degrees F.
b. Humidity: 5 to 90 percent RH (non-condensing).
4. Manual Operators:
a. Provide latching operator per actuator.
b. Operator Type: Hand quadrant lever.

C. Valve Actuators:
1. Select operator for full shut off at maximum pump differential pressure.
2. Size for torque required for valve close off at 150 percent of total system (head) pressure for two-way valves; and 100 percent of pressure differential across the valve or 100 percent of total system (pump) head differential pressure for three-way valves.

3. Terminal unit reheat coil control valves be proportional actuators shall accept a 0 to 10 VDC or 0 to 20 mA control input and provide a 2 to 10 VDC or 4 to 20 mA operating range.
4. Fail-Safe Operation: Mechanical, spring-return mechanism.
    a. Control Valve Normal Fail-Safe position:
        1) AHU heating coil: NO

D. Damper Actuators:
1. General: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.
    a. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.
    b. Provide one operator for maximum 36 sq ft damper section.
2. Coupling: V-bolt dual nut clamp with a V-shaped, toothed cradle.
3. Fail-Safe Operation: Mechanical, spring-return mechanism.
    a. Damper Normal Fail-Safe position:
        1) Outdoor Air: NC
        2) Return Air: NO
        3) Relief Air: NC

E. Mechanical Configuration:
1. Proportional (Modulated):
    a. Input: 0 to 10 VDC.
    b. External Power: 24 VDC.
    c. Position Feedback: 0 to 10 VDC.
    d. Stroke Duration: 60 seconds.
    e. Type: Maintenance-free brushless DC Motor.
    f. Fail Safe Control: Built-in energy storage, return under 20 seconds.
    g. Adjustable Settings: Stroke direction, zero, span, and offset.

F. Angle of Rotation: 95-degree, adjustable range with mechanical end stop.

G. Motor Direction: Clock wise (CW) counter-clock wise (CCW) selectable.

H. Position Indicator: Scale indicator with tracking pointer.

I. Overload Protection Type: Electronic.

J. Electrical Protection: Double-insulated.

K. Provide the following features and accessories where indicated or where required to complete installation:
1. Auxiliary switches (SPST).
2. Battery backup.
3. Conduit connector.
4. Gaskets.
5. Potentiometer interface.
6. Pulse-width modulation (PWM) interface.
7. Resistor kit.
8. Terminal strip.
9. Thermal sensors.
10. Transformer.

2.08 INPUT/OUTPUT SENSORS

A. Temperature Sensors:

1. Use thermistor or RTD type temperature sensing elements with characteristics resistant to moisture, vibration, and other conditions consistent with the application without affecting accuracy and life expectancy.
2. Construct RTD of nickel or platinum with base resistance of 1000 ohms at 70 degrees F.
3. 100 ohm platinum RTD is acceptable if used with project DDC controllers.
4. Temperature Sensing Device: Compatible with project DDC controllers.
5. Performance Characteristics:
    a. RTD:
        1) Room Sensor Accuracy: Plus/minus 0.50 degrees F minimum.
        2) Duct Averaging Accuracy: Plus/minus 0.50 degrees F minimum.
        3) Chilled Water Accuracy: Plus/minus 0.50 degrees F minimum.
        4) All Other Accuracy: Plus/minus 0.75 degrees F minimum.
        5) Range: Minus 40 degrees F through 220 degrees F minimum.
    b. Thermistor:
        1) Accuracy (All): Plus/minus 0.36 degrees F minimum.
        2) Range: Minus 25 degrees F through 122 degrees F minimum.
        3) Heat Dissipation Constant: 2.7 mW per degree C.
    c. Temperature Transmitter:
        1) Accuracy: 0.10 degree F minimum or plus/minus 0.20 percent of span.
        2) Output: 4 to 20 mA.
    d. Sensing Range:
        1) Provide limited range sensors if required to sense the range expected for a respective point.
        2) Use RTD type sensors for extended ranges beyond minus 30 degrees F to 230 degrees F.
        3) Use temperature transmitters in conjunction with RTD's when RTD's are incompatible with DDC controller direct temperature input.
    e. Wire Resistance:
        1) Use appropriate wire size to limit temperature offset due to wire resistance to 1.0 degree F or use temperature transmitter when offset is greater than 1.0 degree F due to wire resistance.
        2) Compensate for wire resistance in software input definition when feature is available in the DDC controller.
    f. Outside Air Sensors: Watertight inlet fitting shielded from direct rays of the sun.
        1) Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.
        2) Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.
    g. Immersion Temperature Sensors: A sensor encased in a corrosion-resistant probe with an indoor junction box service entry body.
    h. Duct Averaging Temperature Sensors:
        1) Application: Air handling applications where the coil or duct area is greater than 10 square feet, or the air is affected by stratification regardless of duct size. .
        2) The averaging sensor tube shall contain at least one thermistor for every 3 feet, with a minimum tube length of 6 feet.
        3) Provide sensor tube length to adequately cover the duct cross-sectional area. Multiple sensors shall be utilized as required to ensure a representative temperature reading in large ducts.
        4) Use on duct sensors for ductwork 10 sq ft or larger.
        5) Use averaging elements where prone to stratification with sensor length 8 ft or 16 ft.

6) Provide for all mixed air and heating coil discharge sensors regardless of duct size.
7) The averaging sensor shall be constructed of rigid or flexible copper tubing.
8) Duct Mounted Averaging Sensor Requirements:
(a) Sensor Type: Thermistor.
(b) Accuracy: +/-2.7 °F at 77 °F.
(c) Operating Temperature: -13 to 221 °F.
(d) Sensor Tube Material: Copper.

i. Insertion Elements:
1) Use in ducts not affected by temperature stratification or smaller than 11 sq inches.
2) Provide dry type, insertion elements for liquids, installed in immersion wells, with minimum insertion length of 2.5 inches.

j. Duct Probe Temperature Sensors:
1) Application: Air handling applications where the coil or duct area is less than 10 square feet, and the air is not affected by stratification.
2) Sensor probe length shall be selected to provide the most representative reading from the sensed airstream.
3) Duct Mounted Sensor Requirements:
(a) Sensor Type: Thermistor.
(b) Accuracy: +/-0.4 °F over a 32 to 158 °F range.
(c) Measurement Resolution: 0.1 °F.
(d) Enclosure Material: Stainless Steel.

k. Outside Air Temperature Sensor:
1) The sensing element shall be fully encapsulated in potting material within a stainless-steel probe.
2) Probe shall be encased in PVC solar radiation shield and mounted in a weatherproof enclosure.
3) Sensor Requirements:
(a) Operating range: -40 to 122 °F.
(b) Accuracy: +/-0.2 °F.
(c) Enclosure Material: ABS Plastic.

l. Insertion Elements:
1) Use in ducts not affected by temperature stratification or smaller than 11 sq inches.
2) Provide dry type, insertion elements for liquids, installed in immersion wells, with minimum insertion length of 2.5 inches.

B. Humidity Sensors:
1. Duct Mounted Sensor: Voltage type encased in a die-cast metal, weather-proof housing.
a. Input Power, Voltage Type: Class 2; 12-30 VDC/24 VAC, 15mA max.
b. Input Power, mA Type: Class 2; Loop powered 12-30 VDC only, 30 mA max.
c. Output Voltage Type: 3-wire observed polarity.
d. Output mA Type: 2-wire, not polarity sensitive (clipped and capped).
e. Humidity:
1) HS Element: Digitally profiled thin-film capacitive.
2) Accuracy 1 percent at 10 to 80 percent relative humidity at 77 degrees F, multi-point calibration, NIST traceable.
(a) Plus/minus 1 percent at 20 to 40 percent RH in mA output mode; (multi-point calibration, NIST traceable).
3) Scaling: 0 to 100 percent RH.
f. Temperature Effect:
1) Duct Mounted: Plus/minus 0.18 percent per degree F.

2) Outdoor Mounted: 4 to 20mA version: (0.0013x%RHx(TdegreeC-25)).

g. Hysteresis: 1.5 percent typical.

h. Linearity: Included in accuracy specification.

i. Reset Rate: 24 hours.

j. Stability: Plus/minus 1 percent at 68 degrees F (20 degrees C) annually, for two years.

k. Temperature Monitoring:

1) Temperature Transmitter Output: Digital, 4 to 20mA (clipped and capped) or 0-5V/0-10V output.

(a) HO Transmitter Accuracy: Plus/minus 2.3 degrees F.

(b) HD Transmitter Accuracy: Plus/minus 1.0 degree F.

l. Operating Environment:

1) Operating Humidity Range: 0 to 100 percent RH noncondensing.

2) Operating Temperature Range: Minus 40 degrees F to 122 degrees F.

2. Wall Mounted Sensor: Voltage type encased in a plastic housing.

C. Static Pressure (Air Pressure) Sensors:

1. Unidirectional with ranges not exceeding 150 percent of maximum expected input.
2. Temperature compensate with typical thermal error or 0.06 percent of full scale in temperature range of 40 to 100 degrees F.
3. Accuracy: One percent of full scale with repeatability 0.3 percent.
4. Output: 0 to 5 vdc with power at 12 to 28 vdc.

D. Equipment Operation (Current) Sensors:

1. Status Inputs for Fans: Differential pressure switch with adjustable range of 0 to 5 inches wg.
2. Status Inputs for Pumps: Differential pressure switch piped across pump with adjustable pressure differential range of 8 to 60 psi.
3. Status Inputs for Electric Motors: Current sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.

E. Damper Position Indicators: Potentiometer mounted in enclosure with adjustable crank arm assembly connected to damper to transmit 0 to 100 percent damper travel.

F. Carbon Dioxide Sensors, Duct:

1. General: Provide non-dispersive infrared (NDIR), diffusion sampling CO2 sensors with integral transducers and linear output.
2. Air Temperature: Range of 32 to 122 degrees F.
3. Relative Humidity: Range of 0 to 95 percent (non-condensing).
4. Power Input: Class 2; 12 to 30VDC or 24VAC 50/60 Hz; 100mA max.
5. Calibration Characteristics:
   a. Automatically compensating algorithm for sensor drift due to sensor degradation.
   b. Maximum Drift: 2 percent.
   c. User calibratable with a minimum calibration interval of 5 years.
6. Construction:
   a. Sensor Chamber: Non-corrosive material for neutral effect on carbon dioxide sample.
   b. Provide duct mounted sensors with duct probe designed to protect sensing element from dust accumulation and mechanical damage.
   c. Housing: High impact plastic.

G. Power Monitoring Sensors:

1. Current measurement (amps) shall be by a combination current transformer and a current transducer. The current transformer shall be sized to reduce the full amperage of the monitored circuit to a maximum five-amp signal, which will be converted to a 4-20 mA DDC-compatible signal for use by the facility management system.

2. Current Transformer: A split core current transformer shall be provided to monitor motor amps.
    a. Operating Frequency: 50-400 Hz.
    b. Insulation: 0.6 kV class 10 kV BIL.
    c. UL recognized.
    d. Five-amp secondary.
    e. Select current ratio as appropriate for application.
3. Current Transducer: A current to voltage or current to mA transducer shall be provided. The current transducer shall include:
    a. 6X input over amp rating for AC inrushes of up to 120 amps.
    b. Manufactured to UL 1244.
    c. Accuracy: +0.5 percent, Ripple +1.0 percent.
    d. Minimum Load Resistance: 30 kohms.
    e. Input: 0-20 amps.
    f. Output: 4-20 mA.
    g. Transducer shall be powered by a 24 VDC regulated power supply (24 VDC + 5 percent).

H. Air Filter Status Sensor:
1. Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for two amps at 120 VAC.
2. A complete installation kit shall be provided, including static pressure tops, tubing, fittings, and air filters.
3. Provide appropriate scale range and differential adjustment for intended service.

I. Air Pressure Safety Sensor:
1. Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for two amps at 120 VAC.
2. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.

2.09 TRANSMITTERS

A. Building Static Pressure Transmitters:
1. One pipe, direct acting, double bell, scale range 0.01 to 6.0 inch wg positive or negative, and sensitivity of 0.0005 inch wg. Transmit electronic signal to receiver with matching scale range.

B. Air Pressure Transmitters:
1. General: Provide dry media differential pressure transducers to monitor duct and room pressure.
    a. Media Compatibility: Dry air.
    b. Input Power: Class 2; 12 to 30 VDC; 2-wire: 20 mA max.
    c. Output: Field selectable, 2-wire, loop-powered 4 to 20 mA (DC only, clipped and capped).
    d. Pressure Ranges: 4 and 7, field selectable.
    e. Response Time:
        1) Standard: T95 in 20 seconds.
        2) Fast: T95 in 2 seconds.
        3) Switch selectable.
    f. Mode: Switch selectable, unidirectional.
    g. Display:
        1) Signed 3-1/2 digit LCD, indicates pressure.
        2) Over-range indicator.
    h. Proof Pressure (pressure differential): 3 psid.

i. Burst Pressure (pressure differential): 5 psid.
j. Accuracy: Plus/minus 1 percent f.s. (full scale) of selected range (combined linearity & hysteresis).
k. Temperature Effect (per transmitter size):
1) 1 inch w.c.: 2.0 percent per degree C.
2) 10 inch w.c.: 0.01 percent per degree C.; (Relative to 25 degrees C) 32 degrees F to 122 degrees F.
l. Zero Drift (1-year) (per transmitter size):
1) 1 inch w.c.: 2 percent maximum.
2) 10 inch: 0.05 percent maximum.
m. Zero adjust: Pushbutton auto-zero and digital input (2-pos terminal block).
n. Operating Environment:
1) 32 degrees F to 140 degrees F.
2) 0 to 90 percent RH noncondensing.
o. Fittings:
1) Brass barb.
2) 0.24 inches outer diameter.
3) {rs#1} V-O fire retardant ABS.

C. Thermowells:
1. When thermowells are required, the sensor and well shall be supplied as a complete assembly, including well head and Greenfield fitting.
2. Thermowells shall be pressure rated and constructed in accordance with the system working pressure.
3. Thermowells and sensors shall be mounted in a threadolet or 1/2-inch NFT saddle and allow easy access to the sensor for repair or replacement.
4. Thermowells shall be constructed of brass.

2.10 OUTPUT DEVICES

A. Control Relays:
1. Control pilot relays shall be of a modular plug-in design with retaining springs or clips.
2. Mounting bases shall be snap mount.
3. DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.
4. Contacts shall be rated for 10 amps at 120 VAC.
5. Relays shall have an integral indicator light and check button.

2.11 FLOW SENSORS

A. Airflow Measurement System (AFMS):
1. Manufacturers:
a. Ebtron.
b. Paragon.
c. Ruskin.
d. TrueFIT AFMS.
2. Products Included in this Section:
a. Permanently mounted Airflow Measurement System (AFMS) for equipment featuring a mixed air damper assembly. The AFMS shall be operated on the BMCS, measuring airflow via the Characterized Airflow Performance method based on ASHRAE Standards 111 and 189.1:
1) Outside Airflow (Ventilation)
2) Temperature at outside air intake
3) Return Airflow and temperature
4) Supply Airflow
5) Mixed Air temperature

6) Outside Air Damper position or Mixed Air Damper Assembly position
(a) Outside Air Damper actuator control

b. Airflow measurement system shall measure airflow by independently measuring outside air intake or return air damper position and the supply air fans/fan arrays airflow rate, by applying the Characterized Airflow method.
c. Outside Air Intake: Provide damper position sensor to comply with ASHRAE standards 111 and 189.1. Sensor shall account for hysteresis in linkages and damper blade deterioration.
d. Fan/Fan Array: Each fan shall include a differential pressure flow sensor with multiple total and static pressure measuring ports installed across the fan inlet as specified in ASHRAE standard 111 or a factory installed piezometer ring airflow station.
e. Duct Airflow: Where flow measurement at the Fan/Fan Array is not possible or flow measurement in the duct is preferred, each system shall include a differential pressure flow sensor with multiple total and static pressure measuring ports that complies with ASHRAE standard 111 for duct traversing.
f. Measurement system accuracy shall be +/- 3% of volumetric airflow rate or better with factory recommended sensor installation locations. Factory recommends that a certified representative verify that sensors are installed as specified. Field accuracy may be validated by a certified factory representative or certified balancing technician.
g. The system shall provide factory controls to allow for fault detection and diagnostics.

2.12 REFRIGERANT MONITORING SYSTEM

A. **Install one in the mechanical room with AHU-2 at the Elementary School. Coordinate the location with the Owner.**

B. Manufacturers:
1. Davis Instruments Manufacturing Co., Inc.
2. Foxboro Company (The).
3. General Analysis Corp.
4. Genesis International Inc.
5. Thermal Gas Systems, Inc.; Haloguard Monitors.
6. Toxalert.
7. Trane Co. (The).
8. Vulcain Alarm.

C. Functional Description of Refrigerant Monitoring System:
1. On leak detection by refrigerant sensor(s), the system shall perform the following:
a. Activate machinery room ventilation.
b. Activate audio and visual alarm inside and outside machinery room.
c. Shut down combustion process where combustion equipment is employed.
d. Notify Building Automation System of alarm condition.

D. Refrigerant Monitor:
1. Description: CMOS or IR sensor shall continuously measure and display the specific gas concentration and shall be capable of indicating, alarming, and shutting down equipment, and automatically activating ventilation system.
2. Follow minimum standards for refrigerant monitoring systems as required by ASHRAE Standard 15, paying special attention to requirements for air monitoring, ventilation, self-contained breathing apparatus, for leak detection and ensuring the safety of chiller plant operating personnel.
3. Performance Requirements:
a. Refrigerant monitor system shall be capable of detecting the presence of any CFC, HCFC or HFC refrigerant regardless of which chiller is select the for Project (i.e. R-454B) , as specificed below and in governing regulations.

b. Any installed unit can be switched to monitor, at a future date, to another refrigerant type by changing one part and recalibration (i.e., CFC-11 to HCFC-123, etc.).
c. Refrigerant Concentration: 0 to 1000 ppm.
d. Sensitivity: 0-10 ppm.
e. Resolution: 0-10 ppm.
f. Operating Temperature: 41 to 104 degrees F.
g. Response Time: 90 percent of a step change in 4 minutes.
h. Relative Humidity: 20 to 95 percent, noncondensing over the operating temperature range.

4. Operating Requirements:
   a. Maximum Power Input: 120-V ac; 60 Hz, 30 W.
   b. Alarm Relays: 3 relays at 5- to 8-A resistive load.
   c. Alarm Set Points: Displayed on front of meter.
   d. Audible Output: Sonic alert at 75 to 80 dB at 60 inches (1525 mm).
   e. Analog Output: 0- to 10-V dc or 4- to 20-mA current sourcing.
   f. Provide three dry contacts for alarm inputs into the BMCS.
   g. Serial Output Type: RS 232.
5. Sensor Configuration: CMOS Photoacoustic IR or Photoabsorptive sensor.
   a. Single-sensing channel.
   b. Expandable to four channels.
6. Display: 10-character, alphanumeric, vacuum-fluorescent indicating lights for each alarm set point; standard alarm; acknowledge switch and test switch mounted on front panel; and alarm status LEDs and service fault LEDs.
   a. Enclosure: NEMA 250, type as required for ambient condition.
7. Alarm Output: Indicating light flashes and horn sounds.
   a. Unit-mounting device with single-light beacon.
   b. Field-adjustable alarm set points.
8. BMCS shall shut down AHU-2 upon alarm.
9. Calibration: Factory calibrated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that systems are ready to receive work.

C. Beginning of installation means installer accepts existing conditions.

D. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.

E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

F. Ensure installation of components is complementary to installation of similar components.

G. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Check and verify location of thermostats with plans and room details before installation. Locate 48 inches above floor. Align with lighting switches. Refer to Section 26 27 26.

C. Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.

D. Provide separable sockets for liquids and flanges for air bulb elements.

E. Provide guards on thermostats in gyms.

F. Provide insulated mounting bases on thermostats and other temperature sensing devices in the following locations:
   1. Exterior walls.
   2. Interior walls that back up to mechanical/utility rooms and other non-conditioned spaces.

G. Provide valves with position indicators.

H. Provide pressure indepenent control valves in the following applications:
   1. AHU hot water coils.

I. Provide mixing dampers of parallel blade construction arranged to mix streams. Provide pilot positioners on mixed air damper motors.

J. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.

K. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.

L. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.

M. Provide boxes, conduit and electrical wiring in accordance with Section 26 05 83. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.
   1. Provide boxes and conduit pathways (to ceiling spaces), for all wall mounted thermostats and sensors and wiring. Refer to Division 26.

3.03 CONTROL PANELS

A. Control panel for each system where more than one control device requires field mounting, (air handling units, exhaust fans, miscellaneous control systems including pump controls, heat exchanger controls, etc.). Single devices may be mounted on piping, wall or ductwork. Install local control panel where indicated on Drawings or suitable location adjacent to system served.

B. Mount panels on wall with suitable brackets or on self-supporting stand. Mount top of panels no higher than 6 ft above floor. Install panels so front cover door can swing fully open without interference.

C. Panels mounted on vibrating equipment shall have vibration isolation protection that ensures their satisfactory operation.

D. All control panels located in accessible areas be provided with keyed locks. Locks shall utilize a single master key. Provide 2 spare key sets to Owner.

E. Panel Layout:
   1. Locate controllers in lower half of panel first and upper half second.
   2. Locate terminal strips either horizontally in upper half of back panel or vertically. Do not locate terminal strips below 2'-0" or above 6' above finished floor.
   3. Separate 24 VDC and 120 VAC, wire, cable, and devices by 6" minimum space.
   4. Enclose wire and cable in wireways or bundle w/ wire ties and secure to back-panel. This does not apply to wire exiting wireways to terminal strips or panel mounted devices.
   5. Space controllers according to manufacturer's requirements with 3" minimum between controllers and other devices on panel and 6" between controller front and door mounted devices. Ensure adequate space is allowed for device heat dissipation.

3.04 SENSORS AND INPUT/OUTPUT DEVICES

A. All input and output devices shall be installed per the manufacturer's recommendation.

B. Building Differential Air Pressure Applications: Transmitter's exterior sensing tip shall be installed with a shielded static air probe to reduce pressure fluctuations caused by wind.
   1. Unless indicated otherwise, locate the exterior sensing tip near the building's main entrance.
   2. The interior sensing tip shall be inconspicuous and located within a central corridor on the same level as the entrance.

C. Outside Air Humidity Sensors: Outside air relative humidity sensors shall be installed with a rain-proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with seal-tight fittings and stainless steel bushings.

D. Outside Air Sensors: Outside air sensors shall be mounted on the north wall to minimize solar radiant heat impact or located in a continuous intake flow adequate to monitor outside air temperatures accurately. Sensors exposed to solar radiation must be installed with solar shields. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate surrounding the sensor element.

E. Low Temperature Limit Switches: Mount element horizontally across duct in a serpentine pattern ensuring each square foot of coil is protected by one foot of sensor. For large duct areas where the sensing element does not provide full coverage of the air stream, provide additional switches as required to provide full protection of the air stream.

F. Duct Mount Sensors:
   1. Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement.
   2. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
   3. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

3.05 ELECTRICAL WIRING

A. Install wiring in accordance with National Electric Code, ANSI/NFPA 70.

B. All wiring materials covered by this section shall be in accordance with the latest revision of the National Electrical Code and applicable local codes and shall carry the UL label where applicable. All wiring running exposed in air plenums shall be plenum cable.

C. Install wiring (low and line voltage) in metal raceways or conduit unless inside control cabinet or unit enclosures. For concealed and accessible areas, plenum-rated wiring and cabling may be used.

D. Class 2 wiring not installed in conduit shall be supported every five feet from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements. Exposed wiring shall only be allowed in concealed accessible locations.

E. Low voltage control wiring and 24 VAC can be run in the same conduit. Power wiring 120 VAC and greater must be in a separate conduit.

F. Fastening shall be secured to walls or ceilings by means of appropriate screws, expansion screws anchors, toggle bolts, hollow wall screw anchors, nylon expansion anchors, or expansion shields. All-purpose plastic anchors are not acceptable.

G. Locate circuits, relays, transformers, or other equipment that contains or must be connected to voltages exceeding 130 volts, in separate cabinets, which may be adjacent to control panels; permanently label "DANGER 277 VOLTS" or appropriate volts.

H. All wiring in mechanical rooms shall be in conduit. Minimum control wiring conduit size shall be 3/4 inch.

3.06 CONTROL WIRING AND POWER CONNECTIONS

A. Provide all incidental control power and wiring required to make the equipment or systems fully operational. Coordinate with equipment manufacture incidental wiring requirements.

B. Unless indicted elsewhere, provide line voltage, 120VAC, 20 amp dedicated control power circuits and LAN outlet to each of the following and as indicated:
   1. BMCS Control panel, 1 circuit.
   2. Air handling Unit, 1 circuit.
   3. DDC Power supply and transformer panel. 1 circuit can power 30 terminal units.
   4. Coordinate required 120V power circuits and LAN outlets with Electrical Contractor.

C. Incidental control wiring includes but not limited to:
   1. Air Handling Units:
      a. Fans
      b. Damper Operators
      c. Valve Operators
   2. Furnaces, Blower Coils, Water Source Heat Pumps, Air to Air Heat Pumps and Condensing Units
      a. Provide 3/4 inch conduit with a minimum of eight distinctively colored or tagged #14 wires between units and remote panels or thermostats for control wiring
   3. HVAC Controls (Including but not limited to):
      a. Manufacturer's Packaged Control Systems
      b. Control Relays
      c. Control Dampers and Valves
      d. Temperature, Flow and Occupancy Sensors
      e. Flow and BTU Meters
      f. Current Sensors
      g. Transmitters
   4. Packaged Rooftop Units, Packaged Exhaust Fan and Make-Up Air Systems
      a. Provide 3/4 inch conduit with a minimum of eight distinctively colored or tagged #14 wires between units and remote panels or thermostats for control wiring
   5. Pumps
   6. Remote Monitoring and Control Panels (Provided by Equipment Manufacturers)
   7. Temporary Heating/Cooling Equipment
   8. Unit Mounted Motor Starters, Contactors, Disconnect Switches, Thermal Overloads and Heaters
   9. Variable Frequency Controls.

3.07 START-UP SERVICES

A. Verify proper location of each device and point-to-point system integrity. Correct as needed.

B. When installation is complete and automatic control system is placed in operation, adjust and calibrate all instruments and devices in system and ensure that system is operating in accord with specified sequences.

C. Diagnose component and system problems. Communicate irregularities to the appropriate contractor for correction.

D. Attend construction meetings as required to coordinate with other contractors and provide input during problem resolution.

3.08 IDENTIFICATION STANDARDS

A. If the owner utilizes a specific equipment or system indentification or naming convention, the contractor shall use for all systems, nameplates and equipment references in all project documentation.

B. Field Devices: All field devices shall be identified by a typed (not handwritten) securely attached tag label.

C. Controller Identification: All controllers shall be identified by typed (not handwritten) securely attached tag label.

D. Panel Identification: All local control panels shall be identified by a plastic engraved nameplate securely fastened to the outside of the controller enclosure.

E. Panel Devices: All panel devices shall be identified by a typed label securely fastened to the back plate of the local control panel.

F. Raceway Identification: All the covers to junction and pull boxes of the control system raceways shall be painted blue or have identification labels stating "Control System Wiring" affixed to the covers. Labels shall be typed, not handwritten.

G. Wire Identification: All low and line voltage control wiring shall be identified by a number or name, as referenced to the associated control diagram, at each end of the conductor cable. Identification number or name shall be permanently secured to the conductor or cable and shall be typed.

3.09 TRAINING

A. Provide demonstration and training in accordance with Section 01 7900 - Demonstration and Training.

END OF SECTION

SECTION 23 09 23
BUILDING MANAGEMENT-DIRECT-DIGITAL CONTROL SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. System description.
B. Contractor Qualifications.
C. Definitions.
D. Work by Others.
E. Control System Interfaces.
F. Controllers.
G. Power supplies and line filtering.
H. System Architecture.
I. Enterprise Server and Operator Workstations (OIW)
J. General Administration and Programming Software.
K. Web-based Operator Software.
L. Network Building Controllers.
M. Fieldbus Controllers.
N. Power supplies and line filtering.
O. BMCS Installation Requirements.
P. BMCS Software Configuration and Programming Requirements.

1.02 SUMMARY

A. The high school and elementary school both have existing BMCS's which will be expanded as part of this project.

B. Scope: Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, configuration, and installation for complete Building Management Control System (also identified as BMCS, Direct Digital Control (DDC) System For HVAC) including all necessary hardware and all operating and applications software as required for the complete performance of the Work, as shown on the Drawings, and as specified herein.

C. Related Sections: This Section includes the Building Management Control System (BMCS) control equipment for HVAC systems and components, including open protocol control components for terminal heating and cooling units. The complete specification has numerous sections that interface to this section. BMCS Contractor is to familiarize themselves with all of the Contract Documents. Related sections and subsections include, but shall not be limited to, the following:
   1. 23 09 13.13 Instrumentation and Control Devices for HVAC.
   2. 23 09 93 Sequence of Operations for HVAC Controls.
   3. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
   4. Applicable general requirements for electrical Work specified within Division 26 Specification Sections apply to this Section.

D. Network level components of the system – workstations, servers, etc. shall communicate using the BACnet protocol, as defined by ASHRAE Standard 135-2004.

E. Except as otherwise noted, the control system shall consist of all necessary Ethernet Network Controllers, Standalone Digital Control Units, Room Controllers, workstations, software,

sensors, transducers, relays, valves, dampers, damper operators, control panels, and other accessory equipment, along with a complete system of electrical interlocking wiring to fill the intent of the specification and provide for a complete and operable system. Except as otherwise specified, provide operators for equipment such as dampers if the equipment manufacturer does not provide these. Coordinate requirements with the various Contractors.

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

G. All interlocking wiring, wiring and installation of control devices associated with the BMCS shall be provided under this Contract. When the BMCS system is fully installed and operational, the BMCS system supplier and representatives of the Owner will review and check out the system per System Acceptance and Testing section of this document. At that time, the BMCS system supplier shall demonstrate the operation of the system and prove that it complies with the intent of the drawings and specifications.

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

1.03 WORK BY OTHERS

A. Cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others' work.

B. Furnish all Airflow Stations, Control Dampers, Control Valves, Flow Meters, Flow Switches, Refrigerant Pressure/Transducers, Sensor Wells as required by the Sequence of Operations and Points List for installation by the Mechanical Contractor.

C. Provide field supervision to the designated contractor for the installation of the following:
   1. Automatic control dampers.
   2. Blank-off plates for dampers that are smaller than duct size.
   3. Sheet metal baffles plates to eliminate stratification.
   4. Control valves, flow meters, flow switches, and sensor wells.
   5. The Electrical Contractor shall provide:
      a. All 120VAC power wiring to motors, heat trace, junction boxes for power to BMCS panels.
      b. Smoke detectors and wiring for the building fire alarm system. BMCS contractor to hardwire to fan shut down.

1.04 REFERENCE STANDARDS

A. General Code Compliance - The codes listed below form a part of this Specification to the extent referenced. The codes are referred to in the text by the basic designation only. The edition/revision of the referenced code shall be the latest date as of the date of the Contract Documents

B. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks.

C. MIL-STD-810 - Environmental Engineering Considerations and Laboratory Tests.

D. NFPA 70 - National Electrical Code.

E. UL (DIR) - Online Certifications Directory.

F. All equipment or piping used in conditioned air streams, spaces or return air plenums shall comply with NFPA 90A Flame/Smoke/Fuel contribution rating of 25/50/0 and all applicable building codes or requirements.

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

H. Provide BMCS components and ancillary equipment, which are UL-916 listed and labeled.

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

1.05 DEFINITIONS

A. Unless specifically defined within the Contract Documents, the words or acronyms contained within this specification shall be as defined within, or by the references listed within this specification, the Contract Documents, or, if not listed by either, by common industry practice.

B. Responsibilities
   1. Provide: Furnish, install, commission, test, and warrant.
   2. Furnish: Purchase and deliver to the appropriate installing Contractor, complete with every appurtenance, document, commission, and warranty.

C. General:
   1. ASHRAE: American Society Heating, Refrigeration, Air Conditioning Engineers
   2. AHU: Air Handling Unit.
   3. ATU: Air Terminal Unit.
   4. BACnet: Building Automation and Control Network
   5. BMCS: Building Management Control System
   6. BTL: BACnet Testing Laboratory
   7. CA: Certification Authority
   8. DDC: Direct Digital Control
   9. ESTCP: Environmental Security Technology Certification Program
   10. HVAC: Heating, Ventilation, and Air Conditioning
   11. I/O: Inputs/Outputs
   12. MER: Mechanical Equipment Room
   13. PICS: Protocol Implementation Conformance Statement
   14. PID: Proportional, Integral, Derivative
   15. RTC: Real Time Clock
   16. VAV: Variable Air Volume Box

D. Communication and protocols
   1. BACnet: Building Automation and Control Network
   2. FTT: Free Topology Transceivers
   3. HTTP: Hyper Text Transfer Protocol
   4. IP: Internet Protocol
   5. LAN: Local Area Network
   6. LON: Echelon Communication – Local Operating Network
   7. MS/TP: Master Slave Token Passing
   8. MQTT: Message Queuing Telemetry Transport
   9. RSTP: Rapid Spanning Tree Protocol
   10. SC: BACnet Secure Connect
   11. SMTP: Simple Mail Transfer Protocol Secure
   12. SQL: Structured Query Language
   13. TLS: Transport Layer Security

E. Controllers and Components
   1. B-AAC: BACnet Advanced Application Controller
   2. APW: Administration and Programming Workstation
   3. ASC: Application Specific Controller
   4. B-BC: BACnet Building Controller
   5. EPMS: Electrical Power Monitoring System
   6. HHD: Hand Held Device
   7. NBC: Network Building Controller

8. SDCU: Standalone Digital Control Units
9. WOW: Web-based Operator Workstation

F. Tools and software
1. SIEM: System Information and Event Monitoring

1.06 SYSTEM DESCRIPTION

A. In accordance with the scope of work the system shall provide a graphical, web-based, operator interface that allows for instant access to any system through a standard browser. Provide PC-based programming workstations, operator workstations and microcomputer controllers of modular design providing distributed processing capability and allowing future expansion of both input/output points and processing/control functions.

B. For this project, the system shall consist of the following components:
1. Enterprise Server: Enterprise Server hardware and software, and architecture. The enterprise server must be running the standard enterprise software developed and tested by the manufacturer of the workstation software, web-based operator workstations, Network Building Controllers and the standalone controllers supporting BACnet.
a. Provide Enterprise Server as required by specification or system architecture.
2. Administration and Programming Workstations: Administration and Programming Workstation Operation hardware and software and architecture. These workstations must be running the standard workstation software developed and tested by the manufacturer of the Network Building Controllers and the standalone controllers. Workstations must conform to the B-OWS BACnet device profile.
3. Web-Based Operator Workstations: Furnish licenses for web connection to the BMCS 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 and they shall operate on the facility intranet with no connection to the internet.
4. Ethernet-based Network Building Controllers: The BMCS system supplier shall furnish the needed quantity of Ethernet-based Network Building Controllers (NBCs). There shall be a minimum of one Network Building Controller located in each building on the campus. These controllers will connect directly to the Operator Workstations and BMCS server over an Ethernet Facility network at a minimum of 100 mbps and provide communication to the Standalone Digital Control Units and/or other Input/Output Modules. Network Building Controllers shall conform to BACnet device profile B-BC. Network Controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Building Controllers (B-BC).
5. Fieldbus Controllers: Provide the necessary quantity and types of Standalone Digital Control Units (SDCUs) to meet the requirements of the project for mechanical equipment control including air handlers, central plant control, and terminal unit control. Each SDCU will operate completely standalone, containing all of the I/O and programs to control its associated equipment. Each BACnet protocol SDCU shall conform to the BACnet device profile B-AAC. BACnet SDCUs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Advanced Application Controllers (B-AAC).
6. 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 in Section 23 09 13.13 in order to perform the sequence of operation specified in Section 23 09 93.

C. The system shall enable an open architecture that utilizes ANSI / ASHRAE™ Standard 135-2004, BACnet functionality to assure interoperability between all system components. Native support for the BACnet, LonTalk, Modbus protocols, and WebServices shall be provided.

D. Drawings are diagrammatic only. Equipment and labor not specifically referred to herein or on the plans and are required to meet the functional intent, shall be provided without additional cost.

E. All inputs and outputs associated with a required sequence of operation for a piece of mechanical equipment shall reside on a single controller such that failure of any one BMCS controller shall not have an impact on more than one controlled system.

1.07 CONTROL SYSTEM INTERFACES

A. System shall fully support a multi-vendor environment and be able to interface and integrate third party systems via vendor protocols including, as a minimum, BACnet, LonTalk and Modbus.

B. The BMCS contractor shall coordinate with all contractors and the associated manufacturers responsible for the systems and shall determine the points that are to be mapped from the BMCS to the third party system and the points that are to be mapped from the third party system to the BMCS.

C. Control Interface Coordination Meeting(s):
   1. The BMCS contractor shall meet with the contractors, equipment suppliers, manufacturers, etc. furnishing the equipment to coordinate information details and functions between the equipment and BMCS. Each contractor/supplier shall provide complete details of the proposed interface including the PICS (Protocol Implementation Conformance Statement) for BACnet equipment, hardware and software identifiers, wiring requirements, communication speeds and required network accessories.
   2. The purpose of this meeting is to ensure that there are no unresolved issues regarding the integration of equipment into the BMCS network and final coordination of all Sequences of Operation.
   3. The meeting(s) shall include the Owner's Representative and Commissioning Authority.
   4. Submittals for this equipment will not be reviewed prior to the completion of these meetings.

D. System and Equipment to BMCS Interfaces shall be provided for, but not limited to:
   1. Manufacturer's packaged system control panels.
   2. HVAC Pumps.
   3. Variable Frequency Controllers.
   4. Air-Handling Units.
   5. Condensing Units.
   6. Roof-Top Units.
   7. Outdoor air quality and wind sensor.
   8. As an example, the BMCS shall interface to the systems via the following:
      a. Outdoor air quality and wind sensor.
         1) Method: The outdoor air quality sensor and wind shall transfer data to the BMCS via a BACnet MS/TP and Modbus MS/TP connections.
         2) Connection Point: The outdoor air quality and wind sensor shall be connected to a subnetwork of the Network Building Controller.
         3) Connection Location: Network Building Controller.

E. Where it is possible to map points from one system to the other that are not identified in these Contract Documents, the BMCS contractor shall advise the Owner, Consultant, and Engineer; and they shall determine whether additional points are to be mapped from one system to the other.

F. Provide mapping, alarm configuration, and graphic creation of, at minimum, twice the listed point quantities within these documents and as directed by the Owner.

G. Provide details of the method of integration and the information to be transferred between the systems as part of the shop drawing package.

H. Equipment manufacturer/contractor shall provide communication port specifically for the interfacing of the system to the BMCS.

I. The BMCS contractor shall be responsible for all cable, conduit, and suitable cable connectors to the port on the system and the BMCS and other components as necessary for the software communications link from the system to the BMCS.

J. The fact that the points are mapped from systems to the BMCS shall be transparent to the operator. It shall not be necessary for the BMCS operator to know that the points are mapped from another system in order to implement such functions as adding and deleting a mapped point on a report/graphic, adjusting schedules and alarm limits associated with a mapped point, including a mapped point in a sequence of operations, etc.

K. If the BMCS contractor cannot document that the exact same interface has been performed between the BMCS and the systems, then the interfaces shall be tested prior to installations at an offsite location. If the test is successful, the BMCS contractor shall advise the Owner and Engineer and a time shall be established that is acceptable to the Owner and Engineer when the interface can be demonstrated.

L. The BMCS hardware shall not be installed at the project location until all system interfaces to the BMCS have been successfully demonstrated or documented.

M. Contractor shall be responsible for providing all equipment necessary to perform the demonstration and for ensuring the presence at the testing of suitably skilled personnel from system manufacturer/contractor. The testing of the interface between the two systems shall verify, at minimum, that:
   1. All data points mapped from the system to the BMCS are displayed correctly on the BMCS monitor and have the same functionality as points directly monitored/controlled by the BMCS.
   2. All data points mapped from the BMCS to the system are displayed correctly on the systems monitor.
   3. All mapped points are identical with regard to value, engineering units, and significant digits on both systems.
   4. All points mapped from the system to the BMCS meet all of the specifications detailed in the contract documents for points directly monitored/controlled by the BMCS.
   5. The communications watchdog is functioning correctly.
   6. Communications speed between the two systems is satisfactory.
   7. Both systems restart and communications between the two systems resume following a power failure without operator intervention.

N. Site tests similar to those detailed above shall be repeated as part of the final acceptance testing.

O. Documentation regarding the BMCS software interfaces shall be provided in sufficient detail as to enable a person reasonably skilled in the writing of real time software applications to add/delete points mapped from one system to the other. At minimum, the documentation shall include a detailed description of each protocol used and the model, version, and firmware details of any protocol converter (gateway) that is used.

P. A watchdog procedure must be implemented that enables the identification of the point of failure, i.e., where in the communications chain between the two systems did the failure occur. The watchdog function must operate at a frequency that detects a failure within 60 seconds.

1.08 SUBMITTALS

A. Specification Compliance Review.

B. Shop drawings and product data shall be in original searchable PDF format.

C. Product data shall be presented according to an included table of contents.

D. Product Data: Provide data for each system component and software module.Submittal data shall contain manufacturer's data on all hardware and software products required by the specification.

E. Shop Drawings:
   1. Indicate trunk cable schematic showing programmable control unit locations, and trunk data conductors.
   2. List connected data points, including connected control unit and input device.
   3. Include a BMCS network riser diagram depicting locations of all controllers, workstations, servers, and connected 3rd party devices with associated network wiring.
   4. Include individual schematics of each mechanical system showing all connected points with reference to their associated controller. Typical drawings will be allowed where appropriate
   5. Software submittals shall contain narrative descriptions of sequences of operation, program listings, point lists, and a complete description of the graphics, reports, alarms and configuration to be furnished with the workstation software.
   6. All components and controllers inclusive or 3rd party shall have a points list for each. Deviation from contract documents shall be reported to design team with alternates and/or a reason for deviation.
   7. Control drawings shall have a completed system architecture. Controllers and components inclusive to the control system as well as 3rd party controllers and components to be integrated and/or communicated with.
   8. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations. Provide demonstration digital media containing graphics.
   9. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
   10. Indicate description and sequence of operation of operating, user, and application software.

F. Manufacturer's Instructions: Indicate manufacturer's installation instructions for all manufactured components.
   1. Installation data sheet for each component.
   2. Installation design details for each I/O device.

G. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
   1. Record actual locations of control components, including control units, thermostats, and sensors.
   2. Revise shop drawings to reflect actual installation and operating sequences.
   3. Include submittals data in final "Record Documents" form.
   4. All wiring pathways, connections, junctions, transformers, etc. shall be as-built of a floor plan drawings and included with record drawings.
   5. The following is a list of post construction submittals that shall be updated to reflect any changes during construction and re-submitted as “As-Built”.
      a. System architecture drawing.
      b. Layout drawing for each control panel.
      c. Wiring diagram for individual components.
      d. System flow diagram for each controlled system.

e. Instrumentation list for each controlled system.
f. Product data sheet for each component.
g. Valve, damper and air flow station schedules indicating the size, configuration, capacity and location of all equipment.
h. Sequence of control.
i. Binding map.
j. A matrix sheet detailing all system addresses and communication settings for the following:
    1) All IP network addresses & settings.
    2) All BMCS device addresses & communication settings.
k. Licenses, guarantees, and warranty documents for equipment and systems.
l. Operation and Maintenance Manuals.

H. Operation and Maintenance Data:
1. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
2. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
3. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
4. Provide product manuals for the key software tasks including, but not limited to:
    a. Operating the system.
    b. Administrating the system.
    c. Engineering the operator workstation.
    d. Application programming.
    e. Engineering the network.
    f. Setting up the web server.
    g. Report creation.
    h. Graphics creation.
    i. All other engineering tasks.
5. List of recommended maintenance tasks associated with the system servers, operator workstations, data servers, web servers, controllers, instrumentation, and web clients including the following.
    a. Define the task.
    b. Recommend a frequency for system maintenance tasks.
    c. Reference the product manual that includes instructions on executing the task.
6. Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
7. Licenses, guarantees, and warranty documents for equipment and systems.
8. Provide the owner with a copy of the following:
    a. Software installed on the servers and workstations.
    b. All licensing information for all software installed on the servers and workstations.
    c. Software used to execute the project even if the software was not installed on the servers and workstations.
    d. All licensing information for all of the software used to execute the project.
    e. Software revisions shall be as installed at the time of the system acceptance.
    f. Firmware files that were downloaded to or pre-installed on any devices installed as part of this project. This does not apply to firmware that is permanently burned on a chip at the factory and can only be replaced by replacing the chip.
    g. Application files that were created during the execution of the project.
    h. Graphic page files created during execution of the project.

I. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in the Owner's name and registered with manufacturer.

1.09 QUALITY ASSURANCE

A. Perform work in accordance with NFPA 70.

B. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for purpose specified and indicated.

C. Comply with ASHRAE 135 for DDC system control components. BTL listed.

D. Security Standards and Reference Guides:
   1. The BMCS system manufacturer shall meet the following criteria.
      a. Certified to Security Development Lifecycle process that is certified to IEC 62443-4-1 by a reputable third-party independent lab.
      b. Subjected to regular and verifiable best practice cyber security testing. Results of this testing shall be made available upon request prior to deployment of the system.
      c. Provide cyber security service incident escalation through a help desk on a 7/24/365 basis.
   2. The BMCS system must provide the following functionality.
      a. Support configuration for inactivity auto log-off of logged clients
      b. Support Self-Signed Certificates, Default Certificates and/or Certification Authority (CA) certificates.
      c. Allow configuration in disabling all devices and software that support HTTP and require access via HTTPS.
      d. Alarm or generate notification on failed access attempts
      e. Servers shall support SNMP V3 monitoring of network performance and stack statistics for the purpose of managing denial of service attacks.
      f. 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.
      g. Support encrypted password authentication for all web services whether serving or consuming.
      h. Have the capability to use blacklisted and whitelisted IPs/MAC addresses to gate access.
      i. 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.
   3. Reference Guides
      a. Transport Layer Security (TLS) TLS 1.3 (August 2018).
      b. Environmental Security Technology Certification Program (ESTCP) Cybersecurity Guidelines.
      c. Security in Internet-Connected Building Automation and Energy Management System.

1.10 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

B. All components, system software, and parts furnished and installed by the BMCS system supplier shall be guaranteed against defects in materials and workmanship for 2 years of substantial completion. Labor to repair, reprogram, or replace these components shall be furnished by the BMCS system supplier at no charge during normal working hours during the warranty period. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software disks.

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

D. Provide five year manufacturer's warranty for field programmable micro-processor based units.

1.11 EXTRA MATERIALS

A. See Section 01 60 00 - Product Requirements, for additional provisions.

1.12 PROTECTION OF SOFTWARE RIGHTS

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 contract. 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. The software license agreement shall have provisions for the following:
   1. Limiting use of software to equipment provided under these specifications.
   2. Limiting copying.
   3. Preserving confidentiality.
   4. Prohibiting transfer to a third party.

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.

1.13 COORDINATION

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

B. Coordinate equipment from other divisions including to achieve compatibility with equipment that interfaces with those systems.

C. Coordinate supply of conditioned electrical circuits for control units, server, and operator workstations.

D. Coordinate with the Facility local area network supplier the required locations for BMCS connections to the Facility local area network.

E. Coordinate with the Owner's Representative on locations for NBC's, Ethernet communication cabling and TCP/IP.

F. Coordinate with the Owner's Representative on requirements for Enterprise Server hardware, Administration and Programming Workstation hardware, and Web-based Operator Workstation hardware to be used in conjunction with the BMCS.
   1. Provide Enterprise Server as required by specification or system architecture.

G. Coordinate with the Owner's Representative on requirements for hand held mobile devices to be used in conjunction with the BMCS.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The high school and elementary school both have Tridium Niagara Open Automation Solutions as the existing Building Automation Manufacturer.

2.02 LOCAL PREQUALIFIED BUILDING AUTOMATION CONTRACTORS:

A. Engineered Controls, Inc.

2.03 SYSTEM DESCRIPTION

A. Automatic temperature control field monitoring and control system using field programmable micro-processor based units.

B. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.

C. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.

D. Controls for variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, and the like when directly connected to the control units. Individual terminal unit control is specified in the Instrumention and Control Devices for HVAC Section.

E. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.

F. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

G. BMCS Contractor shall be responsible for all electrical work associated with the BMCS.
   1. Perform all wiring in accordance with all local and national codes.
   2. Install all line voltage wiring, concealed or exposed, in conduit in accordance with the division 26 specifications, NEC and local building code.
   3. Provide extension of 120 volt, 20 amp circuits and circuit breakers from Emergency power panels for all BMCS equipment, transformers and panel power. Provide and install local UPS Power supply for all BMCS system panels and equipment.
   4. Surge transient protection shall be incorporated in design of system to protect electrical components in all BMCS Controllers and operator's workstations.
   5. All low voltage electrical control wiring throughout the building whether in exposed areas shall be run in conduit in accordance with the division 26 specifications, local building code and the NEC.
   6. Provide all miscellaneous field device mounting and interconnecting wiring for all mechanical systems including fuel oil system, emergency generators, chillers, water treatment, AC units, condensing units, expansion tanks, VFD, unit heaters, filtration systems, terminal units, fan coil units, electric heater's, chiller control system.
   7. All systems requiring interlock wiring shall be hardwired interlocked and shall not rely on the BMCS to operate (e.g. emergency generator to fuel oil pump interlock, emergency generator damper interlock, etc.) Interlock wiring shall be run in separate conduits from BMCS associated wiring.

2.04 SYSTEM ARCHITECTURE

A. The existing BMCS shall be expanded for this project. The BMCS consists of an Enterprise Server, Administration and Programming Workstations (APWs), Web-based Operator Workstations (WOWs), Automated Fault Detection and Diagnostics (AFDD) system, Network Building Controllers (NBCs), and a family of Standalone Digital Control Units (SDCUs). The BMCS shall provide control, alarm detection, scheduling, reporting and information management for the entire facility.

1. Provide Enterprise Server as required by specification or system architecture.

B. All graphics, alarms, schedules, trends, programming, and configuration are to be accessible from a single Workstation simultaneously for operations and engineering tasks.

C. The Enterprise Level BMCS shall support the following:
   1. Built-in reporting functionality.
   2. Standard accessing of data for third-party reporting or analytics software.
   3. The ability to host sufficient Network Building Controllers beneath it to fulfill the requirements of this project with the capability to support an additional 20% spare.

D. The system shall be designed to operate on a top-level Ethernet network using the BACnet/IP protocol.

E. The BMCS shall support BACnet Secure Connect (SC) node, hub and router functions as defined in the Annex AB of ANSI/ASHRAE Standard 135-2020

F. Support for BACnet IP, BACnet MS/TP, Modbus RTU/ASCII (and J-bus), Modbus TCP, BACnet MS/TP, BACnet IP, LonTalk FTT-10A, and WebServices shall be provided at each Network Building Controller location including all required software ready for current and future connection.

G. A sub-network of SDCUs using the BACnet IP protocol shall connect the local, stand-alone controllers with Ethernet-level Network Building Controllers. BMCS contractor shall provide and install all sub-networks for SDCUs including Ethernet cable and required switches.

H. All inputs and outputs associated with a required sequence of operation for a piece of mechanical equipment shall reside on a single controller such that failure of any one BMCS controller shall not have an impact on more than one controlled system.

I. The SDCU BACnet IP sub-network shall utilize Rapid Spanning Tree Protocol (RSTP) network protocol installed in a ring configuration.

J. All NBCs, Workstation(s) and Servers shall reside directly on the Ethernet TCP/IP LAN OT Network.

K. System Expansion
   1. The BMCS 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.
   2. 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.
   3. Design the system such that it has the following future expansion capabilities:
      a. Each control panel enclosure should be sized to support the necessary components required for this project with ample space to add 20% additional components in the future.
      b. Any software license that is regulated by the number of attached I/O or system variables should be provided to support a minimum of 30% additional I/O and system variables.
      c. An adequate number of Network Building Controllers should be provided such that each NBC can support the addition of an additional 20% future sub-network controllers.

2.05 WEB-BASED OPERATOR SOFTWARE

A. Web-based Operator Workstations shall provide the ability for the BMCS to support communication to a user interface device running only a standard web browser connected to the BMCS Local Area Network either physically or through Wi-Fi, without the need for additional software running on the device. There shall not be a requirement to connect to the internet for this capability.

B. The web-based operator software shall be accessible to anyone with proper logon credentials either physically connected onsite or connected by WIFI onsite to the BMCS LAN to interact with the system through a standard web browser interface to perform functions as defined by their predefined level of access. Physical and Wi-Fi connection points shall be as detailed in the Electrical specifications and contract documents.

C. The system shall be able to be accessed on site via a handheld device such as a PDA, Smart Phone, or tablet with browser agnostic connectivity, including viewing graphics, monitoring points and alarms, and control devices. Based on the user's level of access, the following functionality shall be available, but not limited to, via a handheld device.
   1. Setpoint adjustment.
   2. Alarm acknowledgement.
   3. Scheduling.
   4. Summary information.
   5. Trends.
   6. High level security access to override every controllable point for troubleshooting and diagnostics.

D. Day-to-day operation of the system shall be accessible through a standard web browser interface running on a desktop computer, allowing technicians, operators, and occupants to view any part of the system from anywhere on the network based on their access level.

E. User level of access for the web-based operator software shall be the same level of access they are permitted at a Configuration and Programming Workstation.

F. Through the browser interface, operators must be able to view pre-defined groups of points, with their values updated automatically.

G. The BMCS System and NBCs shall support Message Queuing Telemetry Transport (MQTT) subscribe and publish capability.

H. The BMCS shall support tagging of data following a globally recognized schema that can be both human and machine interpretable.

I. Graphic Displays: The browser-based interface shall share the same graphical displays as the Administration and Programming Workstation, presenting dynamic data on site layouts, floor plans, and equipment graphics. The functionality of the web-based graphics will include, but are not limited to, the following:
   1. Support commands to change setpoints, enable/disable equipment and start/stop equipment.
   2. Operators shall be able to navigate through the entire system and change the value or status of any point in any controller.

J. Dashboards: Provide built-in dashboards that enable customizable views of live data which can be public to all users or capable of making them specific to a user based on log in credentials. Dashboards shall have the following functionality:
   1. The user shall have the ability to create custom dashboards.
   2. The dashboards shall have a kiosk mode which allows for occupant level data display on monitors or tablets throughout the building.

K. Alarm Management:
   1. No additional client software shall be required to be installed on a desktop workstation or handheld device in order to view alarms.
   2. Through the browser interface, a live alarm viewer identical to the alarm viewer on the Administration and Programming workstation shall be presented to the user.

L. Groups and Schedules:
   1. Operators shall be able to view pre-defined groups of points, with their values updated automatically.
   2. Operators shall be able to change schedules and modify calendars.

M. User Accounts and Audit Trail:
   1. The same user accounts shall be used for the browser interface and for the operator workstations.
   2. All commands and user activity through the browser interface shall be recorded in the BMCS activity log.

N. Web Services:
   1. The installed system shall be able to use consume information via SOAP and REST web services within the Network Building Controllers (NBCs) with other products and systems

2.06 NETWORK BUILDING CONTROLLERS AND PANELS

A. Provide BMCS Network building Controllers and Panels as follows:
   1. Minimum one (1) BMCS system Primary DDC panel and controller per floor. The application specific controllers installed for the terminal units on a floor will be connected to the BMCS panel on the same floor.
   2. Minimum one (1) BMCS system Primary DDC panel per each major mechanical system:
      a. Air Handling Unit
   3. It is acceptable to wire the following systems into any of the Primary DDC panels:
      a. Miscellaneous alarm monitoring (i.e. ATS, leak, temperature, light …etc.)
      b. Miscellaneous equipment (i.e. Unit Heater, Domestic Water Heater, Standalone Dampers …etc.)
   4. Motors in motor control centers shall be controlled from the DDC controller associated with HVAC system. It shall not be acceptable to control all motors in a MCC from one DDC controller dedicated to the MCC. The intent of this specification is that the loss of any one DDC controller shall not affect the operation of other HVAC systems, only for the points connected to the DDC controller.

B. The Network Building Controllers (NBCs) shall support BACnet Secure Connect (SC) node, hub and router functions as defined in the Annex AB of ANSI/ASHRAE Standard 135-2020

C. Network Building Controllers shall combine network routing functions, control functions, and server functions into a single unit.

D. The BACnet NBC shall be classified as a native BACnet device, supporting the BACnet Network Building Controller (B-BC) profile. NBCs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Network Building Controllers (B-BC).

E. The Network Building Controllers shall provide the interface between the LAN and the fieldbus control devices, and provide global supervisory control functions over the control devices connected to the NBC.

F. The NBCs shall be capable of whitelisting IPs to restrict access to a pre-defined list of hosts or devices, and whitelisting of the extensions for documents.

G. Encrypted and authenticated communication shall be configurable for non-open protocol communications using TLS 1.3.

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

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

J. Network Building Controllers shall be responsible for monitoring and controlling their own connected HVAC equipment.

K. Each NBC shall 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 NBCs shall be supplied to fully meet the requirements of this specification and the point list indicated in Specification Section 23 09 93.

L. NBCs shall be capable of executing application control programs to provide the following.

1. Calendar functions
2. Scheduling
3. Trending
4. Alarm monitoring and routing
5. Time synchronization
6. Native integration of controller data for BACnet, Modbus, and LonWorks
7. Network Management functions for all LonWorks based devices

M. Hardware Specifications
1. The operating system of the controller, application programs, and all other portions of the configuration database, shall be stored in non-volatile, FLASH memory. Network Building Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory.
2. Each NBC shall provide the following on-board hardware for communication:
    a. Two 10/100b Ethernet for communication to Workstations, other NBCs, and IP field bus controllers.
        1) The two Ethernet ports shall support active switch and BACnet/IP communication protocols.
        2) Support IPv4 addressing
        3) One of the Ethernet ports shall support static or DHCP client configuration for communication to Workstation or other NBCs
        4) The other Ethernet port shall support switch mode or DHCP server to set addressing of DHCP client devices
        5) Where a switch is needed, use a Cisco 9000 Catalyst or IE switch, EtherWAN EX63402-01B, or other equal and approved equivalent.
        6) Two RS-485 ports for communication to BACnet MSTP bus or serial Modbus (software configurable).
        7) One TP/FT port for communication to LonWorks devices.
        8) One device USB port
        9) One host USB port

N. Hardware Override Switches:
1. All digital outputs shall include three position manual override switches to allow selection of the ON, OFF, or AUTO output state. These switches shall provide feedback to the controller so that the position of the override switch can be obtained through software. 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. Inputs and Outputs
1. Universal inputs directly connected to the NBC via I/O modules shall be capable of supporting the following input types.
    a. Industry standard thermistor temperature sensors
    b. Industry standard RTD temperature sensors
    c. Analog sensing input devices utilizing varying voltage and/or current signals
    d. Digital input devices
2. The NBC shall support analog and digital outputs directly connected to the Network Building Controller via I/O modules.

P. Local Status Indicator Lamps:
1. The NBC shall have 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).

Q. Real Time Clock (RTC):

1. Each NBC 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 NBC will allow for its own UTC offset, depending upon the time zone. When the time zone is set, the NBC will also store the appropriate times for daylight savings time.

R. Power Supply:
   1. The 24 VDC power supply for the NBCs shall provide ample available power for the NBC and associated IO modules.

S. Automatic Restart After Power Failure:
   1. Upon restoration of power after an outage, the NBC 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 NBC 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.

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. Each NBC 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 NBC shall have adequate memory capacity to support application and historical data retention and 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 fully programmable by the user.

W. Control Software:
   1. The NBC 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.

Y. NBCs 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

Z. History Logging:
1. Each NBC controller shall be capable of locally logging any input, output, calculated value or other system variable either over user defined time intervals or based upon a user configurable change of value. A minimum of 2000 pieces of sampled data for each variable assigned to this feature. Recall of data shall be in either a tabular form or in a graphical form and shall be displayed at the OIW. It shall be possible to concurrently output data for a minimum of three variables. The time period to be covered by the data output shall be selected by the operator using an interactive procedure. When the storage capacity for a variable is full the newly sampled data shall over-write the data stored for that variable for the longest period of time. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to a higher level NBC long term archiving based upon user-defined time intervals, or manual command.
2. The operator shall be able to assign on-line, using an interactive procedure, any BMCS input or output point, calculated variable or setpoint to the historical data trend facility. It shall be possible to have data collection and storage concurrently, at minimum, for one thousand variables.
3. For extended trend logging a minimum of 1500 trends shall be capable, with a minimum number of 600,000 records within.
4. Storage shall be limited at the associated controller to 50 pieces of sampled data. All additional storage shall reside at the NDS.
5. Every hardware input and output point, hosted within the NBC and attached I/O modules, shall be trended automatically without the requirement for manual user 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.
6. Each variable shall be sampled at an operator-defined frequency using an interactive procedure. The sampling frequencies shall be in the following ranges at minimum:
    a. For BMCS monitored points the sample rate shall range from one second to once per day.
7. The presentation of logged data can be in time stamped list formats or in a chart format with fully configurable pen colors, weights, scales and time spans.
    a. For BMCS outputs the sample rate shall range from one second to once per day.
    b. For calculated points the sample rate shall be in the range of the calculation rate to once per day.
    c. Setpoints shall be sampled at the same rate as their associated variable.
8. Comments shall be visible whenever viewing the trend log list.
9. System shall give indication of memory usage and be able to alert the user if too many logs are allocated.
10. The BMCS 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.
11. All historical data shall be available for use by the operator to access in BMCS 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 NBC and can result in the display of one or more alarm messages or reports.

2. Alarms can be configured to be generated based upon a single system condition or multiple system conditions.
3. 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.
4. 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.
5. 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 NBC must have the ability to serve out web pages containing the same information that is available from the WorkStation without any additional engineering labor.
2. The NBC shall be configurable to logging all Embedded Web Server access attempts.
3. The NBC shall have the option to redirect HTTP based Embedded Web Server connections to secure, HTTPS connections.
4. The NBC shall authenticate and authorize all users connecting to the Embedded Web Server.
5. The NBC 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. Network Building Controllers shall be certified for smoke control and smoke management within a fully IP control solution.

DD. Building and Application SpecificControllers:
1. Anticipated Environmental Ambient Conditions:
   a. Outdoors and/or in Wet Ambient Conditions:
      1) Mount within waterproof enclosures.
      2) Rated for operation at 40 to 150 degrees F.
   b. Conditioned Space:
      1) Mount within dustproof enclosures.
      2) Rated for operation at 32 to 120 degrees F.

EE. Fieldbus Controllers:
1. Fieldbus controllers shall reside on a Ethernet sub-network below the Network Building Controller communicating using BACnet/IP protocol. BMCS Contractor is responsible for the complete installation of Ethernet and associated switches for the fieldbus network.
2. All BACnet/IP Fieldbus controllers shall be BACnet Testing Laboratory listed (v12 or later) as specified BACnet Advanced Application Controller (B-AAC)
3. 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 NBC.
   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.
4. 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:
   a. Supporting IPv4 addressing
   b. Supporting Static IP setting, DHCP client and Auto-IP address acquisition
5. Topology

a. BACnet/IP Fieldbus Controller network shall be installed utilizing RSTP loop topology.

6. Performance
   a. 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.
   b. They shall be multi-tasking, real-time digital control processors consisting of communication controllers, controls processing, power supplies with built-in inputs and outputs.
7. Programmability
   a. The BACnet/IP Fieldbus controllers shall support programming language consistent with the NBC.
   b. All control sequences programmed into the BACnet/IP Fieldbus Controllers shall be stored in non-volatile memory.
   c. BACnet/IP Fieldbus controllers shall communicate with the Network Building Controller (NBC) via a BACnet/IP connection at a baud rate of not less than 100 Mbps.
   d. Each BACnet/IP Fieldbus controller shall have sufficient memory, to support its own operating system and databases, including the following.
      1) Control processes
      2) Energy management applications
      3) Alarm management
      4) Historical/trend data
      5) Maintenance support applications
      6) Custom processes
      7) Manal override monitoring
8. Each BACnet/IP Fieldbus controller shall support local trend data up to 2x the built-in inputs/outputs (I/O) and at a minimum be capable of holding 5 days @ 15 min intervals locally.
9. Each BACnet/IP Fieldbus controller shall have adequate built-in configurable I/O to support the connected monitored and controlled I/O of the following types.
   a. Industry standard thermistor temperature sensors
   b. Current Input - 0-20 mA
   c. Voltage Input 0-10 Vdc
   d. Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
   e. Digital outputs
   f. Analog outputs of 4-20 mA and/or 0-10 Vdc
10. BACnet Fieldbus Controllers (B-AAC) shall have internal clocks 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.
    c. Each BACnet/IP Fieldbus controller shall include a real time clock, accurate to +/-1 minute per month.
    d. The RTC shall provide the following: time of day, day, month, year, and day of week.
11. The BACnet/IP Fieldbus controller for VAV applications shall include a built-in ‘flow thru’ differential pressure transducer.
    a. 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., ensuring primary air flow conditions shall be controlled and maintained to within ±5% of setpoint at the specified minimum and maximum air flow parameters

b. The BACnet/IP FieldBus controller for VAV applications shall support a dedicated commissioning tool for air flow balancing.
c. The BACnet/IP Fieldbus controller for VAV applications shall be preprogrammed for an air balancing algorithm.
1) All balancing parameters shall be synchronized in NBC.

12. Each BACnet/IP Fieldbus controller other than those for VAV applications shall have a minimum of 10% spare capacity for each point type represented on the controller for future point connection.
13. Each BACnet/IP Fieldbus controller shall be certified for smoke control and smoke management within a fully IP control solution.

FF. Input/Output Interface
1. Hardwired inputs and outputs tie into the DDC system through building, custom application, or application specific controllers.
2. All Input/Output Points:
a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.
b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.
3. Binary Inputs:
a. Allow monitoring of On/Off signals from remote devices.
b. Provide wetting current of 12 mA minimum, compatible with commonly available control devices and protected against the effects of contact bounce and noise.
c. Sense dry contact closure with power provided only by the controller.
4. Pulse Accumulation Input Objects: Comply with all requirements of binary input objects and accept up to 10 pulses per second.
5. Analog Inputs:
a. Allow for monitoring of low voltage 0 to 10 VDC, 4 to 20 mA current, or resistance signals (thermistor, RTD).
b. Compatible with and field configurable to commonly available sensing devices.
6. Binary Outputs:
a. Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.
b. Outputs provided with three position (On/Off/Auto) override switches.
c. Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.
7. Analog Outputs:
a. Monitoring signal provides a 0 to 10 VDC or a 4 to 20 mA output signal for end device control.
b. Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.
c. Drift to not exceed 0.4 percent of range per year.
8. Tri State Outputs:
a. Coordinate two binary outputs to control three point, floating type, electronic actuators without feedback.
b. Limit the use of three point, floating devices to the following zone and terminal unit control applications:
1) VAV terminal units.
2) Duct mounted heating coils.
c. Control algorithms run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.

9. System Object Capacity:
    a. System size to be expandable to twice the number of input output objects required by providing additional controllers, including associated devices and wiring.
    b. Hardware additions or software revisions for the installed operator interfaces are not to be required for future, system expansions.

2.07 POWER SUPPLIES AND LINE FILTERING

A. Power Supplies:
    1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.
    2. Limit connected loads to 80 percent of rated capacity.
    3. Match DC power supply to current output and voltage requirements.
    4. Unit to be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.
    5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.
    6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.
    7. Operational Ambient Conditions: 32 to 120 degrees F.
    8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD-810 for shock and vibration.
    9. Line voltage units UL recognized and CSA approved.

B. Power Line Filtering:
    1. Provide external or internal transient voltage and surge suppression component for all workstations and controllers.
    2. Minimum surge protection attributes:
        a. Dielectric strength of 1000 volts minimum.
        b. Response time of 10 nanoseconds or less.
        c. Transverse mode noise attenuation of 65 dB or greater.
        d. Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.

2.08 LOCAL AREA NETWORK (LAN)

A. Provide communication between control units over local area network (LAN).

B. LAN Capacity: Not less than 60 stations or nodes.

C. Break in Communication Path: Alarm and automatically initiate LAN reconfiguration.

D. LAN Data Speed: Minimum 19.2 Kb.

E. Communication Techniques: Allow interface into network by multiple operation stations and by auto-answer/auto-dial modems. Support communication over telephone lines utilizing modems.

F. Transmission Median: Fiber optic or single pair of solid 24 gauge twisted, shielded copper cable.

G. Network Support: Time for global point to be received by any station, shall be less than 3 seconds. Provide automatic reconfiguration if any station is added or lost. If transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention.

PART 3 EXECUTION

3.01 GENERAL

A. Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner’s Representative and the Engineer, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

B. Prior to delivery to the Project site, ensure that suitable storage space is available to store materials in a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, and corrosive atmospheres. Materials shall be protected during delivery and storage and shall not exceed the manufacturer-stated storage requirements. As a minimum, store indoors in clean, dry space with uniform temperature to prevent condensation. In addition, protect electronics from all forms of electrical and magnetic energy that could reasonably cause damage.

C. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and equipment tag number or service name as identified within the Contract Documents.

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. Verify that conditioned power supply is available to the control units and all BMCS network devices and computers.

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

G. 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.

H. In addition to the requirements specified herein, execution shall be in accordance with the requirements of Specification Section 26 00 00 and Drawings.

3.02 INSTALLATION

A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.

B. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation. Refer to Section 23 09 93.

C. Provide interfaces between all equipment/systems and BMCS as indicated and required.

D. The contractor shall be responsible for all electrical work associated with the BMCS.
   1. Perform all wiring in accordance with all local and national codes.
   2. Install all line voltage wiring, concealed or exposed, in conduit in accordance with the division 26 specifications, NEC and local building code.
   3. The 120VAC 20 amp dedicated power wiring to each 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 shall not feed any other circuit or device.
   4. Surge transient protection shall be incorporated in design of system to protect electrical components in all BMCS Controllers and operator's workstations.
   5. All low voltage electrical control wiring throughout the building in exposed areas shall be run in conduit in accordance with the division 26 specifications, local building code and the NEC.
   6. Provide all miscellaneous field device mounting and interconnecting wiring for all mechanical systems.
   7. All systems requiring interlock wiring shall be hardwired interlocked and shall not rely on the BMCS to operate. Interlock wiring shall be run in separate conduits from BMCS associated wiring.
   8. Provide the complete installation of Ethernet and associated switches for the BMCS LAN and sub-networks

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

F. Controllers must be connected to a true earth ground.

G. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.

3.03 SOFTWARE CONFIGURATION AND PROGRAMMING

A. The BMCS Contractor shall perform all system configuration and programming to provide a complete and operational Building Management Control System meeting the requirements of this specification.

B. Implement all features of programs to meet specified requirements and to control and monitor equipment and systems as detailed in the sequence of operation. Refer to Section 23 09 93.

C. 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.

D. The BMCS Contractor shall work in conjunction with the Owner's Representative and Engineer during programming configuration to review potential approaches, data presentation, alarming, reporting, and information required to be available to operators. During development of the BMCS user interface Engineer reviews shall take place prior to the start of development, during development and after development completion to ensure that all information is presented in an acceptable method for the user. The BMCS Contractor shall make necessary modifications resulting from these reviews up until the time of final acceptance.

E. The BMCS Contractor shall provide BMCS configuration and programming including, but not limited to, the following:
   1. Programming to achieve system operation for all controlled and monitored systems as defined by the sequence of operation for each system in Specification Section 23 09 93.
   2. Configure those portions of the database that are required by the points list and sequence of operation.
   3. Configure and set up the BMCS local area network and subnetworks.
   4. Initial creation and configuration of the following:
      a. User customized workspaces.
      b. User access and permissions.
      c. User groups.
      d. Custom reporting.
      e. Schedules.
      f. Audit trail.
      g. Alarm reporting, management, and delivery.
   5. Create and configure reports for each controlled and monitored system or equipment capable of including the following information.
      a. Trend comparison data.
      b. Alarm status and prevalence information.
      c. Energy Consumption data.
      d. System user data.
   6. Create and configure alarms for each system and all monitored and controlled I/O points.
   7. Creation of graphical displays and Dashboards for use on the Configuration and Programming Workstation, Web-based Operator Workstations, and Hand Held devices as detailed in this specification for a minimum of two user groups. Subgroups within the two user groups shall also be set up as needed. For example, a subgroup under Facility Operations and Engineering Staff for a particular Service Provider to limit access to only equipment necessary for that particular Service Provider. The primary user groups for this project shall be as follows:
      a. Facility Operations and Engineering Staff.
      b. Facility Occupant/Owner.

8. The system shall be configured to offer each user group a unique set of graphics designed to provide the following functionality:
    a. Facility Operations and Engineering Staff group: Graphics and dashboards shall be designed to provide the user with detailed information about all monitored points, controlled points, calculated points, variables and setpoints, systems, and subsystems connected to the BMCS to effectively operate the facility.
    b. Facility Occupant/Owner group: Graphics and dashboards shall be designed to provide the user with the simplified information necessary to monitor and control the spaces from an occupant's perspective. Dashboards shall contain information pertinent to the occupant regarding the overall operation of the facility.
9. Graphical displays and Dashboards created for the Facility Operations and Engineering Staff user group shall include, but not be limited to, the following:
    a. Navigation Tree providing, but not limited to, the following functionality:
        1) Navigation method to intuitively index between graphical screens, schedules, alarms, and reports, and other BMCS related information.
        2) Drop down menus logically grouped by building, areas, systems, and subsystems.
    b. Graphical displays for each piece of equipment, system, and subsystem providing, but not limited to, the following functionality:
        1) 3D graphical representation of the controlled and/or monitored equipment, system, or subsystem.
        2) Equipment or system name and area served.
        3) All monitored and controlled I/O and system variables associated with the system including engineering units.
        4) All setpoints including engineering units with a methodology to easily adjust setpoints from the graphical screen.
        5) Pop-up menus to present all equipment or system related data in tabular form.
        6) Drill down functionality for pieces of equipment which have more related data than can be practically illustrated on a single graphic screen.
        7) Current alarm conditions associated with the piece of equipment or system.
        8) Links to schedules related to the equipment or system.
        9) Links to reports related to the equipment or system.
        10) Links to BMCS Control drawings and written sequence of operation for the equipment or system displayed on each graphical screen.
        11) Ability for the operator to enter notes regarding the equipment or system.
    c. Graphical displays for each building and area of each building providing, but not limited to, the following functionality:
        1) 3D graphical representation of floor plans with color coded indication of temperature conditions as compared to setpoint and the ability to adjust setpoints for individual rooms and area.
        2) Building and area name.
        3) All monitored and controlled I/O and system variables associated with the area including engineering units.
        4) All setpoints associated with the area including engineering units with a methodology to easily adjust setpoints from the graphical screen.
        5) Links to graphical screens for equipment serving the area.
        6) Drill down functionality for areas which have more related data than can be practically illustrated on a single graphic screen.
        7) Current alarm conditions associated with the area.
        8) Links to schedules related to the area.
        9) Links to reports related to the area.
        10) Ability for the operator to enter notes regarding the area.
    d. Campus dashboard providing, but not limited to, the following functionality:

1) Overall status of equipment and systems for each building.
2) Summary of space environmental conditions for each building.
3) Alarm summary indication for each building and system.
4) Outdoor weather data.

3.04 FIELD QUALITY CONTROL

A. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.

B. 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 BMCS will be tested against the appropriate sequence of operation. 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.

C. The BMCS system supplier shall commission and set in operating condition all major equipment and systems, such as the chilled water and all air handling systems, in the presence of the equipment manufacturer's representatives.

3.05 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 a 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, printers), and that any other related actions occur as defined (i.e. graphic panels are invoked, reports are generated, email notifications, etc.). Submit a Test Results Sheet.

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.

E. Perform an operational test of each third party interface that has been included as part of the building management control 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.

F. A performance verification test shall 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.

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

3.06 FIELD SERVICES

A. A field checkout of all controllers and front end equipment (computers, printers, etc.) shall be conducted to verify proper operation of both hardware and software. A checkout sheet itemizing each device and a description of the associated tests shall be prepared and submitted prior to the completion of the project.

B. The BMCS system supplier shall provide a technician for engineering services required to assist the HVAC Contractor and Balancing Contractor in testing, adjusting, and balancing all systems in the building. The BMCS Contractor shall coordinate all requirements to provide a complete air balance with the Balancing Contractor and shall include all labor and materials in his contract.

3.07 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate complete and operating system to Owner.

B. Provide on-site training to the Owner's representative and maintenance personnel per the following description:

C. On-site training shall consist of a minimum of (4) hours of hands-on instruction geared at the operation and maintenance of the systems.

D. The training curriculum shall include the following.
   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.

END OF SECTION

SECTION 23 09 93
SEQUENCE OF OPERATIONS FOR BUILDING MANAGEMENT CONTROL SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other sections.

B. Sequence of operation for:
   1. Packaged single zone variable air volume air handling unit
   2. Energy Management Strategies
      a. Cascade Temperature Control
      b. AHU DAT Reset: Linear OAT
      c. AHU Economizer: CO2 demand ventilation - Air flow sensors with variable occupancy
      d. Zone space temperature offset
      e. Zone space temperature offset: Unoccupied weekend temperature control

1.02 SYSTEM DESCRIPTION

A. This Section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other Sections.

1.03 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Sequence of Operation Documentation: Submit written sequence of operation for entire HVAC system and each piece of equipment.
   1. Preface: 1 or 2 paragraph overview narrative of the system describing its purpose, components and function.
   2. State each sequence in small segments and give each segment a unique number for referencing in Functional Test procedures; provide a complete description regardless of the completeness and clarity of the sequences specified in Contract Documents.
   3. Include at least the following sequences:
      a. System off.
      b. Start-up.
      c. Warm-up mode.
      d. Normal operating mode.
      e. Unoccupied mode.
      f. Shutdown.
      g. Capacity control sequences and equipment staging.
      h. Temperature and pressure control, such as setbacks, setups, resets, etc.
      i. Detailed sequences for all control strategies, such as economizer control, optimum start/stop, staging, optimization, demand limiting, etc.
      j. Effects of power or equipment failure with all standby component functions.
      k. Sequences for all alarms and emergency shut downs.
      l. Seasonal operational differences and recommendations.
      m. Interactions and interlocks with other systems.
   4. Include initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.

5. For packaged controlled equipment, include manufacturer's furnished sequence of operation amplified as required to describe the relationship between the packaged controls and the control system, indicating which points are adjustable control points and which points are only monitored.
6. Include schedules, if known.

C. Control System Diagrams: Submit graphic schematic of the control system showing each control component and each component controlled, monitored, or enabled.
1. Label with settings, adjustable range of control and limits.
2. Include flow diagrams for each control system, graphically depicting control logic.
3. Include the system and component layout of all equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
4. Include draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.
5. Include all monitoring, control and virtual points specified in elsewhere.
6. Include a key to all abbreviations.

D. Points List: Submit list of all control and monitor points indicating at least the following for each point.
1. Name of controlled system.
2. Point abbreviation.
3. Point description; such as dry bulb temperature, airflow, etc.
4. Display unit.
5. Control point or setpoint (Yes / No); i.e. a point that controls equipment and can have its setpoint changed.
6. Monitoring point (Yes / No); i.e. a point that does not control or contribute to the control of equipment but is used for operation, maintenance, or performance verification.
7. Intermediate point (Yes / No); i.e. a point whose value is used to make a calculation which then controls equipment, such as space temperatures that are averaged to a virtual point to control reset.
8. Calculated point (Yes / No); i.e. a “virtual” point generated from calculations of other point values.

E. Project Record Documents: Record actual locations of components and setpoints of controls, including changes to sequences made after submission of shop drawings.

1.04 CONTROL SYSTEM INTERFACES

A. System shall fully support a multi-vendor environment and be able to interface and integrate third party systems and sequences via vendor protocols including, as a minimum, BACnet, LonTalk and Modbus.

B. System and Equipment to BMCS Interfaces shall be provided for, but not limited to:
1. Manufacturer's packaged system control panels.
2. Pumps.
3. Variable Frequency Controllers.
4. Air-Handling Units.
5. Roof-Top Units.

C. A watchdog procedure must be implemented that enables the identification of the point of failure, i.e., where in the communications chain between the two systems did the failure occur. The watchdog function must operate at a frequency that detects a failure within 60 seconds.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 OPERATING SEQUENCES - GENERAL

A. Sequence of Control indicated illustrates basic control function only. Provide all control devices required for controlling air handling units, exhaust fans, physical plant equipment, terminal equipment, and all related items. Provide monitoring only devices as indicated.

B. Perform the initial input of all required operational data for each point that is to be used based on information supplied by the Owner. Assist the Owner's staff in developing the schedule and shall demonstrate the operation of the system using the data.

C. Provide adequate English language notation in the software to assist the operator in understanding the intent of the programmed sequences.

D. Provide stable operation of all control loops. If the Contractor has not provided self-tuning PID control algorithms then the Contractor shall manually tune all control loops. Verify all control loops are stable whether or not they are self-tuning.

E. Provide any modifications to the operating sequence programs as requested by the Owner without additional costs until the final acceptance of the entire control system.

F. All outputs using PID control shall be adjusted to the actual range of end device. Example: If VFC range is from 20% to 100%, output PID loop shall run from 20%-100% to eliminate spooling of PID outside actual operating range of end device.

G. Graphics shall represent actual range of outputs.

3.02 EQUIPMENT RUN TIME TOTALIZATION

A. Incorporate run time totalization techniques into the programming logic that will accumulate the operating times for motors as selected by the operator using an interactive procedure. Any piece of equipment that has its status monitored by the building management control system (BMCS) shall be selectable for inclusion in this feature. It shall be possible to concurrently monitor the accumulated operating time for every item of equipment monitored and/or controlled by the BMCS.

B. The operator shall be able to establish on-line, using an interactive procedure, a value for the accumulated operating time at which a suitably worded message shall be output to the operator advising that the reporting limit has been reached for a specific motor. The message shall be output at the designated device.

C. The operator shall be able to change the accumulated total for any motor to any value.

D. The accumulated operating times shall be updated at least every 15 minutes.

E. The operator shall be able to obtain on demand or on a scheduled basis a report detailing the accumulated operating times.

F. Operating time software shall be used as the basis for equipment operating selection and standby status. Changeover of units based on operating times shall not take place more than an operator-defined period, initially set at once per week.

3.03 NIGHT (UNOCCUPIED) SETBACK - SETUP

A. Incorporate unoccupied setback-setup techniques into the programming logic to provide the following:
   1. Start HVAC equipment after normal hours of scheduled operation to maintain building after-hour setpoints, while reducing energy consumption.
   2. Night setback temperatures for heating shall be initially set at 55 degrees F to activate the heating equipment and 60 degrees F to stop the heating equipment. Once activated, the units involved shall operate as specified in the respective sequence of operation. Coordinate the operation of this program with the requirements for terminal unit controls.

3. Night setup temperatures for cooling shall be initially set at 90 degrees F to activate the cooling equipment and 85 degrees F to stop the cooling equipment. Once activated, the units involved shall operate as specified in the respective sequence of operation. Coordinate the operation of this program with the requirements for terminal unit controls.

B. The operator shall be able to implement this function for all HVAC equipment using an interactive procedure on an individual or group-controlled basis.

C. The operator shall be able to assign minimum run times for each piece of equipment.

D. The operation of this program shall be disabled when the outside air temperature is outside operator defined limits, initially set at 35 degrees F and 95 degrees F.

E. A report shall be available on demand and on a scheduled basis, which provides the following information:
   1. Night setback/setup setpoints and associated equipment.

F. This feature shall only be implemented for equipment in the BMCS software control mode.

G. Setpoints for each associated piece of equipment shall be displayed on the associated system display graphics. Setpoints shall be changeable via the graphical display.

H. The current status of night setback - setup modes shall be indicated on the associated system graphic.

3.04 OPTIMIZED SCHEDULING

A. Provide an adaptive software program that shall:
   1. Start HVAC equipment at the latest possible time while ensuring that space in the building reaches setpoint conditions by the time occupancy commences.
   2. Stop HVAC equipment at the earliest possible time while ensuring that space in the building shall still be within the setpoint deadband at the scheduled end of occupancy.

B. The operator shall be able to implement this function for each group of terminal units and other HVAC equipment using an interactive procedure. A group of terminal units shall comprise all the terminal units on the same floor of the tower served by the same air handling unit. The operator shall be able to assign start of occupancy and end of occupancy times for each day of the week and for holidays. A separate Monday schedule should be provided for earlier start times.

C. This program shall base the determined equipment start and stop times on monitored data such as space temperatures within the area served by the equipment and ambient conditions. If the BMCS subcontractor requires information other than that provided by the monitoring detailed in the Field Termination Schedules, then the necessary additional instrumentation shall be provided within the base bid price.

D. The operator shall be able to assign limits to the start and stop times. Initially these limits shall be set as follows:
   1. BMCS determined start times shall not be more than three hours before the scheduled occupancy.
   2. BMCS determined stop times shall not be more than one hour before the scheduled end of occupancy.

E. A report shall be available on demand and on a scheduled basis, which provides the following information:
   1. Occupancy schedules.
   2. Time of last equipment start and space conditions at scheduled occupancy time.
   3. Time of last equipment stop and space conditions at scheduled end of occupancy time.

F. This feature shall only be implemented for equipment in the BMCS software control mode.

3.05 ENERGY MANAGEMENT STRATEGIES

A. Apply additional energency management strategies listed below to the applicable systems.

3.06 TYPICAL SYSTEMS START-UP AND SHUT-DOWN INITIATION

A. Air Handling Units:
   1. Initiation of System Start-Up - The system shall be started by one of the following methods as selected by the operator:
      a. Manual:
         1) BMCS single entry operator command.
      b. Automatic:
         1) Based on BMCS occupancy schedule.
         2) Initiated by the BMCS whenever a space requires unoccupied cooling or heating based on setback/setup operation.
   2. Initiation of System Shutdown - System shutdown shall be initiated as follows:
      a. Manual:
         1) BMCS single entry operator command.
      b. Automatic:
         1) Based on BMCS occupancy schedule.
         2) In the event of component failure.
         3) High/low static pressure switch trip
         4) In the event of a building power failure.
         5) In the event of fire alarm shutdown.
         6) Freezestat trip.
         7) When there are not a call for Unoccupied cooling or Unoccupied heating.
         8) In the event the refrigerant detection system goes into alarm (for AHU-2).

3.07 PACKAGED SINGLE ZONE VARIABLE AIR VOLUME AIR HANDLING UNIT (ES AHU-2 AND ACCU-2)

A. Description: System consists of a package controller with features for the BMCS to command and monitor fucntion of the unit remotely. Internal unit components are generally controlled by the packaged controller.

B. Communication interface inputs:
   1. Status.
   2. General alarm.
   3. Set-point adjustment for set points identified in this Section.
   4. Start/stop and operating status of unit.
   5. Data inquiry to include supply air and return air temperature.
   6. Occupied and unoccupied schedules.
   7. Discharge air temperature setpoint
   8. 20 additional owner selected points.

C. System Off - When the system is off:
   1. The existing return air damper at the east wall of the gym shall open 100%. Add a damper position sensor to this damper and monitor via the BMCS.
   2. The relief air damper shall be closed.
   3. The outside air damper shall be closed.
   4. The return air damper shall be open.
   5. Supply fan shall be off.

D. Initiation of System Start-Up - The system shall be started:
   1. Manually initiated by operator through BMCS.
   2. Automatically by BMCS through occupancy schedule.

E. System Operation - After system start-up has been initiated the following shall occur:

1. Differential pressure safety switches shall be provided on inlet and outlet sides of supply fans and inlet of return fans, or on supply fan outlet and return fan inlet where fans are in a common housing. Switches shall stop fans and require manual reset
2. The supply and relief fans shall be started at minimum speed. After an operator defined period of time, the fans shall be enabled for automatic speed control.
3. The supply fan speed shall modulate to satisfy the space heating and cooling temperature setpoints.
4. The relief air damper shall modulate to maintain the building static pressure setpoint. The building pressure sensor shall compare the pressure difference between the inside and outside. Outside pressure shall be taken near the front door, low on the building, preferably south, or alternatively east or west sides of the building.
5. Economizer Control:
    a. Outside and return air dampers shall be modulated inversely proportionate to maintain a mixed air temperature set point 2 deg. (adj.) less than the discharge air set point.
    b. If local control is being used the economizer shall be enable whenever:
        1) Outside air temperature is less than 65 deg (adj.)
        2) And outside air enthalpy is less than return enthalpy.
        3) Supply fan status is on.
    c. If “global” economizer enable is to be used the economizer shall be enabled whenever:
        1) Outside air temperature is less than 65 deg (adj.).
        2) Outside air enthalpy is below 25 btu/lb of dry air with a dead band of 3 btu/lb.
    d. The economizer shall not be used whenever:
        1) Morning warm-up is enabled.
        2) If return air temperature is below 65 degrees (adj.) unless a “pre-cool” sequence is being used.
6. The outside air damper shall modulate to maintain the minimum outdoor air flow setpoint.
7. The heating water valve shall modulate to maintain a supply air temperature set point as calculated based on deviation from set point. Heating supply air temperature setpoint shall be 1 Deg. F. (adj.) less than the cooling supply air temperature setpoint. This shall prevent unnecessary cycling between heating and cooling modes of operation.
    a. Where equipped, the heating coil circulation pump shall be enabled when outdoor air temperature is 38 deg. F. (adj.) or below.

F. System Shutdown - Shall be initiated as follows:
1. Manually initiated by operator through BMCS.
2. Automatically through occupancy schedule.
3. Freezestat trip.
4. High/low static pressure switch trip.
5. Automatically in the event of building power failure or fire alarm.

G. System Setpoints - The setpoints shall be operator changeable and initially set as follows:
1. Supply air temperature setpoint shall be 55 degrees F.
2. Mixed air temperature setpoint shall be 54 degrees F.
3. Supply air pressure setpoint shall be 1.0 inches w.g.
4. Freezestat setpoint shall be 35 degrees F.
5. Supply air duct static pressure high limit set at 2.5 inches w.g.
6. Return air duct static pressure low limit device set at -2.5 inches w.g.
7. The minimum and maximum speed signal positions shall be set by the Balancing Contractor within the fan manufacturer's limitations.
8. The time delay for outside air damper control upon AHU startup shall be set at five minutes.

9. The minimum outside air flow rate setpoint shall be as scheduled on the Mechanical Drawings.
10. The return air CO2 limit shall be 500 ppm above the ambient CO2 reading. This is a dynamically controlled setpoint.
11. The space differential pressure setpoint shall be 0.01 inches w.g.

H. Alarms - The BMCS shall generate an alarm for the following conditions:
1. Fan failure.
2. If the supply air temperature is more than 2 degrees F above/below setpoint.
3. If the supply air static pressure is more than 0.5 inches w.g. above/below setpoint for a period of more than 5 minutes.
4. Freezestat trip.
5. Duct high/low static pressure limit device trip.
6. Heating coil pump failure.
7. All alarms shall be inhibited if the supply/relief fans are not in operation. The alarms, except the fan failure to start, shall remain inhibited following start up of the unit for an operator determined period of time initially set at two minutes.

I. Failure Positions - The following shall occur upon component failure or loss of power:
1. Failure Positions - The following shall occur upon component failure or loss of power:
2. Relief air dampers shall close.
3. Outside air dampers shall close.
4. Return air dampers shall open.
5. The supply fan shall remain in the last commanded state and the speed signal shall go to the minimum speed.
6. Heating coil pump shall operate.
7. Heating water valve shall fail open.

J. Points List:
1. Analog Inputs:
   a. Return air temperature.
   b. Space CO2.
   c. Relief air damper position feedback.
   d. Return air damper position feedback.
   e. Outside air damper position feedback.
   f. Minimum outside air flow.
   g. Outside air flow.
   h. Outside air temperature.
   i. Outside air humidity.
   j. Outside air CO2.
   k. Mixed air temperature.
   l. Supply air fan flow.
   m. Supply fan speed reference feedback.
   n. Supply air temperature.
   o. Supply duct static pressure.
   p. Space humidity.
2. Digital Inputs:
   a. Supply fan status.
   b. Freezestat.
   c. Relief fan fault.
   d. Supply fan high suction static pressure .
   e. Supply fan high discharge static pressure.
   f. Supply fan fault.
   g. Heating coil pump status.

3. Analog Outputs:
    a. Relief air damper.
    b. Return air damper.
    c. Outside air damper.
    d. Supply fan speed.
    e. Heating water valve.
4. Digital Outputs:
    a. Supply fan enable.
    b. Heating coil pump enable.
5. Set points
    a. Supply air set point
    b. Mixed air set point
    c. Differential enthalpy set point
6. Software Interface - The following points shall be provided through the BACnet interface.
    a. Supply fan speed reference feedback.
    b. Supply fan fault.
    c. 20 additional points as selected by the Owner.

3.08 PACKAGED SINGLE ZONE VARIABLE AIR VOLUME AIR HANDLING UNIT (HS AHU-7)

A. Description: System consists of a package controller with features for the BMCS to command and monitor fucntion of the unit remotely. Internal unit components are generally controlled by the packaged controller.

B. Communication interface inputs:
1. Status.
2. General alarm.
3. Set-point adjustment for set points identified in this Section.
4. Start/stop and operating status of unit.
5. Data inquiry to include supply air and return air temperature.
6. Occupied and unoccupied schedules.
7. Discharge air temperature setpoint
8. 20 additional owner selected points.

C. System Off - When the system is off:
1. The existing return air damper at the east wall of the gym shall be closed.
2. The outside air damper shall be closed.
3. The return air damper at the AHU shall be open.
4. Supply and Relief fan shall be off.

D. Initiation of System Start-Up - The system shall be started:
1. Manually initiated by operator through BMCS.
2. Automatically by BMCS through occupancy schedule.

E. System Operation - After system start-up has been initiated the following shall occur:
1. The existing return air damper at the east wall of the gym shall open 100%. Add a damper position sensor to this damper and monitor via the BMCS.
2. Differential pressure safety switches shall be provided on inlet and outlet sides of supply fans and inlet of return fans, or on supply fan outlet and return fan inlet where fans are in a common housing. Switches shall stop fans and require manual reset
3. The supply and relief fans shall be started at minimum speed. After an operator defined period of time, the fans shall be enabled for automatic speed control.
4. The supply fan speed shall modulate to satisfy the space heating and cooling temperature setpoints.
5. The relief air fan (integral to the AHU) speed shall modulate to maintain the building static pressure setpoint. The building pressure sensor shall compare the pressure difference

between the inside and outside. Outside pressure shall be taken near the front door, low on the building, preferably south, or alternatively east or west sides of the building.

6. Economizer Control:
   a. Outside and return air dampers shall be modulated inversely proportionate to maintain a mixed air temperature set point 2 deg. (adj.) less than the discharge air set point.
   b. If local control is being used the economizer shall be enable whenever:
      1) Outside air temperature is less than 65 deg (adj.)
      2) And outside air enthalpy is less than return enthalpy.
      3) Supply fan status is on.
   c. If “global” economizer enable is to be used the economizer shall be enabled whenever:
      1) Outside air temperature is less than 65 deg (adj.).
      2) Outside air enthalpy is below 25 btu/lb of dry air with a dead band of 3 btu/lb.
   d. The economizer shall not be used whenever:
      1) Morning warm-up is enabled.
      2) If return air temperature is below 65 degrees (adj.) unless a “pre-cool” sequence is being used.
7. The outside air damper shall modulate to maintain the minimum outdoor air flow setpoint.

F. System Shutdown - Shall be initiated as follows:
   1. Manually initiated by operator through BMCS.
   2. Automatically through occupancy schedule.
   3. Freezestat trip.
   4. High/low static pressure switch trip.
   5. Automatically in the event of building power failure or fire alarm.

G. System Setpoints - The setpoints shall be operator changeable and initially set as follows:
   1. Supply air temperature setpoint shall be 55 degrees F.
   2. Mixed air temperature setpoint shall be 54 degrees F.
   3. Supply air pressure setpoint shall be 1.0 inches w.g.
   4. Relief fan building differential pressure setpoint shall be set by the balancing contractor, but initially set at 0.01 inches w.g.
   5. Freezestat setpoint shall be 35 degrees F.
   6. Supply air duct static pressure high limit set at 2.0 inches w.g.
   7. Return air duct static pressure low limit device set at -2.0 inches w.g.
   8. The minimum and maximum speed signal positions shall be set by the Balancing Contractor within the fan manufacturer's limitations.
   9. The time delay for outside air damper control upon AHU startup shall be set at five minutes.
   10. The minimum outside air flow rate setpoint shall be as scheduled on the Mechanical Drawings.
   11. The return air CO2 limit shall be 500 ppm above the ambient CO2 reading. This is a dynamically controlled setpoint.

H. Alarms - The BMCS shall generate an alarm for the following conditions:
   1. Fan failure,
   2. If the supply air temperature is more than 2 degrees F above/below setpoint.
   3. If the supply air static pressure is more than 0.5 inches w.g. above/below setpoint for a period of more than 5 minutes.
   4. Freezestat trip.
   5. Duct high/low static pressure limit device trip.

6. All alarms shall be inhibited if the supply/relief fans are not in operation. The alarms, except the fan failure to start, shall remain inhibited following start up of the unit for an operator determined period of time initially set at two minutes.

I. Failure Positions - The following shall occur upon component failure or loss of power:
   1. Failure Positions - The following shall occur upon component failure or loss of power:
   2. Existing return air damper at east wall of gym shall close.
   3. Outside air dampers shall close.
   4. Return air dampers at AHU shall open.
   5. The supply and relief fan shall remain in the last commanded state and the speed signal shall go to the minimum speed.

J. Points List:
   1. Analog Inputs:
      a. Return air temperature.
      b. Space CO2.
      c. Relief air fan flow.
      d. Relief fan speed reference feedback.
      e. Return air damper position feedback.
      f. Outside air damper position feedback.
      g. Minimum outside air flow.
      h. Outside air flow.
      i. Outside air temperature.
      j. Outside air humidity.
      k. Outside air CO2.
      l. Mixed air temperature.
      m. Supply air fan flow.
      n. Supply fan speed reference feedback.
      o. Supply air temperature.
      p. Supply duct static pressure.
      q. Space humidity.
   2. Digital Inputs:
      a. Relief fan status.
      b. Supply fan status.
      c. Freezestat.
      d. Relief fan fault.
      e. Supply fan high suction static pressure .
      f. Supply fan high discharge static pressure.
      g. Supply fan fault.
   3. Analog Outputs:
      a. Relief air damper.
      b. Return air damper.
      c. Outside air damper.
      d. Relief fan speed.
      e. Supply fan speed.
   4. Digital Outputs:
      a. Relief fan enable.
      b. Supply fan enable.
   5. Set points
      a. Supply air set point
      b. Mixed air set point
      c. Differential enthalpy set point
   6. Software Interface - The following points shall be provided through the BACnet interface.

a. Supply fan speed reference feedback.
b. Supply fan fault.
c. Relief fan speed reference feedback.
d. Relief fan fault.
e. 20 additional points as selected by the Owner.

3.09 AHU DEHUMIDIFICATION CONTROL (ES AHU-2 AND HS AHU-7)

A. Dehumidification mode in unit shall control the discharge air temperature set point of an air handler and take precedence over supply air resets.

B. Dehumidification mode operations and control points shall be viewable on a graphic.

C. Dehumidification mode shall be enabled when:
1. Manually selected by operator with timer limit.
2. When return air humidity is above 50% (adj.).
3. Supply air set point shall reset down in 1 degree (adj.) increments every 15 min (adj.) to a minimum of 48 deg (adj.) or until the return air humidity is 5% below the return air humidity set point.
4. Supply air set point shall reset up in 1 degree (adj.) increments every 15 min (adj.) until the normal temperature reset set point is reached or until the return air humidity reaches the set point of 50% keeping the return air humidity between 45% and 50% respectively.

D. Points list:
1. Analog inputs:
a. Return air humidity
b. Return air temperature
2. Set points
a. Return humidity high limit 50%
b. Return humidity low limit 45%
c. Reset increment 1 deg
d. Reset sampling time 15 min.

3.10 ADDITIONAL ENERGY MANAGEMENT STRATEGIES

A. Energy management strategies shall be applied to specific equipment control sequences as indicated.

B. Cascade Temperature Control:
1. This sequence change shall apply to any piece of equipment that satisfies a space temperature directly e.g. terminal units, single zone air handlers, etc. Although this sequence can apply to staged equipment such as dx and electric heat, it is primarily suited to fully modulating heating and cooling e.g. chilled and hot water, scr heat, etc.
2. Cascade Temperature Control - A PID loop shall be used to determine an active “discharge air temperature set point”. Other programs or control systems can then make use of this calculated set point. This will result in a tighter control of space temperature.
3. Calculating the active “discharge air temperature set point” is the first step to this sequence. The calculated “discharge air temperature set point” is changed based on the difference between the space temperature set point and the space temperature.
4. Two sensors are required, space temperature and discharge air temperature. Since two sensors are required for this logic, a failure of one of these sensors should be anticipated. The second stage in this sequence is to modulate a heating/cooling valve to maintain the calculated “discharge air temperature set point” with a separate PID control loop.
5. Alarms shall then be derived from this sequence such as deviation from discharge air set point as well as deviation from space set point.
6. Using this methodology, equipment deviations can be monitored and corrective actions applied before the space temperature deviates from set point appreciably. With the data

set of valve positions, space temperature, space temperature set point, discharge air temperature, discharge air temperature set point, along with other inputs can give the user ability to track equipment performance e.g. valve position, vs. discharge air temperature, vs. outside air temperature.

a. Points required
    1) Space temperature
    2) Space temperature set point
    3) Discharge air temperature
    4) Active discharge air temperature set point
b. Failure sequences
    1) If space temperature fails, the “discharge air temperature set point” should be equal to the space temperature set point and alarm is issued.
    2) If the discharge air temperature sensor fails, control the hot or chilled water valve as appropriate based on space requirement. Default to a PID directly controlling the space with the heating/cooling source and disregard the discharge air sensor.

C. AHU DAT Reset: Linear OAT:
1. Simple strategy - Vary AHU discharge air temperature set point on change in outside air temperature.
2. Detailed explanation - In situation where load is predictable, and more sensible than latent, the discharge air set point of an AHU may be reset on a linear scale based on change in outside air temperature.
    a. For example: 50 deg. Outside air temperature = 58 deg AHU discharge air temperature, 80 deg outside air temperature = 55 deg AHU discharge air temperature.
    b. Any of these values can be adjustable.

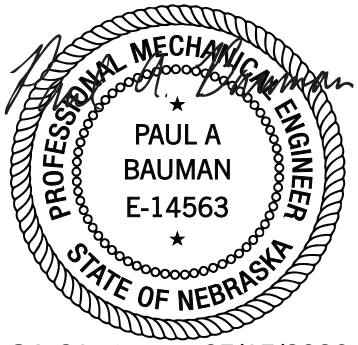
D. AHU Economizer: CO2 demand ventilation - Air flow sensors with variable occupancy:
1. Simple strategy - Vary outside air minimum air flow based on CO2 levels in facility.
2. Detailed explanation -In some buildings a minimum outdoor air flow is often used to satisfy building ventilation requirements. By monitoring building CO2 levels, either by return air or space CO2 sensors, the AHU outside air flow can be reduced and only opened when the CO2 levels rise above desired levels. When CO2 rises above high limit 800 ppm (adj.) outdoor air damper minimum position can be increased from a starting level X cfm (adj.) by 100 cfm (adj.) every 15 min (adj.) to a maximum outside air of Y cfm (adj.) until CO2 levels are below the high level. Damper will remain at calculated flow rate until CO2 levels are below the deadband of 100 ppm to 700 ppm (adj.) When below low level setpoint the outside air minimum air flow setpoint will be decreased by 100 cfm (adj.) every 15 min (adj.) until outside air damper is closed or at starting minimum air flow.
3. Points List:
    a. Analog inputs
        1) Space CO2
    b. Analog Outputs
        1) Outside air damper
    c. Set points
        1) CO2 high limit set point 800 ppm(adj.).
        2) CO2 high limit set point 700 ppm(adj.).
        3) Maximum Outside air flow cfm (adj.).
        4) Minimum Outside air flow cfm(adj.).
        5) Reset time increment set point 15 minutes (adj.).
        6) Reset increment amount 100 cfm (adj.).
    d. Calculated points
        1) Time until next reset.

2) Active outside air flow set point.

E. Zone space temperature offset:
   1. Unoccupied seasonal temperature control.
      a. Simple strategy - While setting back temperatures during unoccupied periods can save money, setting back too far can cause greater recovery costs during some conditions.
         1) Detailed explanation - By raising/lowering unoccupied temperature setpoints in increments the building impact can be less than trying to recover the building all at once in an optimal or regular start sequence.

F. Zone space temperature offset:
   1. Unoccupied weekend temperature control.
      a. Simple strategy - Changing setback amount when unoccupied for longer periods.
         1) Detailed explanation - During the weekend period the unoccupied heating/cooling setpoints can be more significant because of prolonged unoccupied periods.
            (a) Day before full occupancy unoccupied set points can be incremented to lessen occupancy impact.

END OF SECTION



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MECHANICAL SYMBOLS

MECHANICAL PIPING AND PLUMBING SYMBOLS

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
	AUTOMATIC CONTROL VALVE, 2-WAY		FLEXIBLE PIPING		PIPE CONTINUATION
	AUTOMATIC CONTROL VALVE, 3-WAY		UNION		PIPE CAP
	BALANCING VALVE		PIPE IN SLEEVE	FS	FLOW SWITCH
	ISOLATION VALVE (BALL OR BUTTERFLY)		CONCENTRIC REDUCER		AQUASTAT
	CHECK VALVE (ARROW INDICATED FLOW)		ECCENTRIC REDUCER INVERT	HB	HOSE BIBB
	GLOBE VALVE		ECCENTRIC REDUCER CROWN	WH	WALL HYDRANT
	GAS COCK		PIPE PITCH DOWN	PH	POST HYDRANT
	MANUAL AIR VENT		ARROW INDICATED FLOW DIRECTION	SH	SHOWER
V	VACUUM BREAKER	CO OR CO	CLEAN OUT	VTR	VENT THROUGH ROOF ON RISER
BFP	BACKFLOW PREVENTER	GCO	GRADE CLEAN OUT		
	SIGHT GLASS		VALVE IN VERTICAL PIPE		
	PRESSURE GAUGE WITH GAUGE COCK	"FD-X" "FD-X"	FLOOR DRAIN SIZE-TYPE (ROUND OR SQUARE)	"DS-X"	DOWNSPOUT NOZZLE SIZE-TYPE
P T	PRESSURE OR TEMPERATURE MEASURING POINTS	"FS-X"	FLOOR SINK SIZE-TYPE		
	PRESSURE RELIEF VALVE	"RD-X" "OD-X"	ROOF DRAIN AND OVERFLOW DRAIN SIZE-TYPE		THERMOMETER, BOTTOM FEED
	PRESSURE REGULATING VALVE (PRV)		SOLENOID VALVE (REFRIG)		THERMOMETER, SIDE FEED
	PRESSURE REDUCING VALVE		THERMOSTATIC EXPANSION VALVE (REFRIG)		IN-LINE PUMP
PTT	PRESSURE / TEMPERATURE TEST PORT	L" W"	EXPANSION LOOP, LENGTH AND WIDTH	#/HR	F AND T TRAP CAP LBS/HR
M	WATER OR GAS METER	FT-1 MBH	FINTUBE -TYPE (SHADED AREA INDICATES CAPACITY MBH ELEMENT LOCATION)	#/HR	BUCKET TRAP CAP LBS/HR
	AUTOMATIC AIR VENT		DOUBLE GRADE CLEANOUT		NEW TO EXISTING CONNECTION
	MANUAL AIR VENT WITH ISOLATION VALVE	X X	MECH EQUIPMENT WITH ELEC CONNECTION. SEE MECHANICAL/ELECTRICAL COORDINATION SCHEDULE.		POINT OF DISCONNECT
	STRAINER WITH DRAIN VALVE AND HOSE END	(E)	DESIGNATES UTILITIES AND EQUIPMENT MARKS WHICH ARE EXISTING		

HEATING - VENTILATING - AIR-CONDITIONING SYMBOLS

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
XX	AQ - AIR QUALITY SENSOR, AS - ALARM STROBE A - AQUASTAT, CO - CARBON MONOXIDE SENSOR CO/NO2 - CARBON MONOXIDE / NITROGEN DIOXIDE SENSOR, P - DPT PRESSURE SENSOR, NO2 - NITROGEN DIOXIDE SENSOR, NOX - NITROUS OXIDE SENSOR, RD - REFRIGERANT DETECTOR, SL - STROBE LIGHT		RETURN, EXHAUST, OR RELIEF AIR DUCT END OR RISER (RA) (EA) (RLFA)	A	AUTOMATIC DAMPER
		X / X	RECTANGULAR DUCTWORK (FIRST NUMBER IS THE SIDE SHOWN)	SA	SOUND ATTENUATOR
CO2	CO2 SENSOR	X Ø	ROUND DUCT		FLEX CONNECTION
H	HUMIDISTAT				
S	REMOTE SENSOR	X / X Φ	FLAT OVAL (FIRST NUMBER IS THE SIDE SHOWN)	SIZE TYPE CFM	SUPPLY REGISTER OR GRILLE
T T	THERMOSTAT				
T RS	THERMOSTAT WITH REMOTE SENSOR		VOLUME DAMPER	SIZE TYPE CFM	RETURN REGISTER OR GRILLE
T	HEATING RISER				
OR	BREAK / CONTINUATION	M	MOTORIZED DAMPER	X X X	TYP DIFFUSER NECK SIZE, MARK CFM
AD	ACCESS DOOR - SIZE AS SHOWN OR PER SPEC	FRD	FIRE DAMPER WITH ACCESS DOOR	X X X	TYP EXHAUST/RETURN GRILLE NECK SIZE, MARK CFM
	ELBOW WITH TURNING VANES	FSD M	COMBINATION FIRE AND SMOKE DAMPER WITH ACCESS DOOR		NEW TO EXISTING CONNECTION
	SUPPLY, OUTDOOR, OR MIXED AIR DUCT END OR RISER (SA) (OA) (MA)	SD M	SMOKE DAMPER WITH ACCESS DOOR		POINT OF DISCONNECT

MECHANICAL PIPING AND PLUMBING SYSTEMS

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
CWS	CHILLED WATER SUPPLY	FOS	FUEL OIL SUPPLY	W	SITE WATER PIPING
CWR	CHILLED WATER RETURN	FOR	FUEL OIL RETURN	-	COLD WATER (CW)
HWS	HOT WATER SUPPLY	FOV	FUEL OIL VENT	- -	HOT WATER (HW)
HWR	HOT WATER RETURN	RL	REFRIGERANT LIQUID	- - -	HOT WATER CIRCULATING (HWC)
HPWS	HEAT PUMP WATER SUPPLY	RS	REFRIGERANT SUCTION	140°	HOT WATER 140°
HPWR	HEAT PUMP WATER RETURN	RD	REFRIGERANT HOT GAS DISCHARGE	140°	HOT WATER CIRCULATING 140°
GS	GLYCOL SUPPLY	SAN	SANITARY DRAIN	S	COLD SOFT WATER
GR	GLYCOL RETURN	S	STORM DRAIN	S	HOT SOFT WATER
CS	CONDENSER WATER SUPPLY FROM TOWER	OF	OVERFLOW STORM DRAIN	S	HOT SOFT WATER CIRCULATING
CR	CONDENSER WATER RETURN TO TOWER	SSD	SUB SOIL DRAIN	RO	REVERSE OSMOSIS COLD WATER
LPR	LOW PRESSURE CONDENSATE RETURN	KW	KITCHEN WASTE	RO	REVERSE OSMOSIS HOT WATER
LPS	LOW PRESSURE STEAM	KV	KITCHEN VENT	RO	REVERSE OSMOSIS WATER CIRCULATING
MPR	MEDIUM PRESSURE CONDENSATE RETURN	GW	GARAGE WASTE	NP	NON-POTABLE COLD WATER
MPS	MEDIUM PRESSURE STEAM	AW	ACID WASTE	NP	NON-POTABLE HOT WATER
HPR	HIGH PRESSURE CONDENSATE RETURN	AV	ACID VENT	NP	NON-POTABLE HOT WATER CIRCULATING
HPS	HIGH PRESSURE STEAM	V	VENT	G	NATURAL GAS
CO	COIL OR EQUIPMENT DRAIN	ST	SITE STORM SEWER	A	COMPRESSED AIR
PC	CONDENSATE OR BOILER FEEDPUMP DISCHARGE	SS	SITE SANITARY SEWER	IW	INDIRECT WASTE

FIRE PROTECTION

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
F	FIRE LINE		CEILING CLEAN AGENT NOZZLE		FREE-STANDING FIRE PUMP TEST HEADER
SM	SPRINKLER MAIN		SUB-FLOOR CLEAN AGENT NOZZLE		FREE-STANDING FIRE DEPARTMENT CONNECTION
CA	CLEAN AGENT		CEILING DETECTOR		FLUSH FIRE DEPARTMENT CONNECTION
	SPRINKLER BRANCH AND HEADS		SUB-FLOOR DETECTOR		FIRE DEPARTMENT CONNECTION
	RECESSED PENDANT SPRINKLER		CLEAN AGENT ALARM BELL	FHC	FIRE HOSE CABINET
	CONCEALED PENDANT SPRINKLER		CLEAN AGENT HORN WITH STROBE	FVC	FIRE HOSE VALVE CABINET
	UPRIGHT SPRINKLER		ELECTRIC PULL STATION	PIV	POST INDICATOR VALVE
	DRY PENDANT SPRINKLER		ABORT PULL STATION		ISOLATION VALVE WITH TAMPER SWITCH
	HORIZONTAL SIDEWALL SPRINKLER		CLEAN AGENT PRESSURE SWITCH		ALARM CHECK VALVE
	DRY HORIZONTAL SIDEWALL SPRINKLER		WARNING LIGHT		DRY PIPE VALVE
	PRE-ACTION HEAT DETECTOR	CAP	CLEAN AGENT PANEL	FS	FLOW SWITCH
	PRE-ACTION PULL STATION		FIRE HYDRANT		WATER FLOW SWITCH
	PRE-ACTION ALARM BELL		ALARM BELL		NEW TO EXISTING CONNECTION
	PRE-ACTION TROUBLE STROBE		ALARM STROBE		
	DELUGE VALVE FOR PRE-ACTION SYSTEM		FIRE DEPARTMENT HOSE VALVE		POINT OF DISCONNECT
PA	PRE-ACTION RELEASING PANEL		FLUSH FIRE PUMP TEST HEADER		

SYMBOLS INDICATED HERE AND NOT USED IN THE CONTRACT DOCUMENTS DO NOT APPLY TO THIS PROJECT. ADDITIONAL SYMBOLS AND ABBREVIATIONS MAY BE INDICATED IN THE CONTRACT DOCUMENTS.

ABBREVIATIONS

AFF	ABOVE FINISHED FLOOR	DDCV	DOUBLE DETECTOR CHECK VALVE ASSEMBLY BACKFLOW PREVENTER	GA	GAUGE	NIC	NOT IN CONTRACT
AHJ	AUTHORITY HAVING JURISDICTION	DIA	DIAMETER	GALV	GALVANIZED	NO	NORMALLY OPEN
ASHRAE	AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS	DISC	DISCONNECT	GC	GENERAL CONTRACTOR	NOM	NOMINAL
		DIST	DISTRIBUTION	GEN	GENERATOR	NPW	NON-POTABLE WATER
ASME	AMERICAN SOCIETY OF MECHANICAL ENGINEERS	DN	DOWN	GPM	GALLONS PER MINUTE	NTS	NOT TO SCALE
ASTM	STANDARD SPECIFICATIONS OF THE AMERICAN SOCIETY FOR TESTING MATERIALS	DPAC	DRY PIPE AIR COMPRESSOR	GW	GARAGE WASTE	OA	OUTDOOR AIR
		DPS	DOOR POSITION SWITCH	HGT	HEIGHT	OC	ON CENTER
AUX	AUXILIARY	DPV	DRY PIPE VALVE	HP	HORSEPOWER	PERP	PERPENDICULAR
AV	ACID VENT	DWG	DRAWING	HTG	HEATING	PIV	POST INDICATOR VALVE
AVG	AVERAGE	DX	DIRECT EXPANSION	HVAC	HEATING, VENTILATING AND AIR CONDITIONING	PLBG	PLUMBING
AW	ACID WASTE	EA	EXHAUST AIR	HZ	HERTZ, HIGH ZONE WET STANDPIPE	PNL	PANEL
AWG	AMERICAN WIRE GAUGE	EHC	ELECTRIC HEATING COIL	IE	INVERT ELEVATION	PS	PLASTER SINK
BMCS	BUILDING MANAGEMENT CONTROL SYSTEM	EL	ELEVATION	IP	INTERNET PROTOCOL	PSF	POUNDS PER SQUARE FOOT
		ELEC	ELECTRICAL	KW	KILOWATT	PSI	POUNDS PER SQUARE INCH
BFP	DOUBLE CHECK BACKFLOW PREVENTER	EMS	ENERGY MANAGEMENT SYSTEM	LBS	POUNDS	PVC	POLYVINYL CHLORIDE
		EOA	ECONOMIZER OUTDOOR AIR	LZ	LOW ZONE WET STANDPIPE	PWR	POWER
BLDG	BUILDING	EPO	EMERGENCY POWER OFF	MA	MIXED AIR	RA	RETURN AIR
BTU	BRITISH THERMAL UNIT	EQUIP	EQUIPMENT	MAX	MAXIMUM	REQD	REQUIRED
BTUH	BRITISH THERMAL UNIT PER HOUR	EXH	EXHAUST	MBH	1000 BTU/HOUR	RGS	RIGID GALVANIZED STEEL
CFH	CUBIC FEET PER HOUR	EXIST	EXISTING	MECH	MECHANICAL	RH	RELATIVE HUMIDITY
CFM	CUBIC FEET PER MINUTE	F	FIRE WATER	MERV	MINIMUM EFFICIENCY REPORTING VALUE	RLFA	RELIEF AIR
CL	CENTER LINE	FA	FIRE ALARM			RM	ROOM
CLG	CEILING	FCO	FLOOR CLEAN OUT	MIN	MINIMUM	RO	REVERSE OSMOSIS WATER
CLR	CLEAR	FDC	FIRE DEPARTMENT CONNECTION	MISC	MISCELLANEOUS	RPBFP	REDUCED PRESSURE BACKFLOW PREVENTER
CPVC	CHLORINATED POLYVINYL CHLORIDE	FHC	FIRE HOSE CABINET	MOA	MINIMUM OUTDOOR AIR	RPZ	REDUCED PRESSURE ZONE BACKFLOW PREVENTER
CRAC	COMPUTER ROOM AIR CONDITIONER	FHV	FIRE HOSE VALVE	MTD	MOUNTED	SA	SUPPLY AIR
CV	CONSTANT VOLUME	FL	FLOOR	NC	NORMALLY CLOSED	SAN	SANITARY
		FT	FEET	NFPA	NATIONAL FIRE PROTECTION ASSOCIATION	SCHD	SCHEDULE
		FW	FILTERED WATER			SCW	SOFT COLD WATER
						SHW	SOFT HOT WATER
						SIM	SIMILAR
						SM	SPRINKLER MAIN
						SMACNA	SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION
						SPECS	SPECIFICATIONS
						SS	STAINLESS STEEL
						STD	STANDARD
						TEMP	TEMPERATURE
						TYP	TYPICAL
						UG	UNDERGROUND
						UL	UNDERWRITERS LABORATORY
						UNO	UNLESS NOTED OTHERWISE
						UPS	UNINTERRUPTIBLE POWER SUPPLY
						VA	VOLT-AMPS
						VERT	VERTICAL
						VFC	VARIABLE FREQUENCY CONTROL
						VTR	VENT THROUGH ROOF
						W	WATT
						WG	WATER GAUGE
						WP	WEATHERPROOF
						XFMR	TRANSFORMER

DEMOLITION NOTES:

A. THE OWNER SHALL HAVE THE FIRST RIGHT OF SALVAGE FOR ALL MECHANICAL, ELECTRICAL, AND PLUMBING ITEMS AFTER CONTRACTOR REMOVAL. ALL ITEMS NOT RETAINED BY THE OWNER SHALL BE REMOVED FROM THE PREMISES AND DISPOSED OF PROPERLY BY THE CONTRACTOR . VERIFY OWNER'S INTENT PRIOR TO REMOVAL OR DEMOLITION.

B. INFORMATION PERTAINING TO THE EXISTING BUILDING HAS BEEN OBTAINED THROUGH THE BUILDINGS ORIGINAL DRAWINGS WHERE AVAILABLE. REPORT DISCREPANCIES TO THE ARCHITECT/ENGINEER PRIOR TO ANY DEMOLITION. CONTRACTOR SHALL FIELD-VERIFY ALL EXISTING CONDITIONS PRIOR TO COMMENCING WORK.

C. COORDINATE SHUT DOWN OF ALL UTILITIES FOR DEMOLITION WORK WITH THE OWNER.

D. DISCONNECT AND REMOVE MECHANICAL SYSTEMS, EQUIPMENT, AND COMPONENTS AS INDICATED TO BE REMOVED.
PIPING TO BE REMOVED: REMOVE PORTION OF PIPING INDICATED TO BE REMOVED AND CAP REMAINING PIPING WITH THE SAME OR COMPATIBLE PIPING MATERIAL.
DUCTS TO BE REMOVED: REMOVE PORTIONS OF DUCT AND CAP REMAINING DUCTS WITH THE SAME OR COMPATIBLE DUCTWORK MATERIAL.
EQUIPMENT TO BE REMOVED: DISCONNECT AND CAP SERVICES AND REMOVE EQUIPMENT.
EQUIPMENT TO BE REMOVED AND SALVAGED: DISCONNECT AND CAP SERVICES AND REMOVE EQUIPMENT AND DELIVER TO OWNER.

E. IF PIPE OR EQUIPMENT INSULATION TO REMAIN IS DAMAGED IN APPEARANCE OR IS UNSERVICEABLE, REMOVE DAMAGED OR UNSERVICEABLE PORTIONS AND REPLACE WITH NEW PRODUCTS OF EQUAL CAPACITY AND QUALITY.

F. CONTRACTOR IS REQUIRED TO VISIT SITE AND FIELD VERIFY ALL EXISTING CONDITIONS PRIOR TO BIDDING PROJECT.

G. COORDINATE DEMOLITION WITH THE WORK OF OTHER TRADES. PROVIDE TEMPORARY UTILITIES AS REQUIRED TO ALLOW THE WORK OF OTHER TRADES TO PROCEED.

H. DUCTWORK, PIPING, PLUMBING, AND EQUIPMENT SHOWN BOLD SHALL BE REMOVED TO THE EXTENTS INDICATED.

PLUMBING GENERAL NOTES:

A. DO NOT RUN PLUMBING PIPING OR EQUIPMENT ABOVE ELECTRICAL OR TELECOMMUNICATION PANELS AND ASSOCIATED EQUIPMENT OR IN CODE-REQUIRED CLEARANCE SPACES. COORDINATE ALL ROUTING WORK WITH ALL OTHER TRADES.

B. DRAWINGS, PLANS, SCHEMATICS, AND DIAGRAMS INDICATE THE GENERAL LOCATIONS AND THE ARRANGEMENT OF SYSTEMS. WHEREVER PRACTICAL, INSTALL SYSTEMS AS INDICATED. PROVIDE OFFSETS AND ELEVATION CHANGES TO PLUMBING, PIPING, AND DUCTWORK AS REQUIRED TO COMPLETE THE LAYOUT AND COORDINATION PROCESS AS WELL AS MEET ALL REQUIREMENTS OF THE CONTRACT DOCUMENTS.

C. INSTALL AND ROUTE ALL FUEL GAS PIPING AS REQUIRED BY CODE.

D. PROVIDE GAS PRESSURE REGULATORS ON ALL GAS-FIRED EQUIPMENT; INCLUDING REGULATOR VENT PIPING, SHUTOFF VALVE, DIRT LEG, AND UNION. REGULATE GAS PRESSURE AS REQUIRED FOR EACH SPECIFIC PIECE OF GAS-FIRED EQUIPMENT AND PER MANUFACTURER'S RECOMMENDATIONS.

E. DO NOT ROUTE PLUMBING PIPING WITHIN SPACE REQUIRED TO SERVICE ALL HVAC EQUIPMENT.

F. PIPING AND FIXTURES SHOWN WITH THIN LINES INDICATE EXISTING TO REMAIN. PIPING AND FIXTURES SHOWN WITH BOLD LINES INDICATES NEW.

PIPING GENERAL NOTES:

A. DO NOT RUN PIPING OR EQUIPMENT ABOVE ELECTRICAL OR TELECOMMUNICATION PANELS AND ASSOCIATED EQUIPMENT OR IN CODE REQUIRED CLEARANCE SPACES. COORDINATE ALL ROUTING WORK WITH ALL OTHER TRADES.

B. DRAWINGS, PLANS, SCHEMATICS, AND DIAGRAMS INDICATE THE GENERAL LOCATIONS AND THE ARRANGEMENT OF SYSTEMS. WHEREVER PRACTICAL, INSTALL SYSTEMS AS INDICATED. PROVIDE OFFSETS AND ELEVATION CHANGES TO PIPING, PLUMBING, AND CUTWORK AS REQUIRED TO COMPLETE THE LAYOUT AND COORDINATION PROCESS AS WELL AS MEET ALL REQUIREMENTS OF THE CONTRACT DOCUMENTS.

C. ALL PIPING INSULATION SHALL MEET OR EXCEED THE ENERGY CODES INSTALLED R VALUE REQUIREMENTS.

D. INDICATED SIZES FOR PIPE AND PIPING SPECIALTY CONNECTIONS FOR EQUIPMENT AND COILS ARE INTENDED TO ROUTE TO THE EQUIPMENT CONNECTION POINT. WHEN CONTROL VALVE SIZES ARE SMALLER THAN INDICATED PIPE SIZE PROVIDE ECCENTRIC REDUCERS ON INLET AND OUTLET OF CONTROL VALVE.

E. SIZE AND ROUTE REFRIGERANT PIPING PER MANUFACTURERS' RECOMMENDATIONS.

F. ROUTE ALL HORIZONTAL HVAC PIPING IN MECHANICAL ROOMS AT A MINIMUM OF 7'-6" ABOVE FINISHED FLOOR.

G. PIPING AND EQUIPMENT SHOWN WITH THIN LINES INDICATES EXISTING TO REMAIN. PIPING AND EQUIPMENT SHOWN WITH BOLD LINES INDICATES NEW.

H. DIELECTRIC NIPPLES OR FLANGE INSULATION KITS SHALL BE UTILIZED FOR ALL DISSIMILAR PIPE CONNECTIONS. DIELECTRIC UNIONS WILL NOT BE ACCEPTED.

HVAC GENERAL NOTES:

A. DO NOT RUN DUCTWORK, PIPING, OR EQUIPMENT ABOVE ELECTRICAL OR TELECOMMUNICATION PANELS AND ASSOCIATED EQUIPMENT OR IN CODE-REQUIRED CLEARANCE SPACES. COORDINATE ALL ROUTING WORK WITH ALL OTHER TRADES.

B. DRAWINGS, PLANS, SCHEMATICS, AND DIAGRAMS INDICATE THE GENERAL LOCATIONS AND THE ARRANGEMENT OF SYSTEMS. WHEREVER PRACTICAL, INSTALL SYSTEMS AS INDICATED. PROVIDE OFFSETS AND ELEVATION CHANGES TO DUCTWORK, PIPING, AND PLUMBING AS REQUIRED TO COMPLETE THE LAYOUT AND COORDINATION PROCESS AS WELL AS MEET ALL REQUIREMENTS OF THE CONTRACT DOCUMENTS.

C. SEE ARCHITECTURAL-REFLECTED CEILING PLANS FOR DIFFUSER, REGISTER, GRILLE, AND CEILING-MOUNTED DEVICE LOCATIONS.

D. CONTRACTOR SHALL COORDINATE LOCATION OF DUCTWORK IN CEILING SPACE WITH ALL TRADES PRIOR TO FABRICATION AND INSTALLATION OF DUCTWORK.

E. FOR GENERAL DUCTWORK CONSTRUCTION, SEE DUCT FITTING DETAILS.

F. DUCTWORK AND EQUIPMENT SHOWN WITH THIN LINES INDICATES EXISTING TO REMAIN. DUCTWORK AND EQUIPMENT SHOWN WITH BOLD LINES INDICATES NEW.

G. PROVIDE VOLUME DAMPER IN ALL BRANCH TAKEOFFS CONNECTING TO DIFFUSERS, REGISTERS, OR GRILLES AND IN LOCATIONS INDICATED.

H. PROVIDE CLEARANCES TO ALL EQUIPMENT AS REQUIRED BY MANUFACTURERS' INSTALLATION AND OPERATION REQUIREMENTS AND/OR BY CODE.

I. INSTALL ALL DUCT AND PIPING IN MECHANICAL ROOMS AS HIGH AS POSSIBLE. PROVIDE 7'-6" MINIMUM HIGH ACCESS PATHWAYS TO ALL EQUIPMENT.

J. COORDINATE LOCATIONS OF ALL EQUIPMENT HOUSEKEEPING PADS WITH GENERAL CONTRACTOR. MECHANICAL CONTRACTOR IS RESPONSIBLE FOR INSTALLATION OF EQUIPMENT HOUSEKEEPING PADS UNLESS NOTED OTHERWISE.

K. CAP ENDS OF ALL INSTALLED DUCTWORK DURING CONSTRUCTION TO MINIMIZE DIRT, DEBRIS, AND FOREIGN OBJECTS FROM ENTERING THE DUCT SYSTEM.

L. COORDINATE SCHEDULE OF SHUTDOWN FOR EXISTING HVAC SYSTEMS, FOR INSTALLATION OF NEW HVAC SYSTEMS, WITH THE OWNER'S REPRESENTATIVE PRIOR TO SHUT DOWN.

M. ALL INSULATION SHALL MEET OR EXCEED THE ENERGY CODE'S INSTALLED R VALUE REQUIREMENTS.

FIRE PROTECTION GENERAL NOTES:

A. COORDINATE LOCATION OF FIRE SPRINKLER PIPING AND HEADS WITH ALL TRADES PRIOR TO FINALIZATION OF SHOP DRAWINGS AND HYDRAULIC CALCULATIONS.

B. SEE ARCHITECTURAL-REFLECTED CEILING PLANS FOR LOCATIONS OF ALL CEILING-MOUNTED DEVICES.

C. DO NOT RUN FIRE SPRINKLER PIPING ABOVE ELECTRICAL OR TELECOMMUNICATION PANELS AND ASSOCIATED EQUIPMENT OR IN CODE-REQUIRED CLEARANCE SPACES. COORDINATE WITH ELECTRICAL AND MECHANICAL CONTRACTOR.

D. COORDINATE SHUT DOWN OF EXISTING FIRE SERVICE WITH OWNER'S REPRESENTATIVE.

E. SEE SPECIFICATIONS FOR FIRE SPRINKLER HEAD TYPES AND COLORS.

F. ALL WORK SHALL COMPLY WITH NFPA, THE LOCAL AUTHORITIES HAVING JURISDICTION, AND OWNERS' INSURANCE CARRIER.

G. DIELECTRIC NIPPLES OR FLANGE INSULATION KITS SHALL BE UTILIZED FOR ALL DISSIMILAR PIPE CONNECTIONS. DIELECTRIC UNIONS WILL NOT BE ACCEPTED.

H. SPRINKLER CONTRACTOR SHALL PERFORM FIRE HYDRANT FLOW TESTING AT THE PROJECT SITE PRIOR TO HYDRAULIC DESIGN OF THE SYSTEM IN ORDER TO DETERMINE THE CURRENT AVAILABLE WATER PRESSURE AND FLOW AT THE SITE. HYDRAULIC CALCULATIONS AND SYSTEM DESIGN SHALL BE BASED ON THE ACTUAL FLOW TEST DATA OBTAINED BY THE SPRINKLER CONTRACTOR.

SPRINKLER NOTE:

EXISTING BUILDING HAS A FIRE PROTECTION SPRINKLER SYSTEM. THE FIRE PROTECTION SPRINKLER SYSTEM SHALL BE MODIFIED AS REQUIRED BY THE SCOPE OF THIS PROJECT TO MAINTAIN THE REQUIREMENTS OF THE NFPA CODES, THE STATE FIRE MARSHAL'S OFFICE, AND THE OWNERS APPROVING INSURANCE AGENCY. SPRINKLER CONTRACTOR SHALL COORDINATE THE LOCATIONS OF ALL CEILING MOUNTED SPRINKLER HEADS TO AVOID ANY AND ALL INTERFERENCE WITH ALL OTHER TRADES. IF CONFLICTS DO OCCUR SUCH THAT LIGHTS, DUCTS, DIFFUSERS, GRILLES, OR CEILING SYSTEMS CANNOT BE INSTALLED IN THEIR REQUIRED LOCATIONS DUE TO SPRINKLER PIPING INTERFERENCE, THE PIPING SHALL BE RELOCATED OR REROUTED AT NO ADDITIONAL EXPENSE TO THE PROJECT. SPRINKLER CONTRACTOR SHALL MAINTAIN AN ADEQUATE SUPPLY OF EXTRA PIPING, FITTINGS, AND NECESSARY TOOLS TO MAKE FIELD MODIFICATIONS WITHOUT DELAY. AN APPROVED SPRINKLER SHOP DRAWING DOES NOT PRECLUDE REROUTING IF SO ORDERED BY THE ARCHITECT/ENGINEER.

MISCELLANEOUS GENERAL NOTES:

A. CONTRACTOR IS RESPONSIBLE FOR ANY CUTTING AND PATCHING NEEDED FOR MECHANICAL INSTALLATION. PATCHING MUST MATCH EXISTING.

SITE UTILITY PLAN GENERAL NOTES:

A. VERIFY EXACT LOCATION OF EXISTING UTILITIES IN THE FIELD PRIOR TO EXCAVATION. REPORT DISCREPANCIES BETWEEN CONSTRUCTION DOCUMENTS AND ACTUAL CONDITIONS PRIOR TO PROCEEDING WITH WORK.

B. ANY UTILITY SHUTDOWN SHALL BE SCHEDULED AND COORDINATED WITH THE OWNER PRIOR TO SHUT DOWN.

DETAIL NOTE:

A. PROJECT DETAILS ARE PROVIDED ON DESIGNATED DETAIL SHEETS. DETAILS APPLY TO THE ENTIRE PROJECT IN ALL LOCATIONS WHERE DETAILED CONDITION EXISTS AND ARE ONLY REFERENCED TO PROVIDE CLARITY IF NECESSARY.

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800.723.8567 | jeo.com

ORGANIZATION CERTIFICATION OF:
AUTHORIZATION NUMBER: CA-3929

PROFESSIONAL MECHANICAL ENGINEER
PAUL A BAUMAN
E-14562
STATE OF NEBRASKA
CA-2169 05/15/2026

ISSUE

MARK	DATE	DESCRIPTION
1	05/15/2026	ADDENDUM 2

SEWARD PUBLIC SCHOOL DISTRICT HVAC IMPROVEMENTS - PHASE 1

SEWARD PUBLIC SCHOOLS
410 SOUTH ST
SEWARD, NE 68434

JEO PROJECT NO.: 242372.01
DATE: 04.30.2026
QAQC: PAB
DRAWN BY: RRW
SHEET SIZE: 30" x 42"

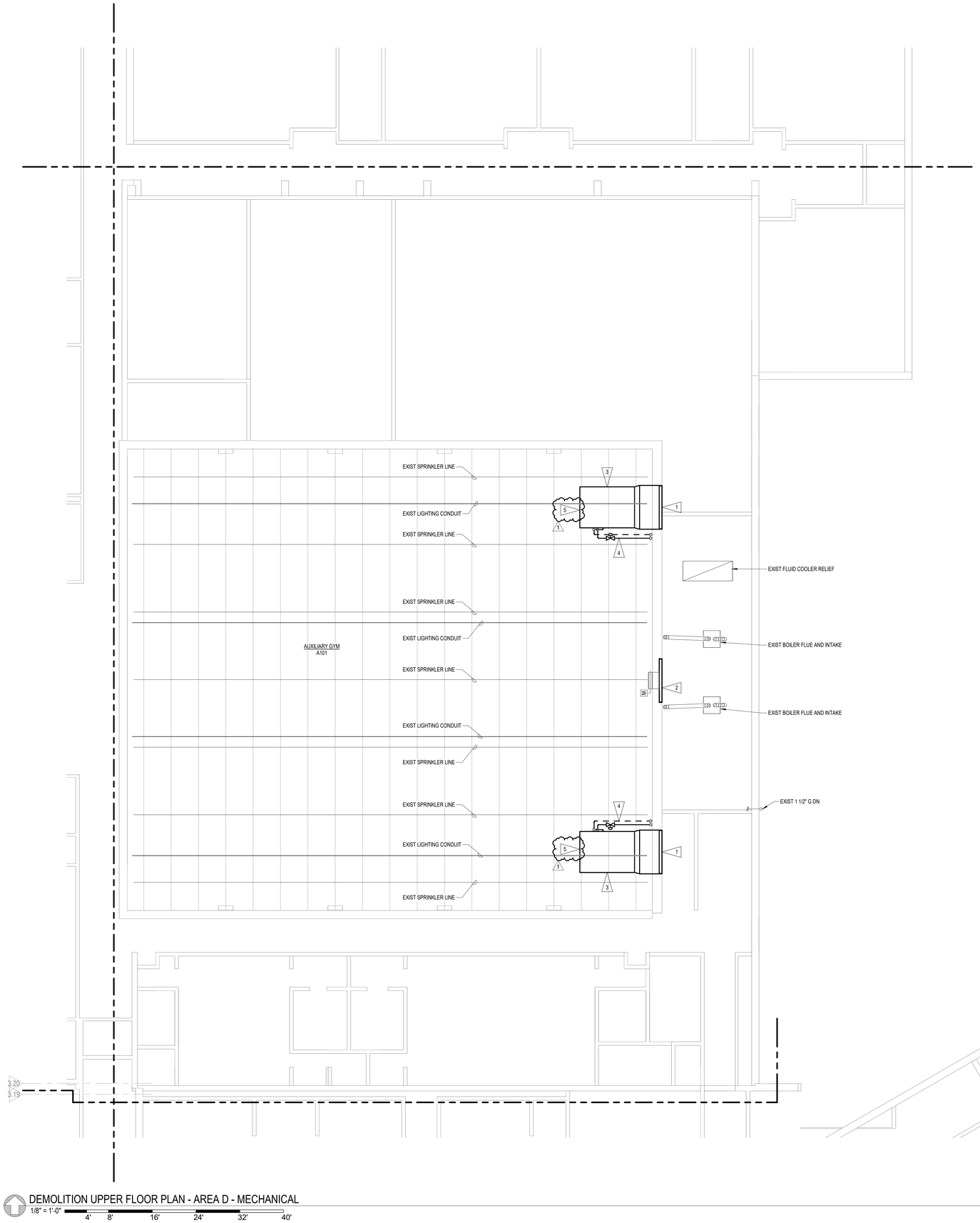
MECHANICAL SYMBOLS, ABBREVIATIONS, AND NOTES

M000 P1

Sheet Size: ARCH E1 (30.0 x 42.00 INCHES)

Autodesk Docs://Seward Public Schools 2026/20251720_MEPT_HS Improvements_v25.rvt

Sheet Size: ARCH E1 (30.0 x 42.00 INCHES)

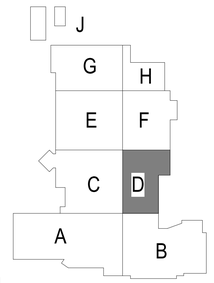


DEMOLITION UPPER FLOOR PLAN - AREA D - MECHANICAL
1/8" = 1'-0"
4' 8' 16' 24' 32' 40'

FLAG NOTES

1. REMOVE EXISTING OUTSIDE AIR LOUVER.
2. REMOVE EXISTING RELIEF AIR LOUVER BUT, LEAVE THE CONTROL DAMPER INSTALLED.
3. REMOVE EXISTING AIR HANDLING UNIT AND ALL ASSOCIATED DUCTWORK AND DAMPERS. REMOVE ASSOCIATED ANGLE IRON SUPPORTS WITHIN JOIST WEBBING. COORDINATE WITH STRUCTURAL AND OWNER.
4. REMOVE EXISTING HEATING WATER SUPPLY AND RETURN SERVING EXISTING AIR HANDLING UNIT. SEE ARCHITECTURAL FOR WALL PATCHING.
5. REMOVE ALL CONTROL POINTS AND GRAPHICS ASSOCIATED WITH EACH AHU FROM THE EXISTING BMCS.

KEY PLAN



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SEWARD PUBLIC SCHOOLS
410 SOUTH ST
SEWARD, NE 68434

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JEO PROJECT NO.:	242372.01
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QAQC:	PAB
DRAWN BY:	RRW
SHEET SIZE:	30" x 42"

DEMOLITION UPPER FLOOR PLAN - AREA D - MECHANICAL

MD102D HS P1

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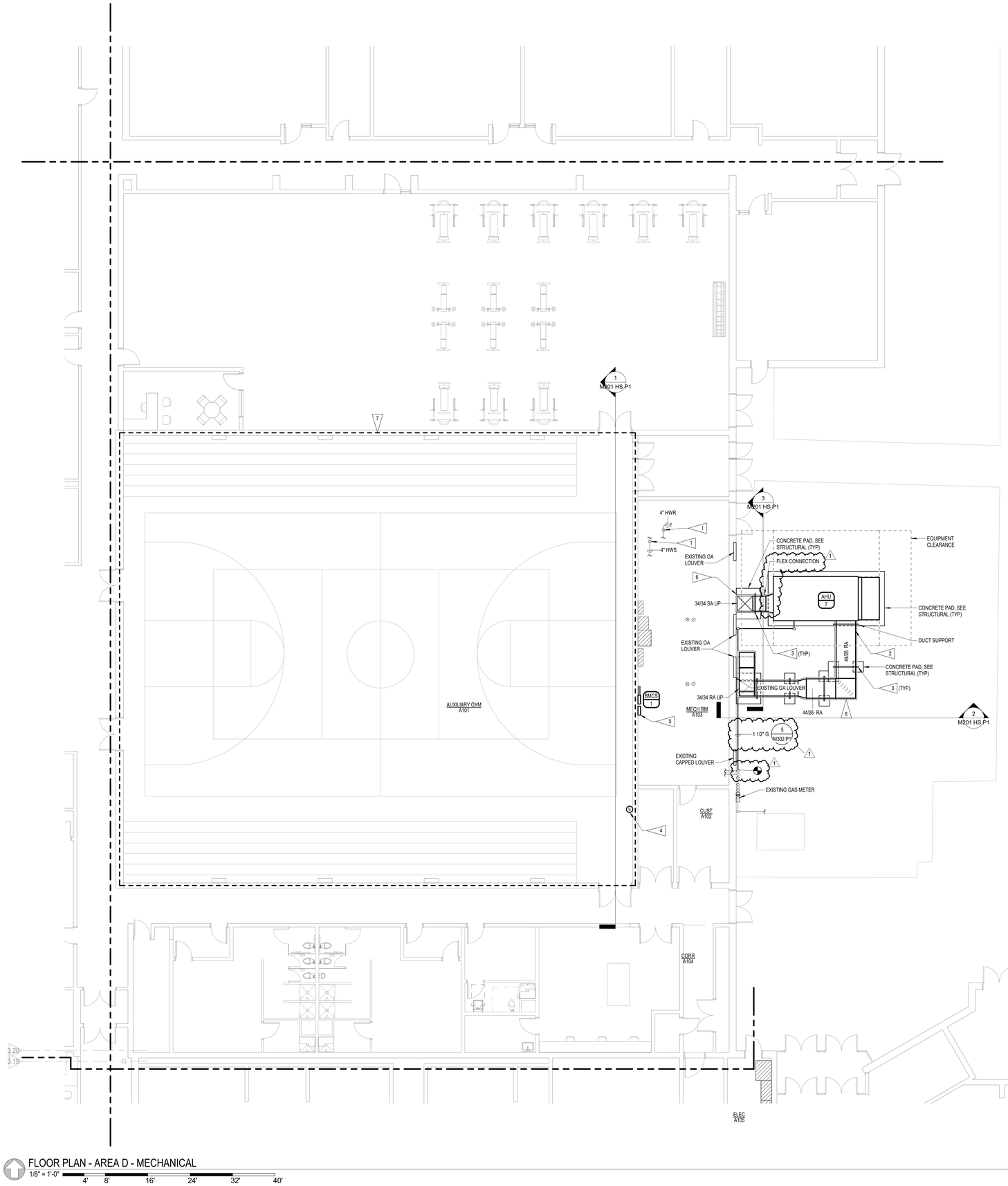
Sheet Size: ARCH E1 (30.0 x 42.00 INCHES)



FLOOR PLAN - AREA D - MECHANICAL

1/8" = 1'-0"

4' 8' 16' 24' 32' 40'

Autodesk Docs://Seward Public Schools 2026/20251720_MEPT_HS Improvements_v25.rvt

FLAG NOTES

1. CAP EXISTING HEATING WATER SUPPLY AND RETURN PIPING AT EXISTING ISOLATION VALVE.
2. CONNECT 44/26 PHENOLIC RETURN AIR DUCTWORK TO SIDE OF INSULATED PLENUM CURB. SEAL WATER TIGHT.
3. MANUFACTURER APPROVED DUCTWORK SUPPORT. ANCHOR DUCTWORK TO CONCRETE PAD. SEE STRUCTURAL FOR CONCRETE PAD. SEE DETAIL 2/M301 P1.
4. COMBINATION ZONE TEMPERATURE SENSOR WITH HUMIDITY AND CO2. SUPPLIED WITH AHU-7. COVER WITH LOCKABLE METAL CAGE. COORDINATE FINAL LOCATION WITH OWNER.
5. EQUIPMENT CONTROL PANEL SUPPLIED WITH AHU-7. CONNECT WITH CONTROL WIRING BACK TO AHU-7. COORDINATE FINAL LOCATION WITH OWNER.
6. ALL EXTERIOR SUPPLY AND RETURN DUCTWORK SHALL BE "THERMADUCT" STEEL CLAD PHENOLIC DUCTWORK. COLOR SHALL BE ASH GRAY. SEE DETAIL 2/M301 P1 FOR DUCT SUPPORT.
7. MODIFY FIRE SPRINKLER SYSTEM WITHIN DASHED AREA AS REQUIRED FOR NEW LAYOUT PER SPRINKLER NOTE ON SHEET M000.

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ORGANIZATION CERTIFICATION OF:
AUTHORIZATION NUMBER: CA-3929

PROFESSIONAL MECHANICAL ENGINEER
PAUL A BAUMAN
E-14562
STATE OF NEBRASKA

CA-2169 05/15/2026

ISSUE

MARK	DATE	DESCRIPTION
1	05/15/2026	ADDENDUM 2

SEWARD PUBLIC SCHOOL DISTRICT HVAC IMPROVEMENTS - PHASE 1

SEWARD PUBLIC SCHOOLS
410 SOUTH ST
SEWARD, NE 68434

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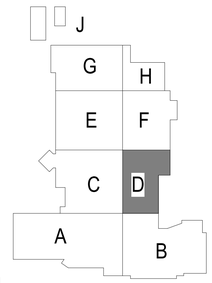
JEO PROJECT NO.:	242372.01
DATE:	04.30.2026
QAQC:	PAB
DRAWN BY:	RRW
SHEET SIZE:	30" x 42"

KEY PLAN



FLOOR PLAN - AREA D - MECHANICAL

M101D HS P1

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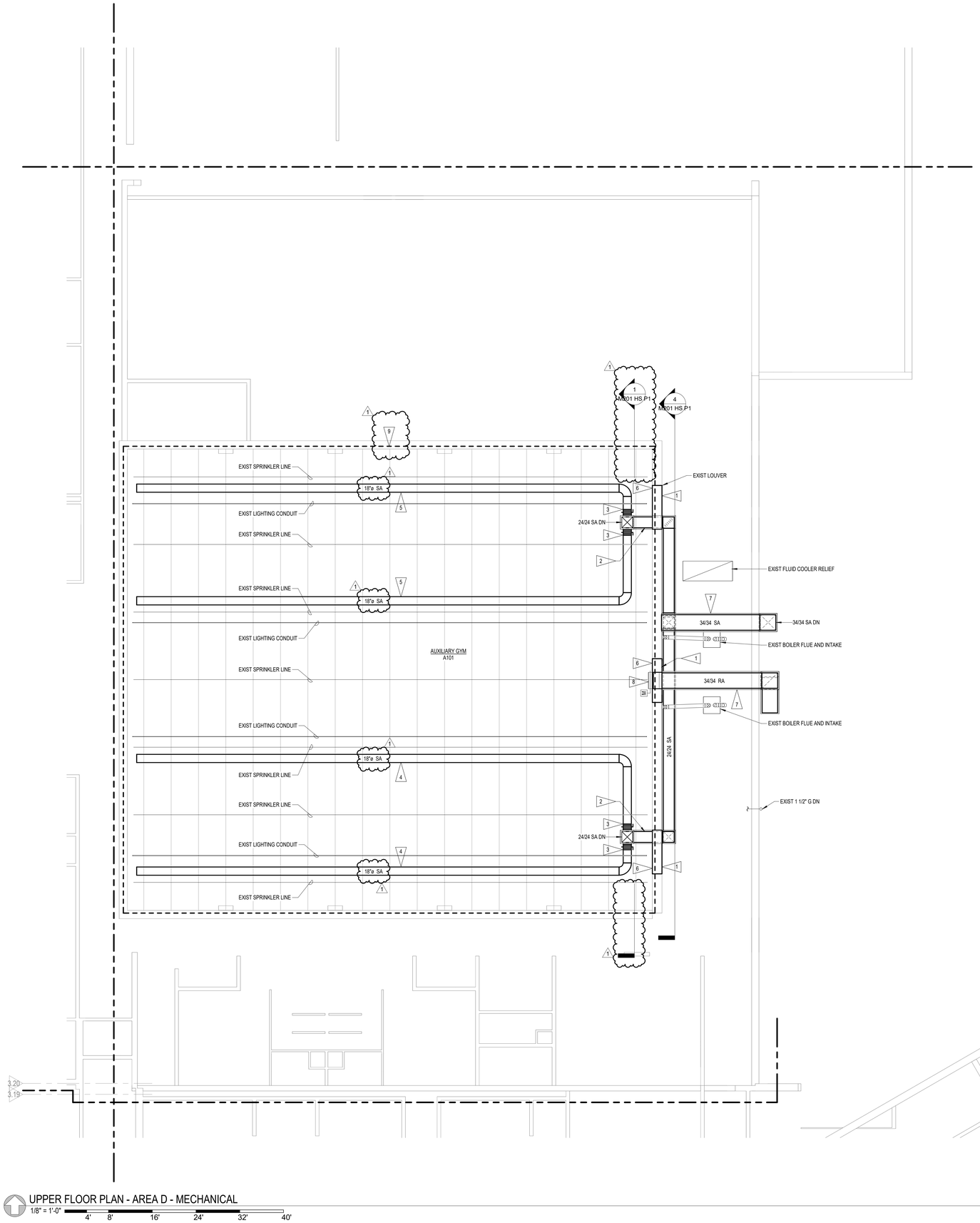

UPPER FLOOR PLAN - AREA D - MECHANICAL
1/8" = 1'-0"
4' 8' 16' 24' 32' 40'

FLAG NOTES

1. INSTALL PAINTABLE 18 GAUGE SHEET METAL PANEL WITH 4" OF RIGID INSULATION IN PLACE OF EXISTING LOUVER. ROUTE NEW PHENOLIC DUCTWORK THROUGH SHEET METAL PANEL FLASH AND SEAL WATER TIGHT. SEE ARCHITECTURAL FOR PAINT TYPE AND COLOR.
2. ALL EXPOSED PHENOLIC DUCTWORK WITHIN GYM SHALL BE PROVIDED WITH PAINTABLE FINISH. SEE ARCHITECTURAL FOR PAINT TYPE AND COLOR.
3. 18"ø PAINTABLE SPIRAL TAKEOFF WITH VOLUME DAMPER TO FABRIC DUCT INLET CONNECTION. SEE DETAIL 5/M301 P1. FABRIC DUCT FROM THIS POINT TO ELBOW SHALL BE WITHOUT ORIFICES. SEE ARCHITECTURAL FOR PAINT TYPE AND COLOR.
4. 88-FOOT LONG SECTION OF 18" DIAMETER, NON-POROUS FABRIC DUCTWORK INCORPORATING HIGH THROW 1.4" PERFORATIONS 200 DEGREE AND 150 DEGREE POSITIONS WHEN LOOKING FROM THE INLET TO THE ENDCAP. FABRIC DUCTWORK TO BE "PRHODA" BRAND DARK BLUE IN COLOR. SUSPEND FABRIC DUCT WITH ALUMINUM SINGLE TRACK PROFILE SYSTEM AS RECOMMENDED BY FABRIC DUCT SUPPLIER. SEE DETAIL 3/M301 P1 AND 4/M301 P1. FINAL COLOR OF FABRIC DUCT SYSTEM SHALL BE AS SELECTED BY OWNER.
5. 88-FOOT LONG SECTION OF 18" DIAMETER, NON-POROUS FABRIC DUCTWORK INCORPORATING HIGH THROW 1.4" PERFORATIONS 210 DEGREE AND 160 DEGREE POSITIONS WHEN LOOKING FROM THE INLET TO THE ENDCAP. FABRIC DUCTWORK TO BE "PRHODA" BRAND DARK BLUE IN COLOR. SUSPEND FABRIC DUCT WITH ALUMINUM SINGLE TRACK PROFILE SYSTEM AS RECOMMENDED BY FABRIC DUCT SUPPLIER. SEE DETAIL 3/M301 P1 AND 4/M301 P1. FINAL COLOR OF FABRIC DUCT SYSTEM SHALL BE AS SELECTED BY OWNER.
6. INSTALL PAINTABLE 18 GAUGE SHEET METAL PANEL. SEE ARCHITECTURAL FOR PAINT TYPE AND COLOR.
7. ALL EXTERIOR SUPPLY AND RETURN DUCTWORK SHALL BE "THERMADUCT" STEEL CLAD PHENOLIC DUCTWORK. COLOR SHALL BE ASH GRAY. SEE DETAIL 2/M301 P1 FOR DUCT SUPPORT.
8. EXISTING 36x60 MOTORIZED RELIEF AIR DAMPER. DAMPER SHALL REMAIN AND BE REUSED FOR NEW RETURN AIR.

1 9 MODIFY FIRE SPRINKLER SYSTEM WITHIN DASHED AREA AS REQUIRED FOR NEW LAYOUT PER SPRINKLER NOTE ON SHEET M000.

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CA-2169 05/15/2026

ISSUE

MARK	DATE	DESCRIPTION
1	05/15/2026	ADDENDUM 2

SEWARD PUBLIC SCHOOL DISTRICT HVAC IMPROVEMENTS - PHASE 1

SEWARD PUBLIC SCHOOLS
410 SOUTH ST
SEWARD, NE 68434

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DATE:	04.30.2026
QAQC:	PAB
DRAWN BY:	RRW
SHEET SIZE:	30" x 42"

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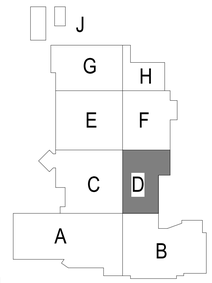
KEY PLAN



UPPER FLOOR PLAN - AREA D - MECHANICAL

M102D HS P1

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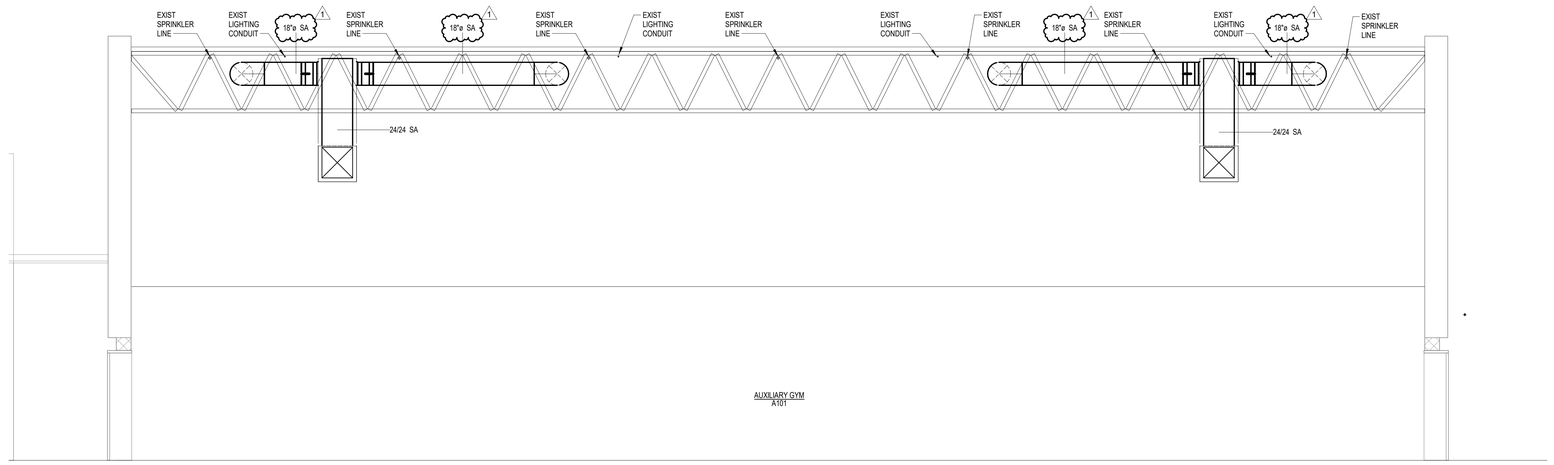
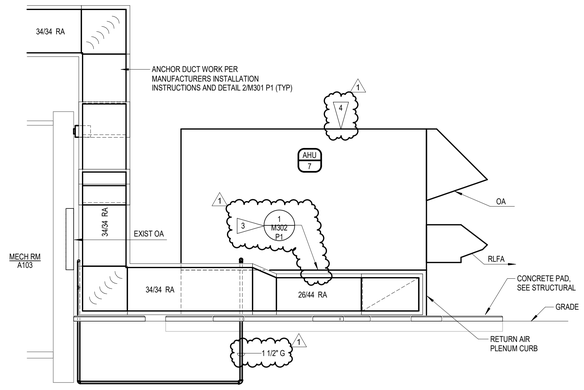


SECTION LOOKING WEST IN GYM - MECHANICAL

1 M201 HS P1 1/4" = 1'-0"

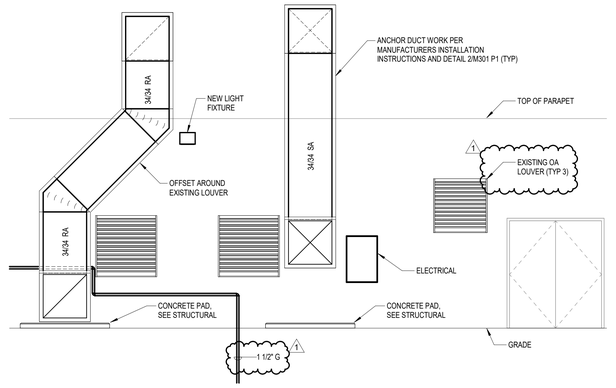
2' 4' 8' 12' 16' 20'



SECTION LOOKING NORTH AT AHU-7 - MECHANICAL

2 M201 HS P1 1/4" = 1'-0"

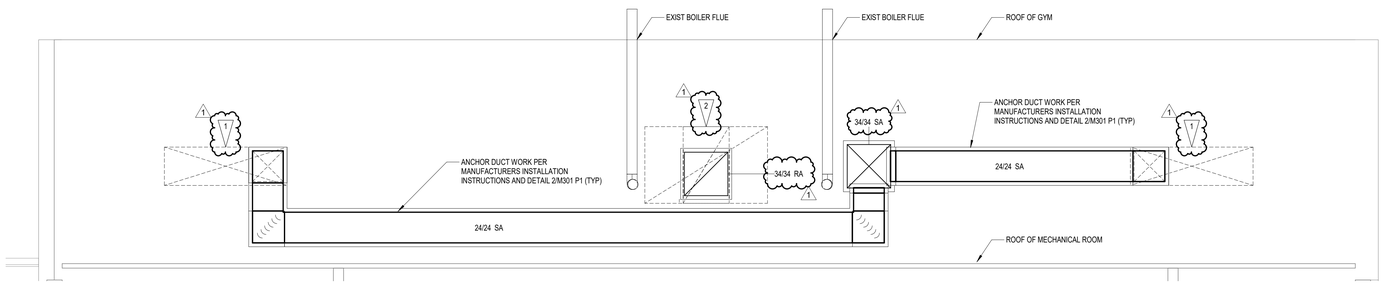
2' 4' 8' 12' 16' 20'



SECTION LOOKING WEST AT EXTERIOR - MECHANICAL

3 M201 HS P1 1/4" = 1'-0"

2' 4' 8' 12' 16' 20'



SECTION LOOKING WEST ON LOWER ROOF AT GYM - MECHANICAL

4 M201 HS P1 1/4" = 1'-0"

2' 4' 8' 12' 16' 20'

FLAG NOTES

1. INFILL EXISTING WALL OPENING FROM REMOVED OA LOUVER WITH METAL PANEL. SEE FLOOR PLAN SHEET M102D-HS-P1 FOR MORE INFORMATION.
2. INFILL EXISTING WALL OPENING FROM REMOVED RLFA LOUVER WITH METAL PANEL. SEE FLOOR PLAN SHEET M102D-HS-P1 FOR MORE INFORMATION.
3. PROVIDE 1 1/2" CONDENSATE TRAP AND PIPE TO DRAIN TO THE ADJACENT ROCK OR GRASS AREA.
4. INSTALL AIRFLOW MEASUREMENT SYSTEM FOR AHU-7 AS MANUFACTURED BY TRUEFIT AFMS OR APPROVED EQUAL, AND INTERFACE WITH AHU FACTORY CONTROLS AND BMCS, SEE SPECIFICATION SECTION 23 09 13.13.

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E-14562
STATE OF NEBRASKA

CA-2169 05/15/2026

ISSUE

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1	05/15/2026	ADDENDUM 2

SEWARD PUBLIC SCHOOL DISTRICT HVAC IMPROVEMENTS - PHASE 1

SEWARD PUBLIC SCHOOLS
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JEO PROJECT NO.:	242372.01
DATE:	04.30.2026
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SHEET SIZE:	30" x 42"

MECHANICAL SECTIONS

M201 HS P1

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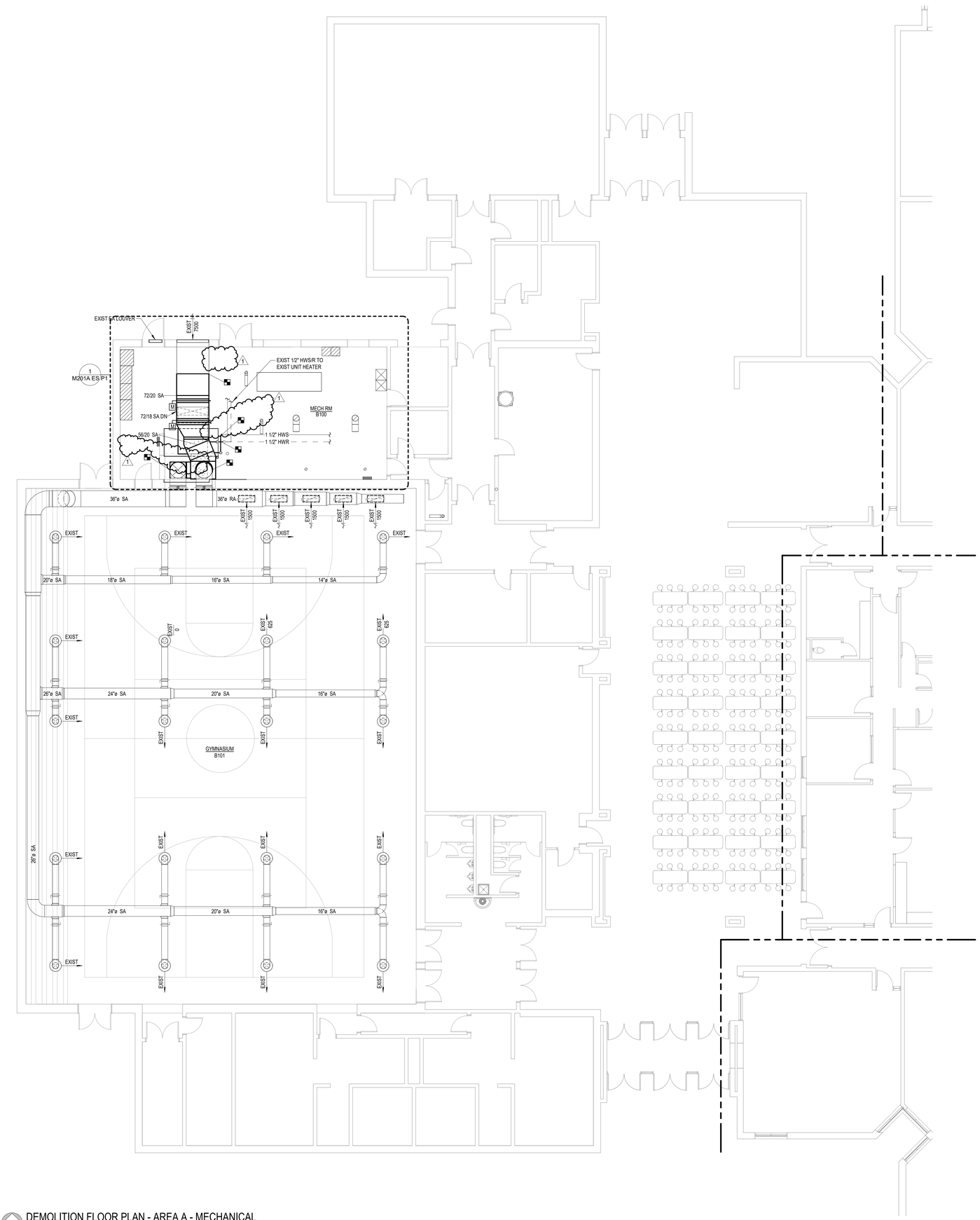

DEMOLITION FLOOR PLAN - AREA A - MECHANICAL
1/8" = 1'-0"
4' 8' 16' 24' 32' 40'

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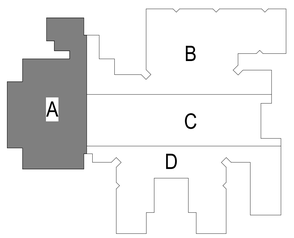

KEY PLAN

DEMOLITION FLOOR PLAN - AREA A - MECHANICAL

MD101A ES P1

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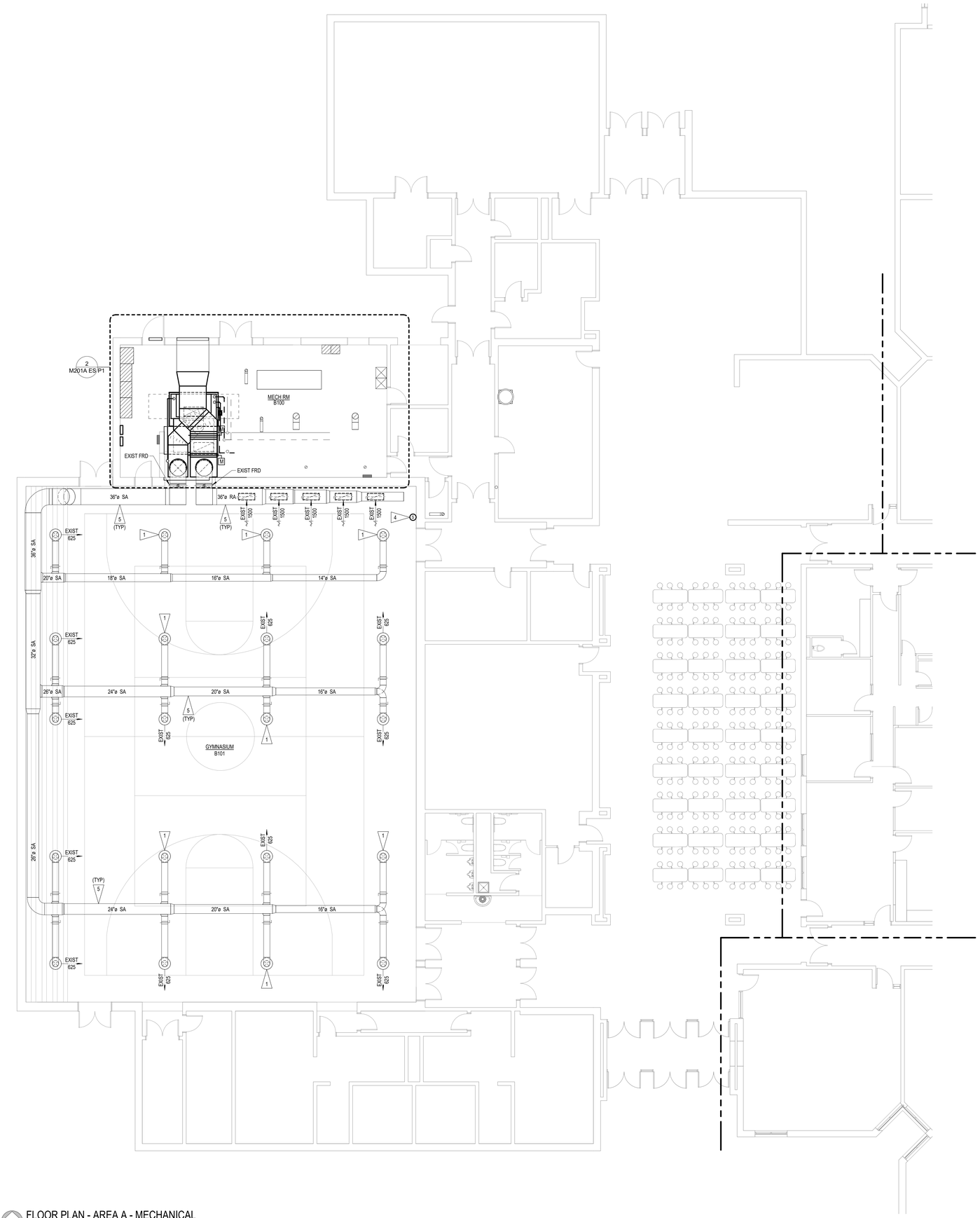

FLOOR PLAN - AREA A - MECHANICAL
1/8" = 1'-0"
4' 8' 16' 24' 32' 40'

FLAG NOTES

1. FULLY CLOSE VOLUME DAMPER IN RUN OUT TO CEILING DIFFUSER. AIR FLOW AT CEILING DIFFUSER SHALL BE 0 CFM.
2. NOT USED.
3. NOT USED.
4. COMBINATION ZONE TEMPERATURE SENSOR WITH HUMIDITY AND CO2. SUPPLIED WITH AHU-2. COVER WITH LOCKABLE METAL CAGE. COORDINATE FINAL LOCATION WITH OWNER.
5. OWNER WILL HAVE DUCT CLEANING PERFORMED OF ALL EXISTING SUPPLY AND RETURN DUCTWORK AFTER DEMOLITION OF EXISTING AHU AND EXISTING DUCTWORK. COORDINATE WITH OWNER TO ALLOW TIME FOR DUCT CLEANING TO OCCUR BEFORE INSTALLING NEW AHU AND DUCTWORK.

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SEWARD PUBLIC SCHOOL DISTRICT HVAC IMPROVEMENTS - PHASE 1

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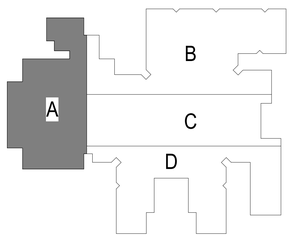

KEY PLAN

FLOOR PLAN - AREA A - MECHANICAL

M101A ES P1

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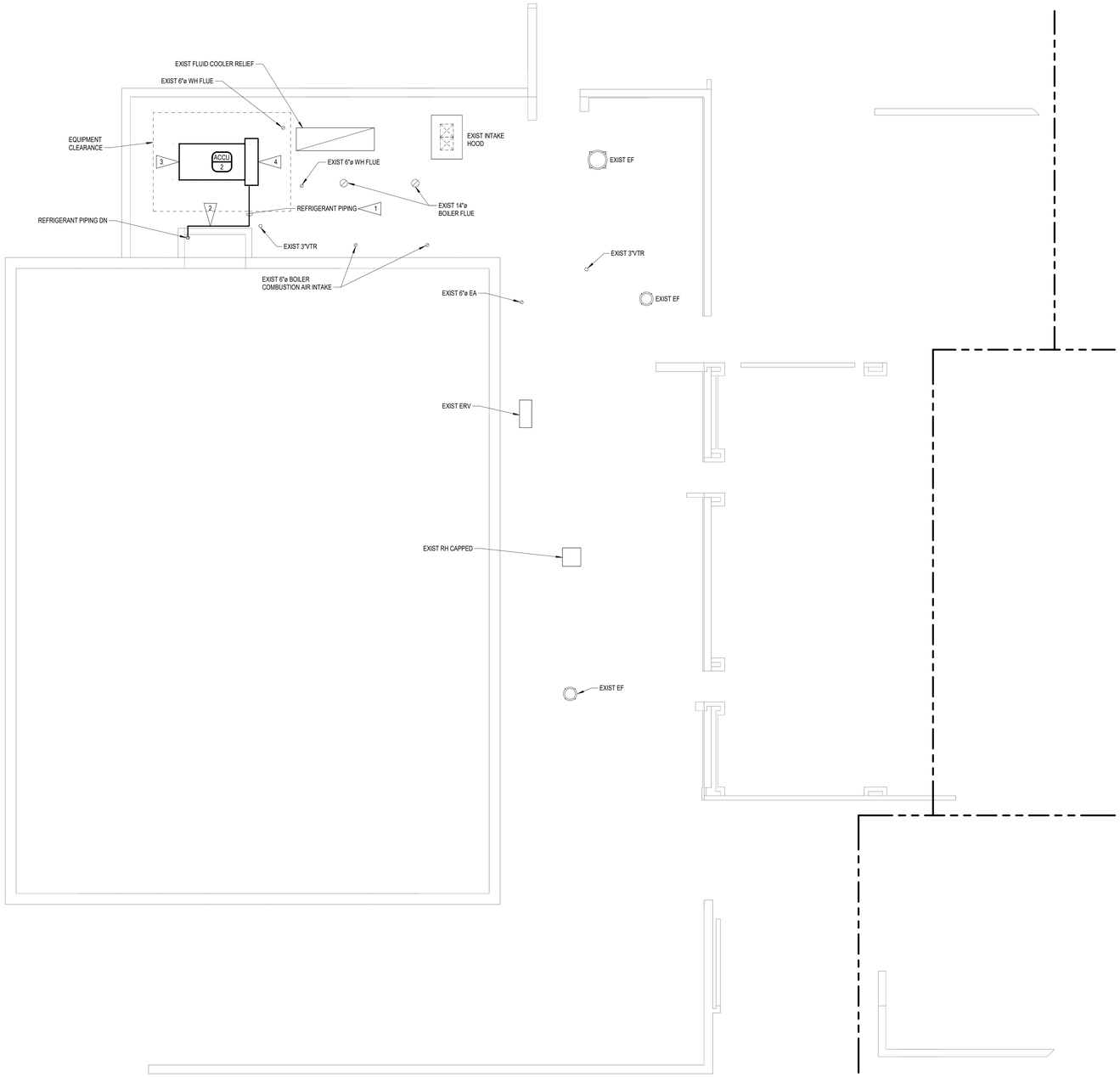

ROOF PLAN - AREA A - MECHANICAL
1/8" = 1'-0"
4' 8' 16' 24' 32' 40'

FLAG NOTES

1. INSTALL ROOF PIPE SUPPORT BLOCKS PER DETAIL 6/M302 P1 AND SPECIFICATIONS.
2. SECURE REFRIGERANT PIPING TO WALL AND SEAL PENETRATION.
3. PROVIDE FOUR SEISMIC SPRING VIBRATION ISOLATORS RATED FOR 1" DEFLECTION WITH ONE LOCATED UNDER THE FOUR CORNERS OF THE CONDENSER SECTION (WEST SECTION) OF ACCU-2. SPRING VIBRATION ISOLATORS SHALL BE MASON INDUSTRIES, MODEL SSLFH-A-310 OR APPROVED EQUAL. ATTACH THE SPRINGS TO THE STRUCTURAL STEEL SUPPORT STRUCTURE AND TO ACCU-2 PER THE MANUFACTURER'S REQUIREMENTS.
4. PROVIDE FOUR SEISMIC SPRING VIBRATION ISOLATORS RATED FOR 1" DEFLECTION WITH ONE LOCATED UNDER THE FOUR CORNERS OF THE COMPRESSOR AND CONTROLS CABINET SECTION (EAST SECTION) OF ACCU-2. SPRING VIBRATION ISOLATORS SHALL BE MASON INDUSTRIES, MODEL SSLFH-A-510 OR APPROVED EQUAL. ATTACH THE SPRINGS TO THE STRUCTURAL STEEL SUPPORT STRUCTURE AND TO ACCU-2 PER THE MANUFACTURER'S REQUIREMENTS.

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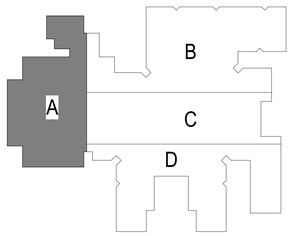

KEY PLAN

ROOF PLAN - AREA A - MECHANICAL

M102A ES P1

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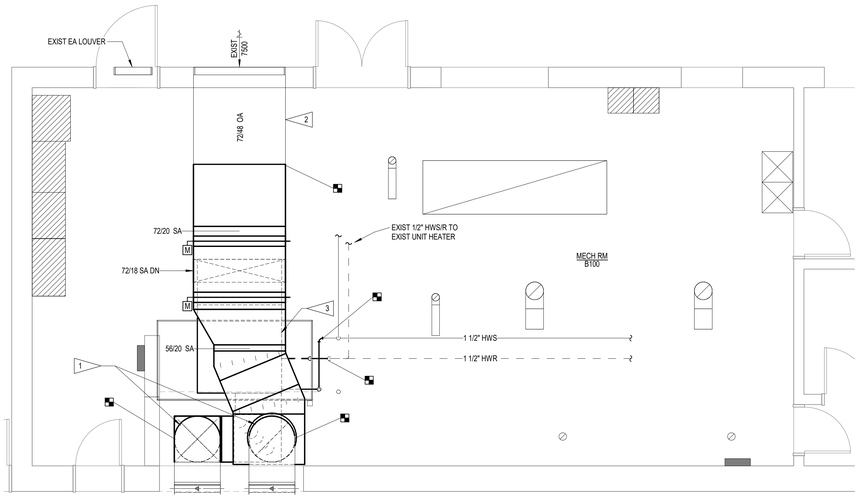
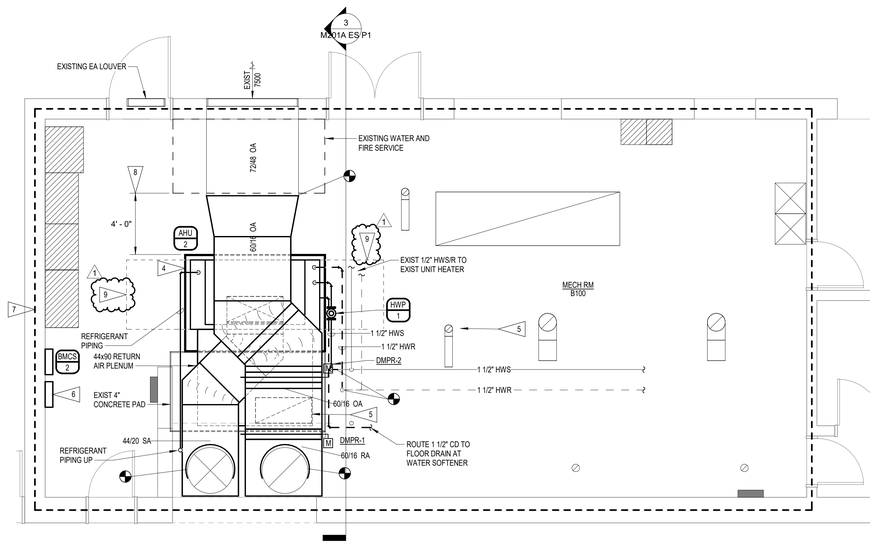


DEMOLITION ENLARGED FLOOR PLAN - AREA A - MECHANICAL

1 / M201A ES P1 — 1/4" = 1'-0"

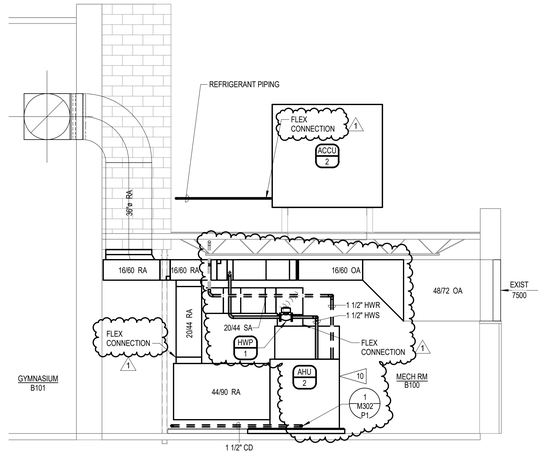
2' 4' 8' 12' 16' 20'



ENLARGED FLOOR PLAN - AREA A - MECHANICAL

2 / M201A ES P1 — 1/4" = 1'-0"

2' 4' 8' 12' 16' 20'



SECTION LOOKING WEST AT AHU-2 - MECHANICAL

3 / M201A ES P1 — 1/4" = 1'-0"

2' 4' 8' 12' 16' 20'

FLAG NOTES

1. REMOVE EXISTING 36"ø SUPPLY AIR AND RETURN AIR DUCTWORK TO APPROXIMATELY 12'-0" A.F.F.
2. EXISTING DUCTWORK FROM LOUVER TO FIRST FLANGE APPROXIMATELY 5'-0" FROM WALL SHALL REMAIN AND BE REUSED. REMOVE AND REPLACE ALL INSULATION PER SPECIFICATIONS.
3. REMOVE EXISTING AIR HANDLING UNIT AND ALL ASSOCIATED DUCTWORK AND DAMPERS SHOWN BOLD.
4. NEW 6'-4" WIDE BY APPROXIMATELY 9'-2" LONG 4" THICK CONCRETE PAD. THICKNESS SHALL MATCH EXISTING CONCRETE PAD THICKNESS.
5. 44x20 DN CONNECT TO 44x90 RETURN AIR PLENUM .
6. EQUIPMENT CONTROL PANEL SUPPLIED WITH AHU-2, CONNECT WITH CONTROL WIRING BACK TO AHU-2. COORDINATE FINAL LOCATION WITH OWNER.
7. MODIFY FIRE SPRINKLER SYSTEM WITHIN DASHED AREA AS REQUIRED FOR NEW LAYOUT PER SPRINKLER NOTE ON SHEET M000.
8. MAINTAIN A MINIMUM 4'-0" CLEARANCE BETWEEN NEW CONCRETE PAD AND FURTHEST EXTENDED PART OF WATER AND FIRE SERVICE.
9. MAINTAIN EQUIPMENT CLEARANCES PER MANUFACTURER'S RECOMMENDATIONS.
10. INSTALL AIRFLOW MEASUREMENT SYSTEM FOR AHU-2 AS MANUFACTURED BY TRUEFIT AFMS OR APPROVED EQUAL, AND INTERFACE WITH AHU FACTORY CONTROLS AND BMCS, SEE SPECIFICATION SECTION 23 09 13.13.

JEO ARCHITECTURE INC

1937 N CHESTNUT ST
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800.723.8567 | jeo.com

ORGANIZATION CERTIFICATION OF:
AUTHORIZATION NUMBER: CA-3929

PROFESSIONAL MECHANICAL ENGINEER
PAUL A BAUMAN
E-14562
STATE OF NEBRASKA

CA-2169 05/15/2026

ISSUE

MARK	DATE	DESCRIPTION
1	05/15/2026	ADDENDUM 2

SEWARD PUBLIC SCHOOL DISTRICT HVAC IMPROVEMENTS - PHASE 1

SEWARD PUBLIC SCHOOLS
410 SOUTH ST
SEWARD, NE 68434

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JEO PROJECT NO.:	242372.01
DATE:	04.30.2026
QAQC:	PAB
DRAWN BY:	RRW
SHEET SIZE:	30" x 42"

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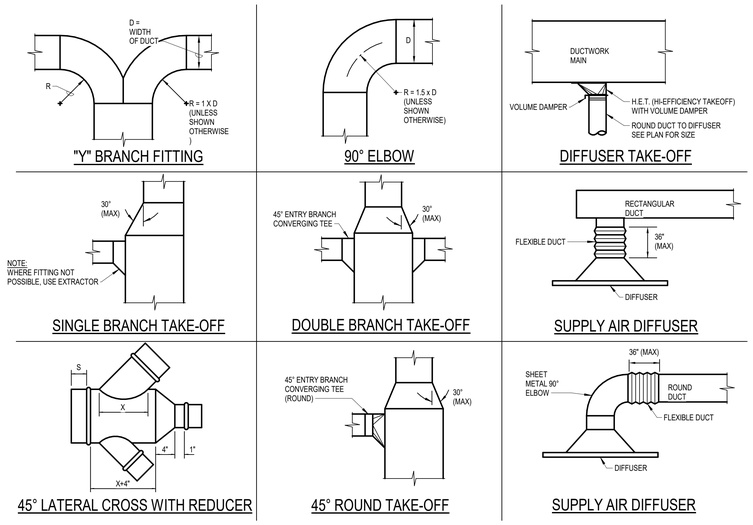
ENLARGED MECHANICAL PLANS AND SECTIONS

M201A ES P1

Autodesk Docs://Seward Public Schools 2026/20251720_MEPT_ES Improvements_v25.rvt

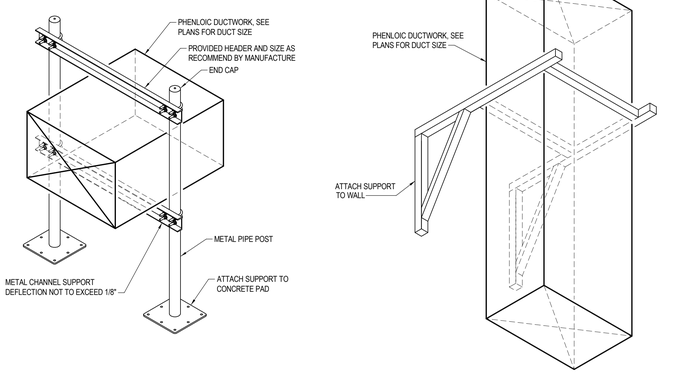
Sheet Size: ARCH E1 (30.0 x 42.00 INCHES)



DUCT FITTING DETAILS

NO SCALE

1 — 05/09/2019 — M301 P1



NOTES:

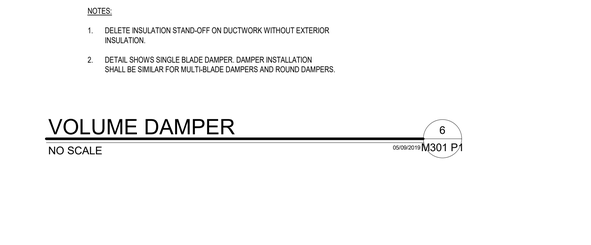
1. LOCATE SUPPORTS MAXIMUM 8'-0" O.C. AND AT ALL CHANGES IN DIRECTION.
2. DUCT SUPPORT MATERIAL, METHOD OF ATTACHMENT AND LOCATIONS SHALL BE APPROVED BY THE GENERAL CONTRACTOR AND DUCTWORK MANUFACTURER.
3. DUCT SUPPORT COMPONENTS TO BE SIZED BY THE MANUFACTURER BASED ON THE PROJECT SPECIFIC DUCT WEIGHTS.
4. PROVIDE ALL REQUIRED BRACING, PADS, CHANNELS, BRACKETS, SCREWS, ETC. REQUIRED PER DUCT MANUFACTURERS RECOMMENDATIONS AND INSTALLATION MANUAL.
5. PROVIDE EITHER GALVANIZED STEEL DUCT SUPPORT COMPONENTS WITH ALL CUT ENDS COVERED WITH TWO COATS OF GALVANIZED PAINT OR PAINT ALL DUCT SUPPORTS WITH A ZINC-RICH PRIMER AND TWO COATS OF SEMI-GLOSS INDUSTRIAL DTM ACRYLIC PAINT. COORDINATE PAINT COLOR TO MATCH THE SELECTED DUCTWORK COLOR.
6. THE HORIZONTAL WALL DUCT SUPPORT CAN BE FLIPPED TO HAVE THE WALL SUPPORT ABOVE THE DUCT FOR AREAS WHERE IT WILL NOT FIT BELOW THE DUCT.

1

EXTERIOR DUCT SUPPORT

NO SCALE

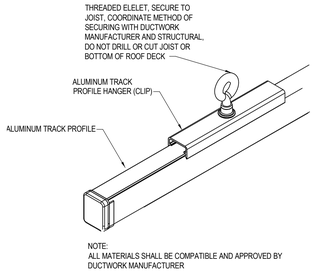
2 — M301 P1



FABRIC DUCT INSTALLATION DETAIL SINGLE TRACK PROFILE

NO SCALE

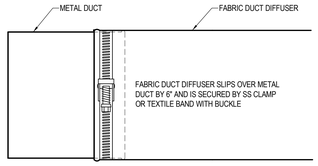
3 — M301 P1



FABRIC DUCT HANGER DETAIL SINGLE TRACK PROFILE

NO SCALE

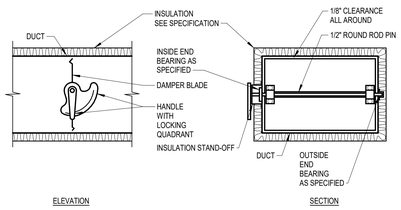
4 — M301 P1



FABRIC DUCT INLET CONNECTION

NO SCALE

5 — M301 P1



NOTES:

1. DELETE INSULATION STAND-OFF ON DUCTWORK WITHOUT EXTERIOR INSULATION.
2. DETAIL SHOWS SINGLE BLADE DAMPER. DAMPER INSTALLATION SHALL BE SIMILAR FOR MULTI-BLADE DAMPERS AND ROUND DAMPERS.

VOLUME DAMPER

NO SCALE

6 — 05/09/2019 — M301 P1

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ORGANIZATION CERTIFICATION OF:
AUTHORIZATION NUMBER: CA-3929

PROFESSIONAL MECHANICAL ENGINEER — PAUL A BAUMAN — E-14562 — STATE OF NEBRASKA

CA-2169 — 05/15/2026

ISSUE

MARK	DATE	DESCRIPTION
1	05/15/2026	ADDENDUM 2

SEWARD PUBLIC SCHOOL DISTRICT HVAC IMPROVEMENTS - PHASE 1

SEWARD PUBLIC SCHOOLS
410 SOUTH ST
SEWARD, NE 68434

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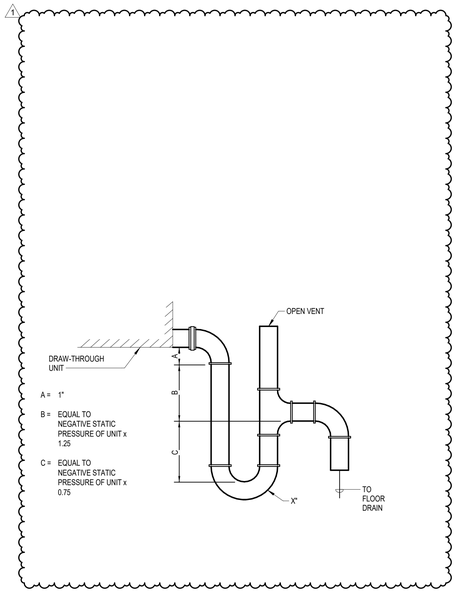
DATE:	04.30.2026
QAQC:	PAB
DRAWN BY:	RRW
SHEET SIZE:	30" x 42"

MECHANICAL DETAILS

M301 P1

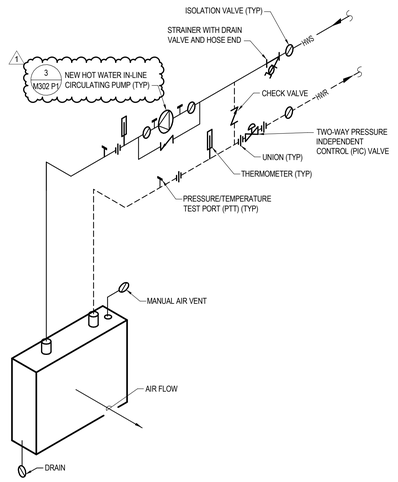
Sheet Size: ARCH E1 (30.0 x 42.00 INCHES)



CONDENSATE DRAIN

NO SCALE

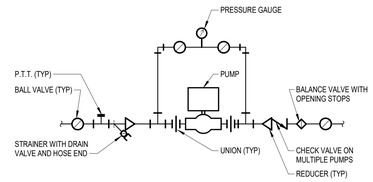
1 — 05/09/2019 — M302 P1



HEATING COIL 2-WAY PIC VALVE AND CIRC. PUMP PIPING

NO SCALE

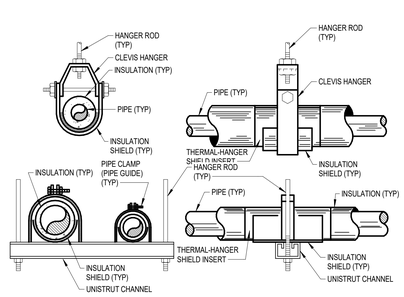
2 — M302 P1



CIRCULATING PUMP PIPING

NO SCALE

3 — 02/10/2026 — M302 P1



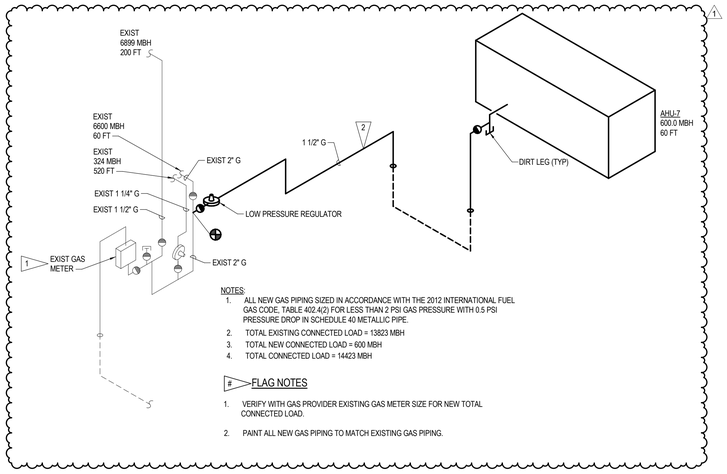
NOTE:

1. SEE SPECIFICATIONS FOR INSULATION, PROTECTIVE SHIELD, AND PIPE SUPPORT REQUIREMENTS.
2. INSTALL PROTECTIVE SHIELD AT EACH PIPE SUPPORT.
3. INSULATION SHALL BE CONTINUOUS THROUGH HANGERS AND SUPPORTS.

INSULATION PIPE SUPPORT

NO SCALE

4 — 05/09/2019 — M302 P1



NOTES:

1. ALL NEW GAS PIPING SIZED IN ACCORDANCE WITH THE 2012 INTERNATIONAL FUEL GAS CODE, TABLE 402.4(2) FOR LESS THAN 2 PSI GAS PRESSURE WITH 0.5 PSI PRESSURE DROP IN SCHEDULE 40 METALLIC PIPE.
2. TOTAL EXISTING CONNECTED LOAD = 13823 MBH
3. TOTAL NEW CONNECTED LOAD = 600 MBH
4. TOTAL CONNECTED LOAD = 14423 MBH

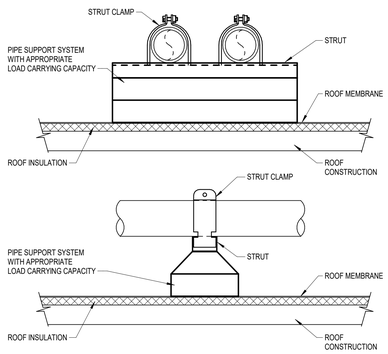
#1 FLAG NOTES

1. VERIFY WITH GAS PROVIDER EXISTING GAS METER SIZE FOR NEW TOTAL CONNECTED LOAD.
2. PAINT ALL NEW GAS PIPING TO MATCH EXISTING GAS PIPING.

GAS RISER DIAGRAM

NO SCALE

5 — M302 P1



NOTES:

1. LOCATE SUPPORTS 8'-0" O.C. AND AT ALL CHANGES IN DIRECTION.
2. PIPE SUPPORT MATERIAL, METHOD AND LOCATIONS SHALL BE APPROVED BY GENERAL CONTRACTOR BEFORE INSTALLATION.

ROOF PIPE SUPPORT BLOCK

NO SCALE

6 — 08/08/2022 — M302 P1

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ORGANIZATION CERTIFICATION OF:
AUTHORIZATION NUMBER: CA-3929

PROFESSIONAL MECHANICAL ENGINEER
PAUL A BAUMAN
E-14562
STATE OF NEBRASKA

CA-2169 05/15/2026

ISSUE

MARK	DATE	DESCRIPTION
1	05/15/2026	ADDENDUM 2

SEWARD PUBLIC SCHOOL DISTRICT HVAC IMPROVEMENTS - PHASE 1

SEWARD PUBLIC SCHOOLS
410 SOUTH ST
SEWARD, NE 68434

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JEO PROJECT NO.:	242372.01
DATE:	04.30.2026
QAQC:	PAB
DRAWN BY:	RRW
SHEET SIZE:	30" x 42"

MECHANICAL DETAILS

M302 P1

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Sheet Size: ARCH E1 (30.0 x 42.00 INCHES)

HYDRONIC PUMP SCHEDULE - ES P1

MARK	SERVES	LOCATION	TYPE	FLOW (GPM)	TOTAL HEAD (FT)	SHUT-OFF HEAD (FT)	MINIMUM EFFICIENCY (%)	FLUID	MAX FLUID TEMP (F)	MAX BHP	SUCTION SIZE (IN)	DISCHARGE SIZE (IN)	MAX RPM	OPERATING WEIGHT (LBS)	MANUFACTURER	MODEL	REMARKS
HWP-1	AHU-2	MECH/ELEC B223	INLINE	30	12	27	59.6	WATER	160	0.15	1.5	1.5	2700	27	TACO	VR15L	1,2,3

REMARKS:
1. SEE MECHANICAL/ELECTRICAL COORDINATION SCHEDULE ON SHEET E101A ES P1 FOR ELECTRICAL DATA.
2. PROVIDE WITH CAST IRON CASING.
3. PROVIDE ECM HIGH EFFICIENCY PUMP WITH BACNET INTERFACE.

DIRECT EXPANSION COOLING COIL SCHEDULE - ES P1

MARK	SERVES	LOCATION	AIRFLOW (CFM)	MIN ROWS	MAX FINS PER IN	COIL AREA (SF)	MAX FACE VELOCITY (FPM)	ENTERING AIR CONDITIONS		LEAVING AIR CONDITIONS		TOTAL CAPACITY (MBH)	SENSIBLE CAPACITY (MBH)	MAX APD (IN. W. G.)	REFRIGERANT	MANUFACTURER	REMARKS
								DB (°F)	WB (°F)	DB (°F)	WB (°F)						
CC-2	AHU-2	MECH/ELEC B223	7500	6	12	27.3	274	80.3	70.7	48.3	47.8	500.0	244.8	0.36	R-454B	ADDISON	1

REMARKS:
1. COOLING COIL CC-2 PROVIDED WITH AHU-2.
2. PROVIDE WITH TWO REFRIGERATION CIRCUITS TO MATCH ACCU.

AIR COOLED CONDENSING UNIT SCHEDULE - ES P1

MARK	SERVES	LOCATION	NOMINAL CAPACITY (TONS)	COMPRESSOR TYPE	NO. COMPRESSORS	REFRIGERANT	AMBIENT TEMP (°F)	MIN EER	DIMENSIONS (LxWxH) (IN)	OPERATING WEIGHT (LBS)	MANUFACTURER	MODEL	REMARKS
ACCU-2	AHU-2	ROOF	45	(3)	(3)	R-454B	105	10.0	146x87x81	2980	ADDISON	SCOA 540D1	1,2,4,5,6,7

REMARKS:
1. SEE MECHANICAL/ELECTRICAL COORDINATION SCHEDULE ON SHEET E101A ES P1 FOR ELECTRICAL DATA.
2. PROVIDE WITH UNIT MOUNTED 65 KAIC RATED DISCONNECT SWITCH, SINGLE POINT POWER CONNECTION, AND FACTORY WIRED 120V GFCI SERVICE RECEPTACLE WITH A 15 AMP CIRCUIT BREAKER DISCONNECT.
3. PROVIDE WITH TWO REFRIGERATION CIRCUITS. EACH CIRCUIT SHALL HAVE A LEAD VARIABLE SPEED SCROLL COMPRESSOR AND A STANDARD SCROLL COMPRESSOR FOR A TOTAL OF TWO COMPRESSORS PER CIRCUIT RESULTING IN FOUR COMPRESSORS FOR ACCU-2.
4. PROVIDE WITH MODULATING HOT GAS REHEAT.
5. PROVIDE WITH REFRIGERANT HOT GAS BYPASS CAPACITY CONTROL.
6. SEE SPECIFICATION SECTION 236213 FOR ADDITIONAL INFO.
7. PROVIDE COTTONWOOD SEED FILTERS WITH MESH VINYL COATED POLYESTER WHICH IS UV, MOLD, MILDEW, AND FLAME RESISTANT AND MOUNT WITH QUICK RELEASE FASTENERS OVER THE CONDENSER COIL AIR INLETS ON THE SIDES AND BOTTOM OF THE CONDENSING UNIT AS MANUFACTURED BY AIR SOLUTION COMPANY OR APPROVED EQUAL.

AIR HANDLING UNIT SCHEDULE - ES P1

MARK	SERVES	LOCATION	CONFIG.	GENERAL DATA: TOTAL AIRFLOW (CFM)	MAX OUTSIDE AIRFLOW (CFM)	MIN OUTSIDE AIRFLOW (CFM)	DIMENSIONS (LxWxH) (IN)	MAX WEIGHT (LBS)	HEATING DATA	COOLING DATA	SUPPLY FAN DATA: FAN TYPE/ QTY	EXTERNAL S.P. (IN. W.C.)	TOTAL S.P. (IN. W.C.)	MAX. RPM	MAX. BHP/ EACH	FILTER DATA	MANUFACTURER	MODEL	REMARKS
AHU-2	ES GYM	MECH/ELEC B223	(5)	7500	7500	4100/ 550 (9)	55x102x80	2470	HC-2 (7)	CC-2 (7)	ECM PLENUM/ 2	1.50	2.38	1471	4.63	(4)	ADDISON	SAOA 540	1,2,3,6,8,10,11,12

REMARKS:
1. SEE MECHANICAL/ELECTRICAL COORDINATION SCHEDULE ON SHEET E101A ES P1 FOR ELECTRICAL DATA.
2. PROVIDE WITH 2" THICK DOUBLE WALL R-13 INSULATED CABINET CONSTRUCTION.
3. PROVIDE WITH UNIT MOUNTED DISCONNECT SWITCH AND SINGLE POINT POWER CONNECTION.
4. PROVIDE WITH 2" THICK PLEATED MERV 8 PRE-FILTER AND 4" THICK PLEATED MERV 13 FINAL FILTER.
5. PROVIDE WITH UPPER SIDE SUPPLY AIR DISCHARGE AND LOWER SIDE RETURN AIR OPENING.
6. PROVIDE WITH FACTORY CONTROLS FOR SINGLE ZONE VAV OPERATION WITH BACNET CONNECTION FOR CONTROL VIA THE BMCS. PROVIDE WITH 10" COLOR TOUCH SCREEN CONTROL PANEL FOR FIELD INSTALLATION.
7. SEE DIRECT EXPANSION COOLING COIL AND HOT WATER HEATING COIL SCHEDULES FOR COILS TO BE PROVIDED WITH AHU.
8. PROVIDE WITH REFRIGERANT MODULATING HOT GAS REHEAT COIL WITH ENOUGH CAPACITY TO REHEAT THE SUPPLY AIR TO 75°F.
9. UNDER CO2 DEMAND CONTROLLED VENTILATION, THE BMCS SHALL CONTROL THE OUTSIDE AIRFLOW TO MODULATE BETWEEN THESE TWO AIRFLOWS.
10. PROVIDE COMBINATION TEMPERATURE, HUMIDITY, AND CO2 ROOM SENSOR WITH LCD DISPLAY AND PUSH-BUTTON OCCUPANCY OVERRIDE FOR FIELD INSTALLATION IN ROOM. SEE DRAWINGS FOR LOCATION.
11. SECTIONALIZE UNIT AS REQUIRED FOR INSTALLATION INTO MECHANICAL ROOM THROUGH THE EXISTING EXTERIOR DOORS. CONTRACTOR SHALL FIELD VERIFY ALL OBSTRUCTIONS ALONG THE INSTALLATION PATH.
12. SEE SPECIFICATION SECTION 237300 FOR ADDITIONAL INFO.

HOT WATER HEATING COIL SCHEDULE - ES P1

MARK	SERVES	LOCATION	AIRFLOW (CFM)	MIN ROWS	MAX FINS/IN	MAX FACE VELOCITY (FPM)	ENTERING AIR CONDITIONS DB (°F)	LEAVING AIR CONDITIONS DB (°F)	TOTAL CAPACITY (MBH)	MAX APD (IN. W.C.)	FLUID DATA: FLUID TYPE	EWT (°F)	LWT (°F)	GPM	MAX WPD (FT)	MANUFACTURER	REMARKS
HC-2	AHU-2	MECH/ELEC B223	7500	2	10	284	30.6	85.0	444.0	0.06	WATER	160	130	30.0	1.1	ADDISON	1

REMARKS:
1. HEATING COIL HC-2 PROVIDED WITH AHU-2.

ROOFTOP UNIT SCHEDULE (GAS HEAT) - HS P1

MARK	SERVES	CONFIG.	AIRFLOW DATA: TOTAL AIRFLOW (CFM)	MAXIMUM OUTSIDE AIRFLOW (CFM)	MINIMUM OUTSIDE AIRFLOW (CFM)	COOLING DATA: AMBIENT AIR TEMP (°F)	MIN EER (AHRI)	EAT (DB/WB) (°F)	TOTAL COOLING (MBH)	SENSIBLE COOLING (MBH)	NUMBER OF COMPRESSORS	REFRIGERANT	HEATING DATA (14): INPUT (MBH)	OUTPUT (MBH)	FAN DATA: EXTERNAL S.P. (IN. W.C.)	TOTAL S.P. (IN. W.C.)	SUPPLY FAN: RPM	SUPPLY FAN: BHP/ EACH	RELIEF FAN: RPM	RELIEF FAN: BHP/ EACH	DIMENSIONS (LxWxH) (IN)	OPERATING WEIGHT (LBS)	MANUFACTURER	MODEL	REMARKS
AHU-7	HS AUX GYM	(6)	9000	9000	5000/ 650 (12)	105	10.3	80.4/ 70.9	594.2	292.4	(6)	R-454B	600	486	2.00	3.07	2127	3.56	1570	2.69	240x107x108	8030	ADDISON	PRMK 660S7	1,2,3,4,5,7,9,10,11,12,13,15,16,17

REMARKS:
1. SEE MECHANICAL/ELECTRICAL COORDINATION SCHEDULE ON SHEET E101D HS P1 HS P1 FOR ELECTRICAL DATA.
2. PROVIDE WITH 2" THICK DOUBLE WALL R-13 INSULATED CABINET CONSTRUCTION.
3. PROVIDE WITH 36" TALL PLENUM CURB WITH 3" THICK R-12 BOARD LINER. VULKEM SEALS AT ALL SEAMS, AND A SEALED SHEET METAL BOTTOM FOR MOUNTING ON A CONCRETE PAD.
4. PROVIDE WITH UNIT MOUNTED 65 KAIC RATED DISCONNECT SWITCH, SINGLE POINT POWER CONNECTION, AND FACTORY WIRED 120V GFCI SERVICE RECEPTACLE WITH A 15 AMP CIRCUIT BREAKER DISCONNECT.
5. PROVIDE WITH 2" THICK MERV 8 PRE-FILTERS AND 4" THICK MERV 13 FINAL FILTERS.
6. PROVIDE WITH END SUPPLY AIR DISCHARGE AND BOTTOM RETURN AIR OPENING TO PLENUM CURB, SEE DRAWINGS.
7. PROVIDE WITH FACTORY CONTROLS FOR SINGLE ZONE VAV OPERATION WITH A BACNET CONNECTION FOR CONTROL VIA THE BMCS. PROVIDE WITH 10" COLOR TOUCH SCREEN CONTROL PANEL FOR FIELD INSTALLATION.
8. PROVIDE WITH TWO REFRIGERATION CIRCUITS. ONE CIRCUIT SHALL HAVE A LEAD VARIABLE SPEED SCROLL COMPRESSOR AND A STANDARD SCROLL COMPRESSOR AND THE SECOND CIRCUIT SHALL HAVE TWO STANDARD SCROLL COMPRESSORS FOR A TOTAL OF FOUR COMPRESSORS.
9. PROVIDE WITH REFRIGERANT MODULATING HOT GAS REHEAT COIL WITH ENOUGH CAPACITY TO REHEAT THE SUPPLY AIR TO 73°F.
10. PROVIDE WITH REFRIGERANT HOT GAS BYPASS CAPACITY CONTROL.
11. PROVIDE COTTONWOOD SEED FILTERS WITH MESH VINYL COATED POLYESTER WHICH IS UV, MOLD, MILDEW, AND FLAME RESISTANT AND MOUNT WITH QUICK RELEASE FASTENERS OVER THE CONDENSER COIL AIR INLET AND OVER THE OUTDOOR AIR INLET AS MANUFACTURED BY AIR SOLUTION COMPANY OR APPROVED EQUAL.
12. UNDER CO2 DEMAND CONTROLLED VENTILATION, CONTROL THE OUTSIDE AIRFLOW TO MODULATE BETWEEN THESE TWO AIRFLOWS.
13. PROVIDE THE SUPPLY FAN WITH TWO ECM PLENUM FANS AND THE RELIEF FAN WITH TWO ECM PLENUM FANS.
14. PROVIDE WITH MODULATING NATURAL GAS HEATING WITH STAINLESS STEEL HEAT EXCHANGER AND 10:1 TURNDOWN.
15. PROVIDE COMBINATION TEMPERATURE, HUMIDITY, AND CO2 ROOM SENSOR WITH LCD DISPLAY AND PUSH-BUTTON OCCUPANCY OVERRIDE FOR FIELD INSTALLATION IN ROOM. SEE DRAWINGS FOR LOCATION.
16. PROVIDE WITH FACTORY WIRED RETURN AIR SMOKE DETECTOR.
17. SEE SPECIFICATION SECTION 237416 FOR ADDITIONAL INFO.

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E-14562
STATE OF NEBRASKA
CA-2169 05/15/2026

ISSUE

MARK	DATE	DESCRIPTION
1	05/15/2026	ADDENDUM 2

SEWARD PUBLIC SCHOOL DISTRICT HVAC IMPROVEMENTS - PHASE 1

SEWARD PUBLIC SCHOOLS
410 SOUTH ST
SEWARD, NE 68434

JEO PROJECT NO.:	242372.01
DATE:	04.30.2026
QAQC:	PAB
DRAWN BY:	RRW
SHEET SIZE:	30" x 42"

MECHANICAL SCHEDULES

M401 P1

Autodesk Docs://Seward Public Schools 2026/20251720_MEPT_HS Improvements_v25.rvt

Sheet Size: ARCH E1 (30.0 x 42.00 INCHES)

MECHANICAL / ELECTRICAL COORDINATION SCHEDULE

ABBREVIATIONS:

A	AMPS	C	COMBINATION STARTER AND SAFETY SWITCH	S	SWITCH	N1	NEMA 1
ENCL	ENCLOSURE	CB	CIRCUIT BREAKER	SF	SWITCH AND FUSTAT	N3R	NEMA 3R
HP	HORSEPOWER	CP	CONTROL PANEL	SS	SAFETY SWITCH	N4X	NEMA 4X
KW	KILOWATTS	C+P	CORD AND PLUG	T	LINE VOLTAGE THERMOSTAT		
PH	PHASE	I	INTEGRAL WITH EQUIPMENT	VFC	VARIABLE FREQUENCY CONTROLLER	SCCR	SHORT CIRCUIT CURRENT RATING
V	VOLTAGE	NF	NON-FUSED				
W	WATTS	OS	OCCUPANCY SENSOR	EC	ELECTRICAL CONTRACTOR		
				MC	MECHANICAL CONTRACTOR		

EQUIPMENT			ELECTRICAL SYSTEM				DISCONNECT				LINE VOLTAGE CONTROLLER			AVAILABLE FAULT CURRENT (AMPS)	
MARK	DESCRIPTION	LOAD	V	PH	FEEDER OR BRANCH CIRCUIT	PANEL - CIRCUIT	FURNISHED BY/ INSTALLED BY	TYPE	RATING (AMPS)	ENCL	FURNISHED BY/ INSTALLED BY	TYPE	ENCL		REMARKS
AHU-	AIR HANDLING UNIT		480 V	3											
AHU-	AIR HANDLING UNIT		480 V	3											
AHU-7	GROUND MOUNTED ROOFTOP UNIT	126 A	480 V	3	3 #1/0, #6 GND - 1 1/2" C.	SWBD 'MSB' HIGH SCHOOL	MC/-	I	-	-	MC/MC	-	-	<65,000	
BMCS-1	BMCS CONTROL PANEL	200 W	120 V	1	2 #12, #12 GND - 1/2"C.	PANEL 'RM' HIGH SCHOOL	EC/EC	S	20	N1	-	-	-	-	

GENERAL NOTES

A. VERIFY/COORDINATE RATINGS FOR EQUIPMENT SUPPLIED BY THE SELECTED MANUFACTURER. WHERE RATINGS ARE OTHER THAN AS REQUIRED FOR SPECIFIED UNIT, DISCONNECTS, MOTOR STARTERS, OVERCURRENT DEVICES AND RELATED REVISIONS SHALL BE PROVIDED ACCORDINGLY. THE CONTRACTOR THAT FURNISHES EQUIPMENT WITH RATINGS OTHER THAN AS NOTED SHALL BE RESPONSIBLE FOR COORDINATION AND COSTS FOR REVISIONS TO ACCOMMODATE SELECTED EQUIPMENT.

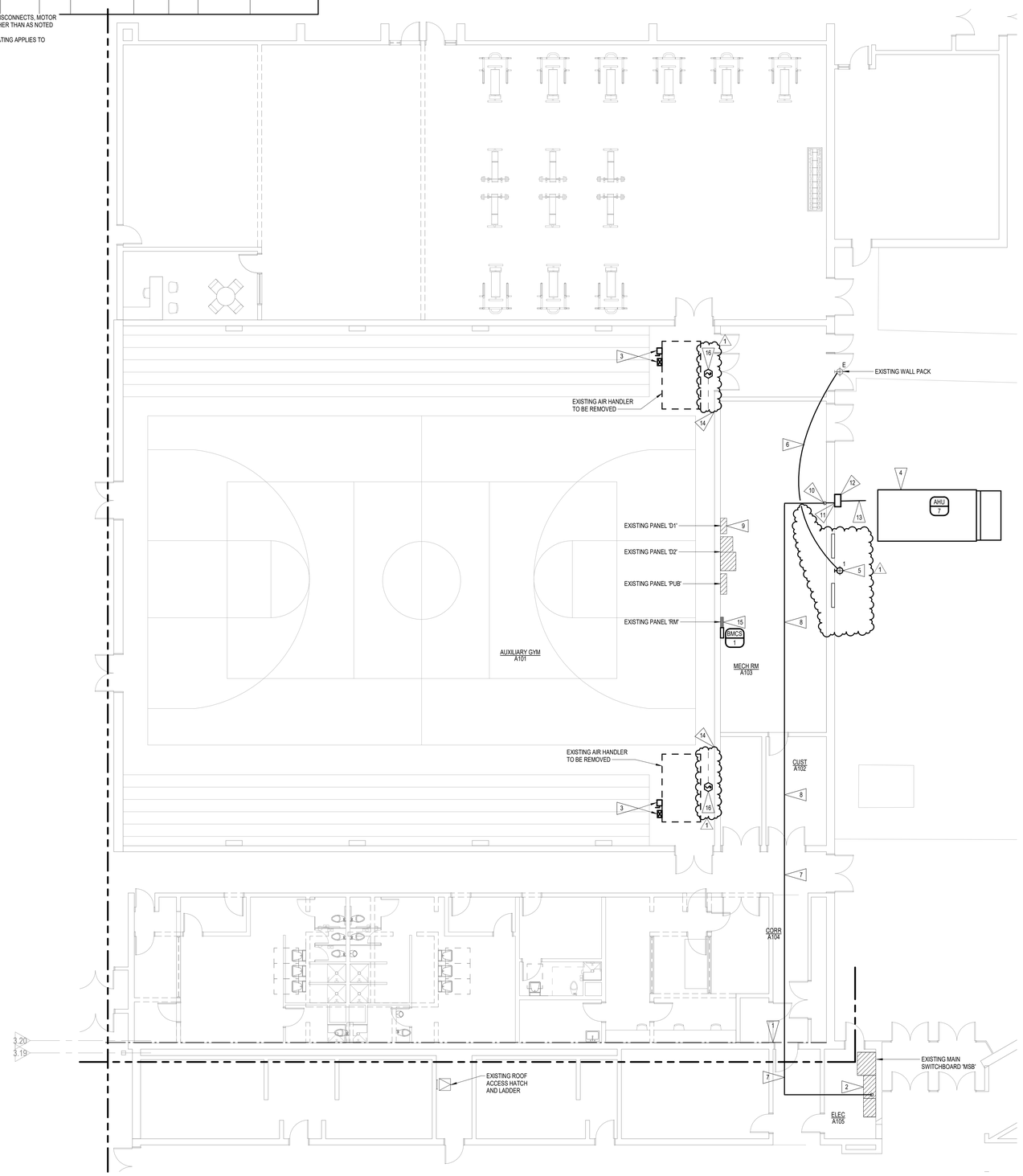
B. SHORT CIRCUIT CURRENT RATING (SCCR) OF EQUIPMENT SHALL BE EQUAL TO OR GREATER THAN THE AVAILABLE FAULT CURRENT LISTED. SHORT CIRCUIT CURRENT RATING APPLIES TO EQUIPMENT AND DISCONNECT.

C. FRACTIONAL HORSEPOWER SINGLE PHASE MOTORS SHALL BE PROVIDED WITH INTEGRAL OVERLOAD PROTECTION.

D. DISCONNECTS SHALL BE FUSIBLE UNLESS NOTED/OTHERWISE.

E. ELECTRICAL CONTRACTOR SHALL PROVIDE CIRCUIT TO EQUIPMENT AS INDICATED.

F. WHERE DISCONNECT IS NOT INDICATED ON PLANS, LOCATE AT EQUIPMENT PER NEC.

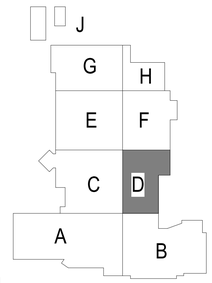


FLOOR PLAN - AREA D - ELECTRICAL
1/8" = 1'-0"
4' 8' 16' 24' 32' 40'

FLAG NOTES

1. THIS LINE REPRESENTS EXISTING BUILDING EXPANSION JOINT. PROVIDE EXPANSION / DEFLECTION FITTINGS WITH BONDING JUMPER FOR ALL CONDUITS CROSSING THIS AREA.
2. PROVIDE A NEW 150 AMP, 3 POLE, 65K AIC BRANCH CIRCUIT BREAKER IN EXISTING SPACE LOCATED IN THE UPPER RIGHT CORNER OF THE SECOND SECTION OF 'MSB'. PROVIDE NEW NAMEPLATE TO MATCH EXISTING NAMEPLATES WITH WORDING 'AHU-7'. EXISTING SWITCHBOARD IS CUTLER HAMMER, POW-R-LINE C, 4,000 AMP, 277/480 VOLT, 3 PHASE, 4 WIRE, 65K AIC.
3. DISCONNECT AND REMOVE STARTER AND SAFETY SWITCH. REMOVE FEEDER BACK TO PANEL 'D1'.
4. PROVIDE FIRE ALARM SYSTEM CONNECTION TO RETURN AIR SMOKE DETECTOR FURNISHED WITH AHU-7. PROVIDE COMPONENTS AS NECESSARY TO INTEGRATE SMOKE DETECTOR WITH EXISTING NOTIFIER SYSTEM.
5. PROVIDE NEW LIGHTING FIXTURE TYPE #1. LUMARK #LDWP-GL-4B-ED-704I-(CONFIRM VOLTAGE). WALL MOUNT AT SAME ELEVATION AS EXISTING WALL PACK TO THE NORTH. SEAL CONDUIT PENETRATION THROUGH WALL WATERTIGHT.
6. CONNECT NEW LIGHTING FIXTURE #1 TO SAME CIRCUIT AND CONTROLS AS THE EXISTING WALL PACK. ROUTE CONDUIT THROUGH THE WALL AND ROUTE THROUGH INTERIOR OF BUILDING.
7. ROUTE NEW CONDUIT AS HIGH AS POSSIBLE ABOVE EXISTING ACOUSTICAL TILE CEILING. PROVIDE OFFSETS, PULL BOXES, AND JUNCTION BOXES AS NECESSARY TO ROUTE CONDUIT AS HIGH AS POSSIBLE. COORDINATE ROUTING TO THE SATISFACTION OF SCHOOL MAINTENANCE STAFF PRIOR TO BEGINNING INSTALLATION. CAREFULLY REMOVE ACOUSTICAL TILES AND TEE GRIDS AS REQUIRED AND SAVE FOR REINSTALLATION. REINSTALL TILES AND GRIDS WHEN INSTALLATION IS COMPLETE.
8. ROUTE NEW CONDUIT AS HIGH AS POSSIBLE BELOW EXISTING PLASTER CEILING. PROVIDE OFFSETS, PULL BOXES, AND JUNCTION BOXES AS NECESSARY TO ROUTE CONDUIT AS HIGH AS POSSIBLE. COORDINATE ROUTING TO THE SATISFACTION OF SCHOOL MAINTENANCE STAFF PRIOR TO BEGINNING INSTALLATION.
9. DISCONNECT AND REMOVE CONDUCTORS FROM EXISTING 40A3P BRANCH CIRCUIT BREAKER LABELED 'GYM AHU'. PROVIDE NEW LABEL 'SPARE'.
10. DROP DOWN FROM CEILING ALONG WALL TO LB FITTING AND PENETRATE WALL.
11. PROVIDE LINK-SEAL CONDUIT SEAL AT WALL PENETRATION.
12. PROVIDE NEMA 3R PULL / JUNCTION BOX.
13. ROUTE BELOW GRADE TO AHU-7 UNIT MOUNTED CIRCUIT BREAKER.
14. PATCH AND PAINT HOLE THROUGH MASONRY WALL RESULTING FROM REMOVAL OF ELECTRICAL CONDUIT.
15. PROVIDE NEW 20A1P, BRANCH CIRCUIT BREAKER IN EXISTING POLE #39 SPACE TO SERVE NEW 'BMCS-1'. UPDATE CIRCUIT DIRECTORY WITH NEW LOAD. EXISTING PANEL IS 120/208 VOLTS, 3 PHASE, 4 WIRE + GROUND, SQUARE 'D', NQ SERIES. NEW BREAKER TO MATCH AIC OF PANELBOARD.
16. PROVIDE NEW SAMPLING TUBE DUCT SMOKE DETECTOR IN NEW SUPPLY AIR DUCTWORK SERVING GYMNASIUM. CONNECT TO EXISTING NOTIFIER FIRE ALARM SYSTEM.

KEY PLAN



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ORGANIZATION CERTIFICATION OF:
AUTHORIZATION NUMBER: CA-3929

PROFESSIONAL ENGINEER — SAMUEL J. HABERMAN — E-14224 — STATE OF NEBRASKA

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FLOOR PLAN - AREA D - ELECTRICAL

E101D HS P1

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