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# TRANSMITTAL COVER SHEET

DATE: SEPTEMBER 6, 2023

TO: ALL PLAN HOLDERS OF RECORD

FROM: HUNTER SWATEK, PROJECT MANAGER

PROJECT: ALABAMA COMMUNITY COLLEGE SYSTEM WORKFORCE SKILLS TRAINING CENTER
GMC PROJECT NO. ABHM210048

RE: ADDENDUM NO. 4 AND
ACKNOWLEDGEMENT OF RECEIPT OF ADDENDUM NO. 4

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## ACKNOWLEDGEMENT OF RECEIPT:

**PLEASE PRINT RECIPIENT'S NAME, FIRM, AND DATE RECEIVED.**

**THEN E-MAIL BACK TO alyssa.martin@gmcnetwork.com FOR OUR RECORDS AND TO ACKNOWLEDGE YOU'RE RECEIPT OF THIS ADDENDUM.**

_____
NAME *(PLEASE PRINT)*

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If there are any problems with this transmittal, please contact sender, at the number listed above.

**ADDENDUM NUMBER 04**

**September 6, 2023**

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**PROJECT:** **ALABAMA COMMUNITY COLLEGE SYSTEM WORKFORCE SKILLS TRAINING CENTER**
**GMC PROJECT NO. ABHM210048**

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**AD1-1 GENERAL:**

A. The following revisions and/or additions to the Drawings and Project Manual are hereby made a part of same, and shall be incorporated in the Work of the Contract the same as if originally included in the Bid and Construction Documents.

B. Bidders shall acknowledge receipt of this Addendum in writing, as provided on the Proposal Form.

C. When a revision and/or addition is called for to the Drawings or Project Manual, they shall be fully coordinated with and carried through all applicable Drawings and portions of the Project Manual, including in part, all related Civil, Landscaping, Architectural, Structural, Plumbing, Mechanical, Electrical, and other Documents.

**AD1-2 PROJECT MANUAL AND SPECIFICATIONS**

1. Specification Section 23 5000 Heating and Air Conditioning Equipment and Specialties – Reference section 2.5 Air Cooled Water Chiller Units, Paragraph E for a deletion
2. Specification Section 26 2200 Dry Type Transformers Specification – Reference revisions to Dry Type Transformers

**AD1-3 DRAWINGS:**

**AD1-4 MISCELLANEOUS:**

**AD1-5 ATTACHMENTS:**

A. Revised Specification Section 23 5000
B. Revised Specification Section 26 2200

**END OF ADDENDUM NUMBER 04**

*PREPARED BY*

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Goodwyn Mills Cawood, LLC.

**SECTION 23 5000**

**HEATING AND AIR CONDITIONING EQUIPMENT AND SPECIALTIES**

## PART 1 - GENERAL

### 1.1 SCOPE:

A. Section 23 0500 – “General Provisions – HVAC” shall apply to and become part of this Section.

## PART 2 - EQUIPMENT AND SPECIALTIES

### 2.1 HOT WATER CONDENSING BOILERS – NATURAL GAS

A. SUMMARY

1. This Section includes packaged, factory-fabricated and assembled, gas-fired, firetube duplex alloy stainless steel ultra-high efficiency condensing boilers, trim and accessories for generating hot water.

B. REFERENCES

1. ASME Section IV
2. CSD-1, Controls and Safety Devices
3. XL GAPS
4. NEC, National Electric Code
5. UL-795 7th Edition
6. AHRI, BTS-2000
7. ASHRAE 90.1

C. SUBMITTALS

1. Product Data: Include performance data, operating characteristics, technical product data, rated capacities of selected model, weights (shipping, installed and operating), installation and start-up instructions, and furnished accessory information.
2. Shop Drawings: For boiler, standard boiler trim and accessories.
    a. End Assembly Drawing: Detail overall dimensions, connection sizes, connection locations, and clearance requirements.

b. Wiring Diagrams: Detail electrical requirements for the boiler including ladder type wiring diagrams for power, interlock and control wiring. Clearly differentiate between portions of wiring that are factory installed and portions to be field installed.

3. Certificate of Product Rating: Submit AHRI Certificate indicating Thermal Efficiency, Combustion Efficiency, Materials of Construction, Input, and Gross Output conform to the design basis.

4. Thermal efficiency curves: Submit thermal efficiency curves between and including minimum and maximum rated capacities, for return water temperatures ranging from 80°F to 180°F.

5. Water side pressure drop curve.

6. Flue gas temperature curves: Submit flue gas temperature curves for minimum and maximum boiler capacity, for return water temperatures ranging from 80°F to 160°F.

a. If submitted flue gas temperatures, minimum or maximum inputs are different from that of the basis of design manufacturer and model, the manufacturer shall be responsible for draft calculations and reselection of the flue gas exhaust system.

7. Source quality-control test reports.

8. Field quality-control test reports: Start-up by a factory authorized service company.

9. Operation and Maintenance Data: Data to be included in Installation and Operation Manual.

10. Warranty: Standard warranty specified in this Section.

D. QUALITY ASSURANCE

1. Manufacturer Qualifications: Firms regularly engaged in the manufacture of condensing hydronic boilers with welded steel pressure vessels, whose products have been in satisfactory use in service for not less than twenty-five (25) years. The manufacturer must be privately owned and headquartered in North America. The specifying engineer, contractor and end customer must have the option to visit the factory during the manufacture of the boilers and be able to witness test fire and other relevant procedures.

2. Aftermarket Support and Service: The manufacturer shall have a factory authorized service training program, where boiler technicians can attend a training class and obtain certification to perform start-up, maintenance and basic troubleshooting specific to the product line.

3. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

4. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code, Section IV Boilers", for a maximum allowable working pressure of 160 PSIG.

5. CSD-1 Compliance: The boiler shall comply with ASME Controls and Safety Devices for Automatically Fired Boilers (CSD-1).

6. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to and Oil Fired Boilers - Minimum Efficiency Requirements."

7. UL Compliance: Boilers must be tested for compliance with UL 795, - Industrial Gas Heating Equipment." Boilers shall be listed and labeled by ETL.

8. AHRI Compliance: Boilers shall be tested and rated according to the BTS-2000 test standard and verified by AHRI.

9. NOx Emissions Compliance: Boiler shall be tested for compliance with SCAQMD and TCEQ.

10. The equipment shall be of the type, design, and size that the manufacturer currently offers for sale and appears in the manufacturer current catalog.

11. The equipment shall fit within the allocated space, leaving ample allowance for maintenance and inspection.

12. The equipment shall be new and fabricated from new materials. The equipment shall be free from defects in materials and workmanship.

13. All units of the same classification shall be identical to the extent necessary to ensure interchangeability of parts, assemblies, accessories, and spare parts wherever possible.

14. In order to provide unit responsibility for the specified capacities, efficiencies, and performance, the boiler manufacturer shall certify in writing that the equipment being submitted shall perform as specified.

E. COORDINATION

1. Mechanical contractor shall coordinate the size and location of concrete bases. Cast anchor-bolt inserts into bases.

F. WARRANTY

1. Standard Warranty: Manufacturer standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period provided the boiler is installed, controlled, operated and maintained in accordance with the Installation, Operation and Maintenance Manual.

   a. Warranty Period for the Pressure Vessel and Heat Exchanger: The boiler manufacturer shall warranty against failure due to:

      1) Flue gas condensate corrosion, and/or defective material or workmanship for a period of ten (10) years, non-prorated, from the date of shipment from the factory.

      2) Thermal shock for the lifetime of the boiler.

   b. Warranty Period for the Burner: The boiler manufacturer shall warranty the mesh burner head against defective material or workmanship for a period of five (5) years, non-prorated, from the date of shipment from the factory.

c. Warranty Period for all other components: The boiler manufacturer will repair or replace any part of the boiler that is found to be defective in workmanship or material for a period of two (2) years, non-prorated, from the date of shipment from the factory.

G. MANUFACTURERS

1. This specification is based on the Endura series boilers featuring PURE Control™ as manufactured by Fulton Heating Solutions, Inc. Equivalent units by LAARS or Lochinvar must meet all performance criteria, and are acceptable.

2. Basis-of-Design Product: Subject to compliance with requirements, provide Fulton Heating Solutions, Inc.

a. Endura model duplex stainless steel firetube condensing boiler.

1) Alternate boilers must equal or exceed all aspects of this specification in its entirety throughout. Boilers seeking an approval shall provide documentation that supports this requirement.

3. The boiler manufacturer shall have the capability to construct an engineered hydronic system, skid mounted, for the above referenced boilers incorporating single point electrical, supply water, return water, fresh water make up, fuel, and drain. The boiler manufacturer shall have the engineering capabilities for all aspects of the mechanical, electrical and control design aspects of the skid mounted system.

H. CONSTRUCTION

1. Description: Factory-fabricated, -assembled, and -pressure tested, duplex stainless steel firetube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including flue gas vent; combustion air intake connections, water supply, water return, condensate drain, and controls. The boiler, burner and controls shall be completely factory assembled as a self-contained unit. Each boiler shall be neatly finished, thoroughly tested, and properly packaged for shipping. Closed-loop water heating service only.

2. Heat Exchanger: The heat exchanger is defined as the surfaces of the pressure vessel where flue gases transfer sensible and latent heat to the hydronic fluid. The heat exchanger shall be a three-pass firetube design constructed using only duplex alloys of stainless steel.

a. The boiler shall be a firetube design, such that all combustion chamber components are within water-backed areas. Watertube boilers will not be accepted.

b. Furnace: First pass of the combustion chamber shall be constructed of duplex alloy stainless steel with a minimum wall thickness of 0.25”and a minimum bottom head thickness of 0.625”.

c. Firetubes: Second and third passes of the combustion chamber shall be constructed of duplex alloys of stainless steel having a minimum wall thickness of 0.109".

d. Furnace to tube connections shall be constructed with low weld intensity, a tube to tube minimum spacing of 2" center to center, minimum 5/8" tube to tube ligament, and shall not contain any overlapping welds.

e. Heat exchange capability shall be maximized within the heat exchanger via the use of corrugated firetube technology. The corrugation process shall not remove any material from the tubes. Aluminum heat transfer enhancements are dissimilar metals and are unacceptable.

f. Material: The heat exchanger shall have the following material characteristics and properties:

1) The metallic crystalline lattice microstructure shall contain approximately equal amounts of body center cubic (BCC) and face centered cubic (FCC) structures to offer high resistance to intergranular corrosion.

2) A minimum Pitting Resistance Equivalent Number (PREN) of 26.

3) A minimum Yield Strength of 65 ksi at 0.2% plastic strain.

4) A minimum Ultimate Tensile Strength of 94 ksi.

5) To minimize stresses caused by uneven expansion and contraction, the Coefficient of Thermal Expansion at 212°F shall not be less than 7.0 in/in °F $10^{-6}$ and shall not be greater than 7.5 in/in °F $10^{-6}$.

6) To increase resistance to pitting and crevice corrosion, the Chromium content
shall not be less than 21% by mass.

7) For high mechanical strength, the Nitrogen content shall not be less than 0.17% by mass.

8) Boilers with heat exchangers constructed of austenitic stainless steels, such as 316L or 304, and ferritic stainless steels, such as 439, are unacceptable.

9) Boilers with heat exchangers constructed of cast aluminum, mild steel, cast iron or copper finned tube materials are unacceptable.

3. Pressure Vessel: Design and construction shall be in accordance with Section IV of the ASME Code for heating boilers.

a. The shell shall be minimum**:** 0.3125"thick steel, SA-790 or SA-516 Grade 70.

b. The top head shall be a minimum 0.375"thick steel, SA-790 or SA-516 Grade 70.

c. The water side of the pressure vessel shall be a counter-flow design with internal water-baffling plates.

d. The boiler return and supply water connections shall be**:** 4”150# ANSI flanged. The water connections shall not be designed to support an external structural load from the piping system.

e. The water volume of the boiler shall not be less than EDR-1500: 104 Gallons and EDR-2000: 102 Gallons.

1) For boilers with a lower water volume, the boiler manufacturer shall provide a buffer tank and all associated buffer tank ancillaries to make equivalent to the total volume of the design basis.

f. The maximum water pressure drop across the boiler inlet and outlet connections, shall not exceed EDR-1500: 0.9 PSID at 150 GPM and EDR-2000: 1.6 PSID at 200 GPM.

4. Fuel/Air Mixture Combustion System: Air and gas pre-mix on the suction side of the fan.

a. A Flame-by-Wire™ or equivalent electronic combustion control system shall be provided to empower technicians to accurately dial-in positions electronically. The system shall feature O2 Compensation™ or equivalent to continuously tune the burner air-fuel ratio in real time, automatically adjusting for changes in seasonality to maximize combustion efficiency and condensate production for greater energy savings and reduced emissions. Pneumatic (regulation”, governor”) type systems offer far less precision and are not capable of independent air and gas control and are not accepted.

b. The air and gas tolerance shall be no greater than +/- 0.2° to allow for much more precise control of air-fuel ratio compared to linkages that may slip, or pneumatic gas valves which drift over time and have difficulty handling environmental and installation fluctuations.

1) Combustion air flow shall be controlled by fan speed and a servo-motor actuated butterfly valve. Fuel flow shall be controlled by a servo-motor actuated butterfly valve.

c. PURE Control™ algorithms with open-loop instrumentation shall be used for autonomous fuel/air ratio tuning without requiring manual input. O2 feedback or monitoring-only systems cannot adjust for operation variability and are not accepted.

5. Burner: Standard natural gas, forced draft.

a. Burner Head: Shall be a woven fiber premix design.

b. Excess Air: The burner shall operate at no greater than 8.0% excess $O^2$ over the entire turndown range. Due to significant reductions in combustion efficiency at high levels of excess $O^2$ boilers exceeding 8.0% excess $O^2$ at any operating condition shall not be accepted.

c. Emissions: When operating on natural gas, the boiler shall maintain a NOx level of <20 ppm, and $CO^2$ emissions less than 50 ppm, over the complete combustion range at a 3% $O^2$ correction.

6. Blower: Variable speed, non sparking, hardened aluminum impeller centrifugal fan to operate during each burner firing sequence and to pre-purge and post-purge the combustion chamber.

a. Motor: Brushless DC variable speed motor with hall effect sensor feedback; internal electronic commutation controller with built in speed control and protection features; long life, sealed, ball bearing with high temperature grease.

b. Variable speed blower: Closed loop PWM signal input with tachometer output.

7. Main Fuel Train:

a. The boiler shall have a pre-mix combustion system, capable of operating at a minimum 4”W.C. incoming natural gas pressure while simultaneously achieving emissions performance, full modulation, and full rated input capacity. Maximum natural gas pressure allowed to the inlet of the fuel train shall be no less than 28” W.C.

b. A factory mounted main fuel train shall be supplied. The fuel train shall be fully assembled complete with high and low gas pressure switches, wired, and installed on the boiler and shall comply with CSD-1 code. The fuel train components shall be enclosed within the boiler cabinet.

c. Standard CSD-1 fuel train shall comply with AXA XL.

8. Ignition: Direct spark ignition with transformer.

9. Boiler Enclosure:

a. Sealed Cabinet: Jacketed steel enclosure with left hinged full height front access door, fully removable latching access panels, gasketed seams to maintain sealed combustion, mounted on a steel skid with steel plate decking.

b. Control Enclosure: NEMA 250, Type 1.

c. Finish: Internally and externally primed and painted or powder coated.

d. Combustion Air: Drawn from the inside of the sealed cabinet, preheating the combustion air.

10. Rigging and Placement: The boiler shall come with lifting eyes and fork hole accessibility for rigging.

11. Exhaust Manifold: Shall be constructed of stainless steel, with an area for the collection and disposal of flue gas condensate.

12. Characteristics and Capacities:

    a. Heating Medium: Closed loop hot water with up to 30% ethylene glycol by volume. Standard capacities shall be based on 100% water.

    b. Design Water Pressure Rating: 160 psig.

    c. Safety Relief Valve Setting: 125 psig.

    d. Minimum Return Water Temperature: No minimum temperature required.

    e. Maximum Allowable Water Temperature: 210°F.

    f. Minimum Water Flow Rate: No minimum flow rate required to protect the heat exchanger.

    g. Maximum Water Flow Rate: No maximum flow rate requirement.

    h. Minimum Delta-T: No minimum delta-T required.

    i. Maximum Delta-T: 100°F

    j. Minimum Side Clearance: Shall not exceed 1” between any number of boilers.

    k. Maximum Allowable Operating Setpoint: 200°F

    l. Jacket Losses: External convection and radiation heat losses to the boiler room from the boiler shall comply with IAW ASHRAE 103-2007, and shall not exceed 0.2% of the rated boiler input at maximum capacity.

13. The boiler shall have its efficiency witnessed and certified by an independent third party, and the efficiency must be listed on the AHRI directory (www.ahridirectory.org) for natural gas operation. The test parameters for efficiency certification shall be the BTS- 2000 standard. The certified thermal efficiency for natural gas firing shall not be less than EDR-1500: 93.5% and EDR-2000: 93.7%.

14. A zero flow or low flow condition shall not cause any harm to the pressure vessel or heat exchanger of the boiler. Flow switches, dedicated circulator pumps, or primary-secondary arrangements shall not be required to protect the boiler from thermal shock. Boilers requiring the use of flow switches or primary-secondary piping arrangements are unacceptable.

15. The dimensions of the boiler shall not be more than (Height x Width x Depth): 80”x 34” x 61”.

16. The dry weight of the boiler shall not be less than EDR-1500: 2,260 lbs and EDR-2000: 2,360 lbs.

17. The equipment shall be in strict compliance with the requirements of this specification and shall be the manufacturer standard commercial product unless specified otherwise. Additional equipment features, details, accessories, etc. which are not specifically identified but which are a part of the manufacturer standard commercial product, shall be included in the equipment being furnished.

I. TRIM

1. Safety Relief Valve: ASME Rated.

2. Pressure and Temperature Gauge: Minimum 3-1/2" diameter, combination pressure and -temperature gauge. Gauges shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.

   a. Mounted in the field in the boiler supply water piping prior to the first isolation valve by the boiler installer.

3. Combustion Air Inlet Filter: 50 Micron.

4. Flue Gas Condensate Drain Trap: A flue gas condensate drain trap shall be provided to prevent positive pressure exhaust gases from entering the boiler room.

5. Flue Gas Condensate Neutralization: Provide and install manufacturer pH neutralization kit downstream of condensate drain trap.

J. CONTROLS

1. The boiler electrical controls shall include the following devices and features:

   a. 7"color touch screen control display factory mounted on the front cabinet panel door.

      1) The control display shall serve as a user interface for programming parameters, boiler control and monitoring; and shall feature a screen saver, alarm horn speaker, boiler status, configuration, history and diagnostics.

   b. Integral controls power supply.

   c. Flame safeguard control with 9 combustion fuel/air load profile points.

   d. All standard controls shall be factory mounted and wired according to UL requirements.

2. Burner Operating Controls: To maintain safe operating conditions, factory mounted and wired burner safety controls limit burner operation:

   a. High Limit: A manual reset mechanical Aquastat device shall stop the burner if operating conditions rise above maximum boiler design temperature.

   b. Low-Water Cut Off: Electronic probe type mounted in the pressure vessel shall prevent burner operation on low water alarm.

   c. Air Safety Switch: Prevent operation unless sufficient combustion air is proven.

d. Blocked Exhaust: Prevent operation in the event of a blocked flue gas exhaust stack.

3. O2 Compensation: To maximize efficiency throughout seasonality:

a. System shall use algorithms to automatically adjust the fuel/air ratio during operation, optimizing combustion reliability, flame stability, combustion efficiency, and the dewpoint temperature for formation of flue gas condensate.

b. O2 monitoring-only type systems that cannot automatically adjust combustion for seasonal variability shall not be accepted. Systems that trim but at less than a 100% duty cycle are unable to cope with rapid changes in operating conditions and shall not be accepted.

4. Boiler Operating Controls and Features:

a. Inlet Water Temperature Monitoring.

b. Combustion Air Temperature Monitoring.

c. Flue Gas Exhaust Temperature Monitoring: Sensor probe shall be stainless steel.

d. Proportional Integral Derivative (PID) temperature load control capability for hydronic and domestic hot water in standalone or lead/lag operation.

e. Operating temperature sensor for automatic start and stop.

1) The temperature sensor shall have tolerance according to IEC 60751

f. Time of day display.

g. Customizable boiler name display.

h. Two customizable boiler interlock terminals displayed.

i. Alarm history for a minimum 100 most recent alarms including status at time of lockout.

j. Administrative password protection options.

k. Indirect domestic hot water priority.

l. Outdoor air temperature (OAT) reset controls with warm weather shutdown:

1) OAT reset shall automatically adjust the setpoint according to changes in the
outdoor temperature, and disable the boilers above a warm weather shutdown temperature.

2) The boiler manufacturer shall provide an OAT sensor.

3) The temperature sensor shall be field installed in an outdoor area not exposed to direct sunlight or the exhaust of other mechanical equipment, and wired the boiler controller.

4) The control shall be field programmed with the outdoor reset schedule.

m. Variable Speed System (Secondary) Pump Control:

1) When installed in a variable primary flow configuration, the boiler controller shall provide the capability to control two variable speed hydronic heating pumps. One pump shall be duty, and one standby.

2) The duty system pump shall be enabled upon the outdoor air temperature dropping below the warm weather shutdown temperature. Pumps shall be automatically rotated.

3) Variable speed signal shall be provided to modulate pump speed according to hydronic heating loop Delta-T. A user selectable parameter allows for Delta-P in place of Delta-T.

n. Motorized isolation valve control:

1) Upon heat demand for the boiler, the control shall provide an enable/open signal.

2) After the burner is disabled and upon the heat exchanger delta-T dropping to a user programmable delta-T, the signal will be disabled.

a) Boilers which utilize only a time delay close as the only means of valve actuation are unable to optimize for residual heat, and will not be accepted.

3) In variable primary arrangements, the control shall hold the lead boiler isolation valve open at all times.

5. Building Automation System Interface: Hardware and software to enable building automation system (BAS) to monitor, control, and display boiler status and alarms.

a. Hardwired Contacts:

1) Monitoring: Boiler Status, Burner Demand, General Alarm.

2) Control with Factory Installed Jumper: Safety Interlock for External Device, Remote Enable, Emergency Stop (E-Stop).

3) Remote Setpoint Signal: 4-20 mA or 0-10 VDC.

b. Communication Protocol: A communication interface with BAS shall enable BAS operator to remotely enable and monitor the boiler plant from an operator workstation.

1) The boilers will communicate with each other and the Building Automation System via a daisy chain addressed Modbus network. Field wiring between nodes shall be twisted pair low voltage with shielded ground.

2) A BACnet MSTP and IP protocol communication gateway shall be provided. The BACnet gateway is field installed on a boiler. Additional boilers in the lead/lag system shall not require a dedicated BACnet gateway for the BAS to monitor status. A communication point mapping list shall be provided.

3) A LonWorks protocol communication gateway shall be provided. The LonWorks gateway is field installed on a boiler. Additional boilers in the lead/lag system shall not require a dedicated LonWorks gateway for the BAS to monitor status. A communication point mapping list shall be provided.

K. ELECTRICAL POWER

1. Single-Point Field Power Connection: Factory-installed and factory-wired switches, transformers, control and safety devices and other devices shall provide a single-point field power connection to the boiler.
2. Electrical Characteristics:

a. Voltage: 120 V.

b. Phase: Single.

c. Frequency: 60 Hz.

L. VENTING

1. The boiler shall be capable of operating with a stack effect not exceeding -0.04”W.C. and a combined air intake and exhaust venting pressure drop not exceeding +1.50”W.C.

2. Combustion Air Intake: Direct vent the boiler using sealed combustion by drawing combustion air in from the outdoors.

a. Sealed Combustion: Schedule 40 PVC pipe or smooth-walled galvanized steel, vent termination with 1/2”x 1/2”mesh bird screen.

3. Flue Gas Exhaust: The flue gas exhaust stack shall be AL 29-4C or 316L stainless steel, listed and labeled to UL-1738 / C-UL S636 for use with Category II/IV appliances, guaranteed appropriate for the application by the manufacturer and supplier of the venting.

4. Common Exhaust Vents: The draft system shall be designed for Category II and to prevent the backflow of exhaust gases through idle boilers.

5. Condensate drain piping must be galvanized, stainless steel, or Schedule 40 CPVC. Copper, carbon steel, or PVC pipe materials are not accepted.

M. SOURCE QUALITY CONTROL

1. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

2. Each boiler shall be installed and operated in a functioning hydronic system, inclusive of venting, as part of the manufacturing process. A factory test fire report corresponding to the boiler configuration shall be included with each boiler.

N. EXAMINATION

1. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.

   a. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

2. Examine mechanical spaces for suitable conditions where boilers will be installed.

3. Proceed with installation only after satisfactory conditions have been verified.

O. BOILER INSTALLATION

1. Install boilers level on concrete pad, minimum 4 inches high.

2. Install gas-fired boilers according to NFPA 54. Equipment and materials shall be installed in an approved manner and in accordance with the boiler manufacturer installation requirements.

3. Assemble and install boiler trim.

4. Install electrical devices furnished with the boiler but not specified to be factory mounted.

5. Install control wiring to field-mounted electrical devices.

P. CONNECTIONS

1. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

2. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

3. Connect gas piping to boiler gas train inlet with isolation valve and union. Piping shall be at least full size of gas train connection. Provide a reducer if required.

4. Connect hot water supply and return water connections with shutoff valve and union or flange at each connection.

5. Install piping from safety relief valves to the nearest floor drain.

6. Install piping from flue gas condensate drain connection to the condensate drain trap and to the nearest floor drain.

7. Boiler Venting:

   a. Install flue venting and combustion air-intake.

   b. Connect to boiler connections, flue size and type as recommended by the manufacturer.

8. Ground equipment according to Division 26 Section “Grounding and Bonding for Electrical Systems.”

9. Connect wiring according to Division 26 Section -Voltage Electrical Power Conductors and Cables.”

Q. FIELD QUALITY CONTROL

1. Perform tests and inspections and prepare test reports.

   a. After boiler installation is completed, the manufacturer shall provide the services of a field representative to inspect components, assemblies, and equipment installations, including connections and provide startup of the boiler and training to the operator.

   b. Arrange with National Board of Boiler and Pressure Vessel Inspectors for inspection of boilers and piping. Obtain certification for completed boiler units, deliver to Owner, and obtain receipt.

2. Tests and inspections:

   a. Perform installation and startup checks according to manufacturer written instructions.

   b. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.

   c. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.

      1) Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.

      2) Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3. Remove and replace malfunctioning units and retest as specified above.

4. Occupancy Adjustments: When requested within 12 months of startup, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to 2 visits to Project during other than normal occupancy hours for this purpose.

## 2.2 WATER TREATMENT EQUIPMENT: (SEE SECTION 23 1600 – "HVAC WATER TREATMENT")

A. Provide one shot chemical feeders, 5 gallon capacity, with the following (closed) systems:

1. Hot water.

2. Chilled water.

For each one-shot feeder provide inlet, outlet, fill, vent and drain valves together with fill funnel with hinged cover.

## 2.3 BOILER VENTS: (See "2.1 HOT WATER CONDENSING BOILERS – NATURAL GAS", Paragraph "L" VENTING.)

## 2.4 ELECTRIC PIPE LINE HEATERS:

A. Electric heaters equal to "Auto-Trace" or Chromolox "Self-Regulating Freeze Protection" heating cable, wattage as required to prevent freezing in 0°F ambient, equipped with conduit connectors and outdoor thermostat set at 32°F.

B. Extent:

1. All chilled water piping outdoors above grade.

C. Installation: Minimum installation requirements are based on 1-1/2" thick cellular glass insulation over electric pipe line heaters and self-regulating low temperature cable. Provide 1 or 2 straight runs of pipe line heaters as indicated at the heat output noted. Follow manufacturer's recommendations for installation.

| Nominal Pipe Size | Electric Heater Output (w/Ft.) | Number Of Straight Runs of Pipe Line Heater Per Pipe |
|---|---|---|
| 2" and under | 3.0 | 1 |
| 2-1/2" | 3.0 | 1 |
| 3" | 3.0 | 1 |
| 4" | 5.0 | 1 |
| 6" | 8.0 | 1 |

| | | |
|---|---|---|
| 8” | 8.0 | 1 |
| 10” | 8.0 | 1 |
| 12” | 8.0 | 1 |

**2.5 AIR COOLED WATER CHILLER UNITS:**

A. Include multiple microprocessor controlled scroll compressors, condenser and condenser fan and liquid cooler, all enclosed in a single casing. Provide a separate refrigerant circuit for each compressor. Chiller shall have power wiring arranged for a dual power feed to unit. Refrigerant: R-454B. Chillers shall be certified in accordance with the latest Standard AHRI 550/590. Chillers shall have a minimum NPLV of 15.7 EER.

B. Cabinet: heavy gauge aluminum or galvanized steel for outdoor installation. (Galvanized steel casings shall be finished with enamel over bonderizing.) Equip cabinets with access panels, condenser inlet guards and fan outlet guards. Provide padlock connections for power and control panels.

C. Compressors: hermetic scroll-type compressors, including the following:

1. Complaint design for axial and radial sealing.
2. Refrigerant flow through the compressor with 100% suction cooled motor.
3. Large suction side free volume and oil sump to provide liquid handling capability.
4. Compressor crankcase heaters to provide extra liquid migration protection.
5. Annular discharge check valve and reverse vent assembly to provide low-pressure drop, silent shutdown and reverse rotation protection.
6. Initial oil charge.
7. Oil level sightglass.
8. Vibration isolator mounts for compressors.
9. Brazed-type connections for fully hermetic refrigerant circuits.
10. Compressor motor overloads capable of monitoring compressor motor current.
11. Factory-mounted compressor acoustic sound blankets.

D. Condenser coils: all-aluminum microchannel coils.

~~E. Provide entire chiller (including condenser coil) with factory or field applied seacoast coating. Apply Luvata® Insitu, or equal: protective coating shall be a spray-applied, low VOC, synthetic, water-based coating embedded with 316 stainless steel to all surface areas, Coating shall be flexible when cured and have a dry film thickness of 1. 2. mills of thickness and resistant to cracking due to thermodynamic expansion and contraction.~~

~~Coating shall be compliant with EPA standards and registered with the SCAQMD as an environmentally sustainable single part water based coating, registered and permitted with local EPA air management agencies for use as a HVAC protective coating product.~~

~~Application company shall be fully permitted, licensed and can demonstrate an association with all major factory brands for a period longer that 5 years and show a history of workmanship compliance excellence with the manufacture of such equipment specified.~~

~~Coating applicator shall prove to be in business and financially solvent for a period exceeding the specified warranty of 5 years.~~

~~Coating shall have superior hardness characteristics per ASTM D3363-92A and a crosshatch adhesion of 4B-5B per ASTM B3359-93. Humidity and water immersion resistance shall be up to a minimum of 1000 hours (ASTM D2247).~~

~~Polymer coating will meet ASTM requirements in relation to microbial contamination as per G-21 and D-3273 testing protocol.~~

~~Corrosion durability shall be confirmed through testing of no less than 5,000 hours salt spray per ASTM B117-90.~~

~~Provide 5-year written and submitted conditional warranties.~~

~~Preferred Product – Luvata "Insitu" (or equal). Recommended Application Company – Luvata Electrofin Inc.~~

F. Condenser fans: dynamically and statically balanced, direct drive, corrosion resistant glass fiber reinforced composite blades molded into a low noise, full airfoil cross section, providing vertical air discharge and low sound. Each fan in its own compartment.

G. Vibration Isolation: Provide seismic deflection rated vibration isolators sized for operational weight of chillers.

H. Fan Motors: High efficiency, direct drive, rigid mounted, with double sealed, permanently lubricated, ball bearings.

I. Water chiller: shell and tube or shell and coil direct expansion chiller (with a separate refrigerant circuit for each compressor), shell baffles to provide capacity shown, drain connection, 1-1/2" thick evaporator foamed plastic insulation. Paint all foamed plastic insulation with two (2) coats of manufacturer approved weather resistant paint.

J. Interconnecting refrigerant piping: Type L hard copper, wrought copper sweat fittings silfossed, foamed plastic insulation.

K. Provide (liquid receiver if condenser coil will not contain entire system charge where 80% full at 100°F) suction and discharge service valves and liquid stop valve.

L. Controls: factory wired, located in a readily accessible rain and dust tight control cabinet with provision for padlocking.

1. Compressor motor controls: line voltage contactors and both temperature and current sensitive overload devices, cycle timer to limit compressor starts to 5 or 6 minute intervals, oil pressure switch, high and low pressure switches and crank case heater.

2. Chiller controls: solenoid liquid valve for each circuit, operating thermostat to cycle solenoids valves, and low limit chilled water thermostat.

3. Provide automatic reset upon power loss.

M. Pump:

1. Pump package includes: two pumps, expansion vessel, drainage valve, shut-off valve at entering and leaving connections.

2. The pump package is single point power integrated into the chiller unit power with a separate factory wired control panel and separate power for freeze protection.

3. The control of the pump is integrated into the chiller controller. The Symbio (TM) 800 unit control module displays evaporator pump starts and run-times. Freeze protection down to an ambient of -29˚C (-20˚F) is included as standard. The cold parts of the pump package will be insulated. Designed with one redundant pump, it is controlled to operate both pumps through a lead/lag and failure/recovery functionality.

4. A variable speed drive is installed in an additional panel to control the pump. The inverter is adjusted upon start up to balance the system flow and head requirements. The purpose is to save on wasted pump energy caused by a traditional balancing valve.

N. Chillers shall have a minimum 14,000 amps interrupting capacity (AIC) rating.

O. The chiller warranty shall include the entire chiller and shall be for 5 years from start-up date. During the warranty period the manufacturer shall furnish all **parts** and **labor** required for any warranty failure. The warranty shall include any expenses required for travel, lodging, meals, etc. for the technician performing the work or any freight costs for replacement parts.

P. The installation, pressure testing, evacuation, dehydration, charging and initial startup, final assembly and alignment of all refrigeration equipment shall be done under the supervision of the manufacturer's factory trained representative. Include services of a factory trained technician for instructing Owner's operating personnel in machine operation: One (1), Eight (8) hour day. Training shall be scheduled and coordinated with the Owner a minimum of two (2) weeks prior to date of training. Review of factory start-up reports along with operation and maintenance (O&M) manuals shall be included in Owner training.

Q. Provide a minimum of three (3) sets of hard copies and two (2) CD's with PDF files with manufacturer's operating and maintenance (O&M) manuals and parts lists for all equipment and materials furnished. Provide a maintenance schedule listing routine maintenance operations and suggested frequency thereof. Include all warranty dates on equipment and guarantees. Refer to O&M requirements.

R. Verification of Capacity and Efficiency: Chiller shall be run-tested at the manufacturer's plant or laboratory, to check performance (tons and KW), vibration, operating controls, safety cutouts and to confirm reliable operation with no oil loss. The manufacturer shall provide to the Owner a certified test report to confirm that the chiller performs as specified before final payment. Attach a sample test report with the proposal to insure conformance with AHRI 550/590. Each proposal must include a factory sample test report. The performance test shall be run in accordance with AHRI 550/590. The procedures and instrumentation listed below conforms to AHRI 550/590. The guidelines must be followed to insure the accuracy of this performance test.

S. The equipment will be accepted if the test procedures and results are in conformance with AHRI Standard 550/590. If the equipment fails to perform within allowable tolerances, the manufacturer will be allowed to make necessary revisions to his equipment and retest as required. In the event that these revisions do not achieve submitted performance the following penalties will be imposed. If such test revisions are required or the testing is delayed and the travel time is extended at the fault of the manufacturer, the manufacturer will be responsible for all incidental costs associated with such delays (hotel, meals, flight change fees, etc.)

1. Capacity Test: For each ton below AHRI 550/590 tolerance; five hundred dollars per ton will be assessed to the chiller manufacturer or deducted from the contract price.

2. Power Consumption Test: The power consumption penalty shall be based on the tolerances set forth in AHRI Standard 550/590. The power consumption penalty (P.C.P.) will be calculated based upon the following formula:

P.C.P. = [Measured KW - (scheduled KW)] x $1000/KW

T. Mount chiller on seismic vibration isolators on structural steel as shown. Coordinate exact location and mounting with Structural.

U. Provide differential pressure switch with chiller.

V. Provide full integrated BAS connectivity via BACnet® MS/TP. Coordinate requirements with Andover Controls vendor prior to order being placed. See controls sequences on drawings for capabilities. BAS shall have capability of load limiting chiller.

W. Provide 5 year non-prorated compressor parts and labor warranty as part of the chiller warranty.

X. Chillers shall be Trane Model CGAM ***or Carrier Model 30RC***.

## 2.6 VARIABLE FREQUENCY SPEED CONTROLLERS:

A. For each motor so scheduled provide a variable frequency, AC, solid state, induction motor speed controller. The speed controller shall be self-contained, with all components enclosed in a NEMA 1 cabinet and be capable of operation 1-40 degrees centigrade. The controller shall be capable in operating with ± 10% of system voltage and 60 Hz ± 3% frequency variation. It shall have 10-1 frequency range. The speed controller shall be wall or floor mounted.

B. The speed controller shall be automatically controlled by a pneumatic 3-15 psi signal, 10 volt dc, 4-20 milliamps, control signal. 20 milliamps shall correspond to maximum speed and 4 milliamps shall correspond minimum speed. The controller shall have capability to invert the input signal, if necessary due to process requirements. Coordinate control signal with controls contractor.

C. The VFD's shall limit harmonic distortion reflected onto the utility system to a voltage and current level as defined by IEEE 519 for general systems applications, by utilizing the standard 3% nominal impedance integral ac three-phase line reactor. An isolation transformer or external line reactor may be substituted as an option. Provide line reactor on the output of the drive to limit standing wave and to prevent damage to the VFD and motor. **All VFD's for motors 150 HP or more shall be Active Front End (AFE) utilizing insulated gate bipolar transistors (IGBTs) instead of diodes in the rectifier circuit. Active Front End (AFE) drives shall limit total harmonic distortion to 3%.**

D. Total harmonic distortion shall be calculated under worst case conditions in accordance with the procedure outlined in IEEE Standard 519-1992. Copies of these calculations shall be provided in the submittal. The contractor shall provide any needed information to the VFD supplier three (3) weeks prior to submittal date.

E. If the system cannot meet the IEEE 519-1992 harmonic levels with VFD's provided with the standard input line reactor or optional input isolation transformer, the VFD manufacturer shall supply a twelve pulse, multiple bridge rectifier ac to dc conversion section with a phase shifting transformer.

F. The speed controller shall be completely prewired at the factory and shall have one input power connection and one output power connection to the motor. If isolation transformer, line filters, or other equipment is required external to the speed controller cabinet, then all interconnecting wiring shall be provided at no extra cost to the Owner. See Electrical single line wiring diagram for input wire size and lug size required. Each motor connected to the VFSC in a fan array shall have a Manual Motor Protection (MMP) overload device. Note: VFSC to be supplied separate for each application.

G. Sound power developed by speed controllers shall not numerically exceed NC-75 sound pressure and by motors shall not exceed 4 dB(A) above specific motor across the line delivered sound pressure levels in 2nd through 8th octave bands.

H. VFD programmable parameters shall be adjustable from the keypad. The display shall be alphanumeric, programmable with status indicators. The display shall be in plain English words for parameters, status and diagnostic messages. Alphanumeric codes and/or tables are unacceptable.

I. Standard advanced programming and trouble-shooting functions shall be available by using a personal computer's RS-232 port or RS-485 port and Windows™ based software. In addition, the software shall permit control and monitoring via the VFD's RS-232 port or RS-485 port. VFD manufacturer may offer a BAS serial link and field bus adapter for standard protocols.

J. Provide two (2) programmable Form C contact outputs (one for motor running and one for fault trip) and one (1) programmable 24VDC open collector output (for drive ready).

K. Provide six (6) digital inputs for start/stop, local/remote, external interlock, two preset speeds and run enable.

L. The drive shall record and log faults. The VFD shall display all faults in plain English.

M. The variable frequency drive(s) and all components shall be designed, manufactured and tested and approved in accordance with the latest applicable ANSI, IEC, UL, CUL, CSA and NEMA standards. Each drive shall be rated to withstand a minimum of 65,000 amps fault current. (Verify available fault current with electrical.)

N. The supplier of the drive assembly shall be the manufacturer of the electromechanical power components used within the assembly, such as bypass contactors, circuit breaker, fused disconnect switch devices when specified.

O. The supplier of this equipment shall have produced similar electrical equipment for a minimum period of ten (10) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

P. The VFD's shall be of the Pulse Width Modulated (PWM) design converting the utility input voltage and frequency to a variable voltage and frequency output via a two-step operation. Adjustable Current Source VFD's are not acceptable. Insulated Gate Bipolar Transistors (IGBT's) shall be used in the inverter section. Bipolar Junction Transistors, GTO's or SCR's are not acceptable.

Q. The VFD's shall be capable of operating any NEMA Design B squirrel cage induction motor, regardless of manufacturer, with a horsepower and current rating within the capacity of the VFD. VFD carrier frequency shall be limited to 3-8 kHz for optimum motor performance.

R. The VFD's shall be able to start into a spinning motor. The VFD's shall be able to determine the motor speed in any direction and resume operation without tripping. If the motor is spinning in the reverse direction, the VFD's shall start into the motor in the reverse direction, bring the motor to a controlled stop, and then accelerate the motor to the preset speed.

S. The speed controller shall incorporate the following minimum features:

1. Door interlocked circuit breaker or disconnect switch with input fuses capable of being locking in off/open position.

2. All control inputs isolated from ground and power.

3. Hand-off-automatic selector (on face of panel).

4. Ground fault protection, over current, over voltage, under voltage, over temperature, loss of speed reference, and UL 5086 motor overload protection.

5. Pilot light indication for VFD and bypass modes (on face of panel).

6. Individual acceleration/deceleration adjustments.

7. Maximum and minimum speed adjustments.

8. 120V AC control power transformer for low voltage control that can easily interface with building safe interlock circuits.

9. Solid State microprocessor based logic for starting and stopping motors.

10. One analog output signal for output frequency.

11. Insensitivity to incoming phase rotation.

12. Auto reset with coast down timer with 0.05 second dropout (after power or thermal shutdown).

13. Output current limiters.

14. Motor stall protection.

15. Manufacturer's warranty of 2 years from date of start-up.

16. Output isolation contactor.

17. Bypass contactor mechanically and electrically interlocked with the output isolation contactor.

18. Overload relays for bypass contactor.

T. Provide factory check-out and start-up service.

U. Speed controllers shall be suitable for use with current shown on the Electrical drawings.

V. Speed controllers shall be ABB ACH-580, Danfoss, Reliance, Square D, Cutler-Hammer.

## 2.7 LINE MOUNTED PUMPS:

A. Line mounted pumps: 1750 rpm spring coupled pumps with iron bodies, bronze trim, stainless steel shafts, sleeve bearings, mechanical seals, resiliently mounted motors and gauge tappings in pump flanges, B&G, Patterson, Taco, ***or Armstrong***.

## 2.8 BASE MOUNTED PUMPS:

A. Base mounted pumps: enclosed impeller design, arranged to permit removing impeller without dismantling piping. Motors: 1800 rpm, drip proof, high efficiency (see Motors). Provide casings designed for pressure shown, but not less than 175 psig at suction. Provide motors sized to prevent overload at zero head horse power with impeller furnished.

B. Shafts: turned from heat treated carbon steel, key seat for the impeller, threaded for shaft nuts, finish turned over entire surface.

C. Shaft Sleeves: Equip portions of the shafts coming in contact with the water with removable bronze or stainless steel sleeves.

D. Impeller: bronze with machined finish on the outside and smooth surfaces inside, balanced to prevent vibration. Impeller diameters shall not exceed 85% of maximum diameter for volute.

E. Casing wearing rings: bronze, easily replaced, installed to prevent rotation.

F. Equip pumps with mechanical seals suitable for use with design water temperatures. Provide 1 spare shaft seal of each size used on job.

G. Bearings: ball grease lubricated type of ample size to insure cool running without the necessity of water cooling, effectively sealed against the entrance of water, dust or dirt and leakage of grease.

H. Couple motor to pump with flexible coupling equal to Dodge "Paraflex".

I. Mount motor and pump on common rigid steel or cast iron base and grout pump base per manufacturer's recommendations.

J. Pumps shall be Armstrong, Aurora, Bell & Gossett, Paco, Patterson or Taco.

K. Align pump and motor in accordance with manufacturer's instructions. Check alignment after first 8 hours operation.

## 2.9 STANDARD HORIZONTAL OR VERTICAL AIR HANDLING UNITS:

A. Horizontal or vertical air handling units: factory fabricated units having capacity shown, consisting in general of a mixing box section, a filter section, a preheat coil section, an access section, a cooling coil section, drip pan and drain sections, and supply and return fan sections, all the product of a single manufacturer. Provide all sections of the same frame size with support rails for all sections. Mount units on ribbed neoprene pads on concrete curbs as shown.

B. Casing: not lighter than 18 gauge galvanized steel, all sections of casing insulated with 2" thick 3 lb./cu.ft. coated fiberglass insulation. All sections shall be of double wall construction with perforated 26 gauge galvanized steel liner on air side of all sections except coil section, which shall be solid.

C. Drain pans: double construction with insulation between pans and 16 gauge type 304 stainless steel inner pan.

D. Coil sections shall be double wall solid construction with the coils scheduled. Coils shall comply with the requirements below for coils.

E. Provide spacer sections for installing control bulbs between pre-heat and cooling coils. At least 18" space must be provided between preheat and chilled water coils.

F. Provide pipe access plenums at each coil pipe connection.

G. Provide hinged and latched access doors in casings at fan sections, filter sections, plenum sections, upstream and downstream from cooling coils and elsewhere as shown and/or required for access to equipment and/or controls. Construct doors with 1-1/2" insulation between 2 sheets 24-gauge galvanized steel. Set doors in frames arranged so that doors will be flush with exterior of casing. Equip each door with at least 2 hinges and 2 sets of double acting latches. Latches shall be made from nonferrous metal, with a lever handle on the outside and a lever handle on the inside of the casing. Lever handle on the outside of the casing shall cam over a door pull with a stop. Doors shall be reinforced to prevent wracking and warping. Provide 3" butt hinges and weld to doors and to door frames. Provide galvanized steel nosings on casing insulation at doors. All pressurized access doors shall open into the fan section. Install gaskets at all section connections.

H. Automatic dampers shall comply with the requirements for automatic dampers below.

I. Air filters: see equipment schedule and "Air Filters". Provide side access filter sections, complying with the requirements under "Air Filters".

J. Provide vapor proof marine lights in all sections. Lights shall be factory wired with switches located next to access door. Wiring to be in compliance with NEC and Division 26.

K. Fans: Plug fan forward curved or backward curved blade centrifugal fans, complying with the requirements for "Centrifugal Fans, General" statically and dynamically balanced to a peak vibration velocity of 0.157 inch/second, with corrosion resistant coating. Bearings shall be minimum ***($L_{50}$ 200,000)*** hour self-aligning grease lubricated ball bearings. Grease fittings shall be extended to accessible locations after units are installed. Fan and fan motor shall be mounted on spring isolated base inside unit, and snubbing isolators shall be provided for discharge flexible connections. Isolators shall comply with the requirements for Vibration Isolators (Section Materials & Methods, HVAC). Fan motor shall be mounted on an adjustable base and shall be equipped with V-belt drive sized for 150% motor nameplate rating, adjustable pitch motor pulley for motors 25 H.P. and smaller. For plug fan section access doors provide time delay door switches, chains and screened wheel guards.

L. AC units shall be Trane, ***Carrier*** or approved equal.

## 2.10 SPLIT SYSTEM AIR CONDITIONERS - SMALL:

A. Split system air conditioners shall consist of a wall mounted indoor section, outdoor condensing unit, connecting refrigerant piping, and electronic controls. System shall be UL rated.

B. Indoor unit shall consist of centrifugal evaporator fan(s), evaporator coil, drain pan with condensate pump and safety switch, all enclosed in a plastic casing equipped with adjustable supply grille and return air grille. Provide 3 pole disconnect switch.

C. Outdoor unit shall consist of compressor, condenser coil, condenser fan, and controls, all enclosed in a metal grilled cabinet suitable for roof or pad mounting. Provide refrigerant piping kit, pre-insulated, properly sized for capacity shown. (See drawings to determine length.) Provide low ambient operation to 20°Fdb outdoors.

D. Controls shall consist of a wall mounted remote controller utilizing a microprocessor. Functions shall include:

1. Computerized dehumidification.
2. Operation mode setting.
3. Self-diagnostic display.
4. Room temperature display.
5. Twenty-four hour on-off timer.
6. Fan speed indicator.
7. Memory.
8. Low ambient operation.

E. Split system air conditioners shall be Trane-Mitsubishi, ***Carrier*** or approved equal.

## 2.11 COILS

A. Rated in accordance with ARI Standard 410-72 with capacities and dimensions shown.

B. Provide coils (other than sprayed coils) with aluminum fins and seamless copper tubes.

C. Sprayed coils shall have copper fins and seamless copper tubes. Solder coat fins and tubes.

D. Headers may be iron castings or steel or copper tubing. Braze return bends.

E. Space fins not closer than 10 per inch except that fin spacing may be decreased to maintain maximum coil depth of 8 rows (minimum 4 row coil for chilled water coils).

F. Circuit water coils to maintain pressure drops shown.

G. Prove coils tight with 200 psig under water air test.

H. Coil casings: 16 gauge stainless steel with flanges drilled for mounting.

I. Coils: Trane, ***Carrier*** or approved equal.

## 2.12 AIR FILTERS:

A. Type Filters: Replaceable. UL Standard 900 - Class II Type Filters. Replaceable filters. Maximum face velocity 300 fpm, maximum initial resistance 0.3" WG, minimum 30% ASHRAE 52-72 test efficiency. Minimum ratio of media area to face area 4.6:1. All components fire retardant and suitable for use in approximately 85% RH atmosphere. Turn system over to Owner with clean filters and furnish two (2) sets of spare filters for each unit. Farr 30/30.

B. Frames: minimum 18 gauge galvanized steel, riveted into banks and sealed air tight between adjacent frames and between frames and casing walls using United Duct Sealer.

C. For each filter bank provide one magnehelic gauge with static pressure tips, shut off and vent cocks, range 0 to 3" WG.

D. Side access housings for filters having efficiencies less than 80% shall have PVC air seals. Side access housings for filters having efficiencies of 80% or greater shall be equipped with camming mechanism to force filter gaskets into edge seal. All housings shall have hinged and latched access doors and slide-in racks for metal panel or throwaway prefilters. Housings: minimum 18 gauge galvanized steel reinforced with galvanized angles or formed shapes. Side access housings downstream from supply fans shall be constructed and gasketed to be air tight under 6" WGSP. Housings downstream from cooling coils shall be insulated with l/2" thick fire retardant foam plastic insulation.

E. Filters for exhaust systems: Replaceable filters in side access housings. Maximum face velocity 250 fpm. Maximum initial pressure drop 1" WG minimum DOP EFFICIENCY 99.97%. All components fire retardant. Side access housings shall be designed for outdoor use and shall be equipped with camming mechanism to force filter gaskets into edge seal. Housing shall be equipped with hinged and latched access doors. Housings shall be constructed of not lighter than 18 gauge galvanized steel reinforced with galvanized angles or formed shapes. Turn systems over to Owner with clean filters (and furnish complete sets spare filters of each size).

F. For each pre-filter bank, each after-filter bank, and each exhaust filter provide one magnehelic gauge with static pressure tips, shut off and vent cocks, range 0 to 3" WG.

**2.13 CENTRIFUGAL FANS, GENERAL:**

A. Fan ratings: certified in accordance with AMCA Standard 210. Provide Fans of class required for service based on static pressures 20% greater than those scheduled.

B. Provide forward curved blade, radial blade, backward curved blade or air foil blade fans as scheduled. All fans shall be statically and dynamically balanced with $L_{50}$ 200,000 hour rated self-aligning, grease lubricated ball or roller bearings rigidly supported by bearing stands.

C. For all fans furnish adjustable motor bases or rails.

D. Size V-belt drives for 50% overload, and provide adjustable pitch motor pulleys for drives of 15 BHP and smaller.

E. For all fans (outside casings) provide belt and drive guards.

F. Provide scroll access doors with quick-operating latches for all exhaust fans.

G. Equip all fans with flanged outlets and casing drains.

H. Sound power levels shall not exceed those shown.

I. Size fan motors to provide at least 5% drive loss, with motor service factors not exceeding 1.0. Provide high efficiency motors as specified under "Motors".

J. Provide weather hoods for motors, drive, and vibration isolators for fans located outdoors.

K. Where scheduled provide variable inlet vanes with rods extended for connection to control operators.

L. Where scheduled provide corrosion resistant coating consisting of 2 coats of chlorinated rubber base paint on all parts in airstream.

M. Where shown on electrical drawings provide 2 speed separate winding motors (1800/900 rpm).

N. Where shown on electrical drawings provide motors suitable for 2-step increment starting.

O. Vibration isolators: See Section Materials and Methods - HVAC.

P. Fans: Buffalo, Trane, Clarage or Acme.

**2.14 IN-LINE CENTRIFUGAL FANS:**

A. AMCA approved air and sound rated direct or belt driven fans as scheduled, complete with V-belt drives sized for 50% overload, self aligning grease lubricated ball bearings, adjustable pitch motor pulleys, adjustable motor bases and statically and dynamically balanced backward curved blade wheels, all enclosed in a galvanized steel housing with inlet bell and outlet duct collars. (Fan wheel and motor assembly shall be hinged for access.)

B. Fans shall be Greenheck type SQ, Carnes, Peerless, Acme, Penn or Loren Cook.

**2.15 CENTRIFUGAL ROOF EXHAUSTERS:**

A. Centrifugal power roof ventilators with AMCA certified air and sound ratings, belt or direct driven as shown. Provide permanently oiled bearings, statically and dynamically balanced backward curved blade wheels and spun aluminum housing with curb cap, disconnect switches, back-draft damper and outlet bird screen. For belt driven fans provide V-belt drive sized for 50% overload, adjustable pitch motor pulley and adjustable motor base. For each fan furnish an 18 gauge galvanized steel insulated prefabricated curb with integral cant. Furnish baffled sound absorbing curbs where required to obtain noise levels specified. Static pressures scheduled are external to sound curbs.

B. Fans shall be Greenheck, Acme, Carnes, Penn or Loren Cook.

**2.16 PROPELLER FANS:**

A. AMCA rated fans, belt or direct driven as scheduled. Equip belt driven fans with V-belt drives sized for 50% overload, adjustable pitch motor pulleys and adjustable motor bases.

B. Equip each fan with belt and wheel guards and a mounting panel not lighter than 16 gauge.

C. Provide gravity or motor operated shutters where indicated in equipment schedule. Equip motor operated shutters with spring return motors with oil-immersed gear trains.

D. Where indicated on plans provide fans equipped with panels reversed for supply operation.

E. Where shown provide penthouses constructed of not lighter than 18 gauge galvanized steel and 18 gauge galvanized steel prefabricated curbs. Equip penthouses with access doors and internal insulation not lighter than 1" x 3 lb/cu. ft.

F. Fans: Coolair, Greenheck, Acme, Stanley or Loren Cook.

**2.17 ELECTRIC WALL HEATERS:**

A. UL listed recessed convection heaters with finned sheathed heating elements, resiliently mounted direct driven propeller fan with motor heat shield, concealed thermostat, concealed on-off switch, high limit controls, and junction box for connecting power wiring.

B. Cabinets: 16 gauge steel, with pencil proof welded steel bargrilles (bars 1/16" x 3/8" minimum). Equip cabinet with adjustable recessing frame. Finish: Baked enamel, over bonderizing. Architect will choose color from manufacturer's standard selections.

C. Electric wall heaters: 2 KW and larger, Markel 3400 series, less than 2 KW, Markel Series 3120, Erincraft AWH or equal.

**2.18 UNIT HEATERS (ELECTRIC):**

A. UL listed electric unit heaters having capacity shown with resiliently mounted direct driven propeller fan with guard, finned-sheathed heating elements, and enameled steel enclosure not lighter than 20 gauge. Heater shall be equipped with automatic reset high limit controls, power contactors and control transformer for 24 volt control, factory wired to terminal strips.

B. For horizontal heaters provide adjustable horizontal louvers. For vertical heaters provide louver.

C. For each unit heater provide room thermostat to cycle contactor and fan.

D. Electric Unit Heater: Chromalox, Erincraft or Berko.

**2.19 EXPANSION JOINTS, ANCHORS AND GUIDES:**

A. Expansion joints: 150 psig WP controlled flexing bellows type packless joints with stainless steel bellows, compression traverses not less than those shown and extension traverses not less than 1/4". Joints 2" and smaller: screwed with union ends. Joints 2-1/2" and larger: flanged.

B. Alignment guides: prefabricated guides consisting of a steel spider clamped to pipe riding inside a steel cylinder with integral mounting feet. Install guides 4 and 18 pipe diameters upstream and downstream from each expansion joint.

**2.20 WATER SPECIALTIES:**

A. Install ASME rated pressure relief valves as noted, providing full size drain lines to within 1 ft. of floor. Relief valves: Watts, McDonnell & Miller, or equal.

B. Install 1/2" IPS x 75 psig WP float type automatic air vents in water lines as shown and/or required to prevent air binding. Run 3/8” OD line to outdoors or nearest floor drain or AC system drain line from each vent. Install a 1/2" ball valve ahead of each air vent. Vents shall be Armstrong, or equal.

C. Strainers: 125 psig WP, pot or angle type as shown. Strainers 2" and smaller: bronze or iron bodies with screwed connections; strainers 2-1/2" and larger: iron bodies and flanged connections. Screens: bronze, monel metal or stainless steel with perforations as follows:

| Strainer Size | Perforation Size |
|---|---|
| 3/4" to 2" inclusive | 1/32" |
| 2-1/2" to 6" inclusive | 1/16" |
| 8" to 12"inclusive | 1/8" |
| Over 12" | 1/4" |

The free area of each screen shall be not less than three times the area of the strainer inlet pipe. Equip each strainer with 1/2" valved drain, and unless the strainer design is devoid of air pockets, a 1/4" air vent cock.

D. Compression and expansion tanks: black steel (bladder) tanks ASME stamped for 125 psig WP. Provide tappings and specialties as shown. (Initial air charge: as required to provide 10 psig fill pressure at top of system.) Taco or American Wheatley.

E. Line mounted air separators: tangential separators with tappings shown, without strainers. Separators shall be Bell & Gossett, Taco or American Wheatley.

F. Install backflow preventers equal to Watts 900 in all (potable) city water connections to HVAC water systems.

G. Install air control fittings equal to Bell & Gosset "Airtrol", in all compression tanks and boilers as shown.

H. Install drain valve with hose connection and air venting provision on each compression tank.

I. Flow control valves: weighted check valves with provision for holding valve open, B&G.

J. Install combination flow control and stop valves equal to B&G "triple duty" valves where shown.

K. Install cast iron suction diffusers with integral strainers, flanged connections, flanged covers and gauge, vent, and drain tappings in pump suctions as shown. Main strainer screens: as specified for strainers, above. Remove start-up screens after system has been flushed.

L. Divertor fittings: B&G monoflo fittings, or equal.

M. Radiator valves: union end, 150 psig WP, brass, composition disc, composition mushroom handle, spring packed.

N. Pressure reducing valves for make up water connections 125 psig WP, iron, bronze trim, set point range as required to provide 10 psig fill pressure at top of system, B&G or equal.

O. Install gauge glass sets with valves, drain cock, and protector rods where shown. Do not install gauge glasses on closed compression tanks.

P. Balancing valves, 2” and smaller: Bronze body, ball type, 125 psig working pressure, 250°F maximum operating temperature, and having threaded ends. Valves shall have fixed orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain set positions.

Q. Calibrated balancing valves ("Circuit Setter"): 125 psig WP, 2" and smaller bronze, screwed; 2-1/2" and larger IBBM, flanged plug valves. All with indicator for angular position of valve, meter connections with positive shut-off valves and internal seals to prevent leakage around stem. For each valve provide a flow vs. differential pressure vs. angular position calibration chart and pre-formed foam insulation suitable for temperatures from 35 to 250F. Armstrong, B&G, Illinois, Taco or TMI Flow Design or equal.

R. Flow meters: 150 psig WP venturi flow meters, bronze, screwed in sizes 2" and smaller; steel, butt welded in sizes 2-1/2" and larger, 2% accuracy, maximum line pressure drop 1.0 ft. water. Provide quick connect gauge valves for each venturi meter. For entire job provide one portable cased differential pressure meter with shut-off and vent valves and 40 feet of 150 psig WP hose, together with a calibration curve for each meter. Armstrong, Presco.

**2.21 REFRIGERANT SPECIALTIES:**

A. Install moulded desiccant core filter dryer in each liquid line. Provide throwaway dryers for lines 1/2" and smaller. Provide replaceable core dryers for lines 5/8" and larger. Dryers shall be Sporlan "Catchall". For heat pump units filter dryer to be bi-directional flow.

B. Install moisture indicating sight glass in each liquid line. Install a refrigerant charging valve in each liquid line near each sight glass.

C. Service valves: wing cap valves, Henry.

D. Expansion valves: thermostatic valves with external equalizers, Sporlan.

E. Hot gas bypass valves: self contained valves sized to pass gas flow at last step of compressor unloading and shall discharge between expansion valve outlet and distributor. Sporlan.

**END OF SECTION**

**SECTION 26 22 00**

**DRY TYPE TRANSFORMERS**

## PART 1 - GENERAL

### 1.1 GENERAL

A. THE WORK UNDER THIS SECTION INCLUDES BUT IS NOT LIMITED TO THE FOLLOWING:
1. Dry Type Transformers

### 1.2 GENERAL REQUIREMENTS

A. Voltage for 3 phase units shall be 480V to 120/208V, three phase, four wire unless shown otherwise. Voltage of single phase units shall be 480V to 120/240V single phase, three wire unless shown otherwise.

## PART 2 - PRODUCTS

### 2.1 INSULATION

A. Transformers shall be ventilated with insulation to withstand a minimum of 150 degree Celsius temperature rise (Class 220 insulation) unless specifically shown otherwise on the drawings.

### 2.2 ENERGY EFFICIENCY

A. Transformers shall comply with the latest applicable DOE energy efficiency requirements and latest edition of NEMA standard TP-1 and shall be labeled for the EPA Energy Star Program.

### 2.3 SOUND RATING

A. Sound level design may not exceed the following:

| | KVA | DESIGN SOUND LEVEL |
|---|---|---|
| 2. | 0-45 | 40 db |
| 3. | 46-112.5 | 44 db |
| 4. | 113-150 | 47 dbp |
| 5. | 151-300 | ~~**49 db**~~ **52db** |
| 6. | 301-750 | 58 db |

B. Sound levels shall be determined in accordance with NEMA and ASA Standards. Core and coils shall be mounted on vibration isolator pads.

### 2.4 ENCLOSURES

A. Transformers mounted in dry, interior locations shall be furnished with NEMA 1 enclosures unless shown otherwise.

B. Transformers mounted outdoors or in wet locations shall be furnished with NEMA 3R enclosures with drip shields unless shown otherwise.

C. Transformers installed inside motor control centers or other similarly enclosed equipment may be “open” units not requiring additional enclosures.

## 2.5 CLEARANCE REQUIREMENTS

A. Transformer construction/efficiency/ventilation shall allow 3” (or less) clearance from rear and sides.

## 2.6 TAPS

A. All units shall be equipped with a minimum of two (2) 2 ½% taps above nominal (FCAN) and a minimum of four (4) 2 ½% taps below nominal (FCBN) as required to allow adjustment of the turns ratio of the transformer to account for site voltage adjustments.

## 2.7 MANUFACTURER

A. Transformers shall be Square 'D', G.E., Siemens or Cutler Hammer.

# PART 3 - EXECUTION

## 3.1 GENERAL

A. Minimum clearances shall be provided on all sides of transformers per manufacturer’s and code requirements.

B. Where site voltages so require, transformer taps shall be adjusted to maintain nominal voltage on secondary side of transformer. Adjustment of dry-type transformer taps shall not be made until all upstream voltage adjustments (such as voltage tap adjustments at service transformers) are finalized.

C. Refer to Specification Section 26 05 26 for transformer grounding requirements.

D. Refer to Specification Section 26 05 53 for transformer identification requirements.

## 3.2 MOUNTING

A. Transformers shall be mounted as indicated on plans. No units shall be wall mounted unless shown or directed otherwise.

B. Floor mounted transformers:
1. Shall be installed on a minimum of four (4) double-deflection neoprene vibration isolators (by Amber/Booth, Korfund Dynamics or Mason Industries - size as required – with seismic restraint capability ratings as required by the associated seismic zone).
2. Shall be installed on four inch thick concrete pads unless specifically shown otherwise. Pad shall have beveled edges.

C. Suspended transformers:
1. Shall be trapeze-mounted on unistrut frame supported by a minimum of four steel rods and shall be mounted as high as possible or at height directed (transformers shall not be mounted above lay-in ceilings or in areas with restricted ventilation). Shall be installed using a minimum of four (4) double-deflection neoprene vibration isolators (by

Amber/Booth, Korfund Dynamics or Mason Industries - size as required – with seismic restraint capability ratings as required by the associated seismic zone).

2. Contractor shall supply extra supports as may be required due to size and weight.
3. Additional seismic bracing shall be provided for suspended transformers in seismic zones as required to provide a fully code-compliant installation.

**END OF SECTION 26 22 00**