

SECTION 23 52 16.16 SAMPLE SPECIFICATION FOR ALUMINUM CONDENSING BOILERS
PATTERSON-KELLEY **MACH® BOILERS** w/ NURO® BOILER CONTROL

Part 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. ANSI Z21.13 / CSA 4.9 (Gas Fired Low Pressure Steam and Hot Water Boilers)
- B. ASME Section IV ("H" Stamp Heating Boilers)
- C. ASME CSD-1 (Controls and Safety Devices)
- D. NBIC - Part 1 (Installation)
- E. NFPA 54/ANSI Z221.3 (National Fuel Gas Code)
- F. NFPA 70 (National Electric Code)

1.02 SUMMARY

- A. This section includes gas-fired, high efficiency condensing hot water boilers with cast Aluminum heat exchangers.
- B. Related Sections include, but are not limited to, the following:
 - 1. Section 03 30 00 "Cast-in-Place Concrete"
 - 2. Section 23 01 00 "Operation and Maintenance of HVAC Systems"
 - 3. Section 23 05 16 "Expansion Fittings and Loops for HVAC Piping"
 - 4. Section 23 05 19 "Meters and Gages for HVAC Piping"
 - 5. Section 23 05 23 "General-Duty Valves for HVAC Piping"
 - 6. Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment"
 - 7. Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping..."
 - 8. Section 23 05 53 "Identification for HVAC Piping and Equipment"
 - 9. Section 23 07 19 "HVAC Piping Insulation"
 - 10. Section 23 09 13 "Instrumentation and Control Devices for HVAC"
 - 11. Section 23 11 23 "Facility Natural-Gas Piping"
 - 12. Section 23 11 26 "Facility Liquefied-Petroleum Gas Piping"
 - 13. Section 23 21 00 "Hydronic Piping and Pumps"
 - 14. Section 23 25 13 "Water Treatment for Closed-Loop Hydronic Systems"
 - 15. Section 23 37 00 "Air Outlets and Inlets"
 - 16. Section 23 51 00 "Breechings, Chimneys, and Stacks"
 - 17. Section 23 53 00 "Heating Boiler Feedwater Equipment"

1.03 SUBMITTALS

- A. The contractor shall submit, in a timely manner, all submittals for approval to the engineer. Under no circumstances shall the contractor install any materials until the engineer has made final approval on the submittals.
- B. Product data and/or drawings shall be submitted to the engineer for approval and shall consist of:
 - 1. General assembly drawing of the boiler including product description, model number, dimensions, clearances, weights, service sizes, etc.
 - 2. Schematic flow diagram of the boiler's gas valve train(s).
 - 3. Schematic wiring diagram of the boiler's control system that shows all components, interlocks, etc. and shall clearly identify factory wiring and field wiring.
- C. Full Function Factory Fire Test must be performed and documented on the boiler's fire test label. A Factory Authorized Start-up must be completed prior to final acceptance by the engineer.
- D. Operation and Maintenance Manuals shall be submitted prior to final acceptance by the engineer and shall contain shop drawings, product data, operating instructions, cleaning procedures, replacement parts list, maintenance and repair data, etc.

1.04 QUALITY ASSURANCE

- A. The equipment shall, at a minimum, be in strict compliance with the requirements of this specification, shall perform as specified and shall be the manufacturer's standard commercial product unless specified otherwise.
- B. Electrically operated components specified are to be "Listed" and/or "Labeled" as defined by NFPA 70, Article 100.
- C. Boiler shall bear an ASME "H" stamp in accordance with ASME Section IV.
- D. Boiler shall be CSA certified to the ANSI Z21.13 / CSA 4.9 standard for Gas Fired Low Pressure Steam and Hot Water Boilers and shall bear an authorized CSA rating label.
- E. Boiler shall be AHRI listed and certified in accordance with the Commercial Boiler program and the BTS-2000 testing standard.
- F. Boiler shall be SCAQMD certified (*relevant jurisdictions*).
- G. Boiler shall undergo a Full Function Factory Fire Test and bear a fire test label.
- H. Boiler shall be registered through the National Board from the factory.
- I. The manufacturer shall make available, upon request, all quality assurance documentation and results of Full Function Factory Fire Test based on the boiler's serial number.

1.05 COORDINATION

- A. Equipment shall be handled, stored and installed in accordance with the manufacturer's instructions.
- B. Factory Authorized Start-up must be completed after all appliance connections are completed, e.g. gas piping, hydronic piping, exhaust venting & electrical.

1.06 WARRANTY

- A. The boiler manufacturer shall warrant each boiler, including boiler, trim, boiler control system, and all related components, accessories, and appurtenances against defects in workmanship and material for a period of twelve (12) months from date of startup, provided that startup is completed within six (6) months of shipment and the start-up report is furnished to the manufacturer within thirty (30) days of startup.
- B. The boiler manufacturer shall warrant the boiler's fuel burner for a period of five (5) years from date of startup, provided that startup is completed within six (6) months of shipment and the start-up report is furnished to the manufacturer within thirty (30) days of startup.
- C. The boiler manufacturer shall warrant the boiler's heat exchanger for a period of ten (10) years from date of startup, provided that startup is completed within six (6) months of shipment and the start-up report is furnished to the manufacturer within thirty (30) days of startup.
- D. The boiler manufacturer shall also warrant the boiler's heat exchanger against failure due to thermal shock for a period of ten (10) years from date of startup, provided that startup is completed within six (6) months of shipment and the start-up report is furnished to the manufacturer within thirty (30) days of startup.

1.07 CERTIFICATION

- A. Manufacturer's Certification - The boiler manufacturer shall certify the following:
 - 1. The products and systems furnished are in strict compliance with the specifications.
 - 2. The boiler, burner and other associated mechanical and electrical equipment have all been properly coordinated and integrated to provide a complete and operable boiler.
 - 3. The boiler shall be in compliance with ANSI Z21.13 / CSA 4.9 (latest edition).
 - 4. The boiler shall be CSA certified for at least 92% efficiency based on operating conditions specified for testing under ANSI Z21.13 / CSA 4.9.
 - 5. The boiler shall be in compliance with ASME Section IV (latest edition).
 - 6. The boiler shall be in compliance with ASME CSD-1 (latest edition).

B. Contractor's Certification - The installing contractor shall certify the following:

1. The products and systems installed are in strict compliance with the specifications and all applicable local and/or state codes.
2. The specified field tests have been satisfactorily performed by a factory authorized startup agent.
3. The equipment furnished contains inter-changeable parts with the specified equipment so that all major equipment parts can be obtained from the specified manufacturer.

Part 2 - Product

2.01 MANUFACTURERS

- A. Furnish and install factory "packaged" low pressure hot water boiler(s) as manufactured by Patterson-Kelley or as approved and accepted by the Engineer as defined in the table below:

Model Number	Fuel Type	Vent Category	Max Input High Fire (BTU/Hr)	Min Input Low Fire (BTU/Hr)	Turndown Ratio	Max Output (BTU/Hr)	CSA Efficiency
CM300	NG or LP	II or IV	300,000	60,000	5:1	280,500	93.5%
CM399	NG or LP	II or IV	399,000	80,000	5:1	371,070	93%
CM500	NG or LP	II or IV	500,000	100,000	5:1	460,000	92%
C750T	NG	II or IV	750,000	75,000	10:1	712,500	95%
C750	LP	II or IV	750,000	150,000	5:1	712,500	95%
C750GG	Dual Fuel						
C900T	NG	II or IV	900,000	90,000	10:1	846,000	94%
C900	LP	II or IV	900,000	180,000	5:1	846,000	94%
C900GG	Dual Fuel						
C1050T	NG	II or IV	1,050,000	105,000	10:1	987,000	94%
C1050	LP	II or IV	1,050,000	210,000	5:1	987,000	94%
C1050GG	Dual Fuel						
C1500H	NG or LP	II or IV	1,500,000	300,000	5:1	1,440,000	96%
C1500HGG	Dual Fuel						
C1500T	NG	II or IV	1,500,000	150,000	10:1	1,440,000	96%
C2000H	NG or LP	II or IV	2,000,000	400,000	5:1	1,920,000	96%
C2000HGG	Dual Fuel						
C2000T	NG	II or IV	2,000,000	200,000	10:1	1,920,000	96%
C2500	NG or LP	II or IV	2,500,000	500,000	5:1	2,375,000	95%
C2500GG	Dual Fuel						
C3000	NG or LP	II or IV	3,000,000	600,000	5:1	2,850,000	95%
C3000GG	Dual Fuel						
C4000	NG or LP	II or IV	4,000,000	800,000	5:1	3,800,000	95%
C4000GG	Dual Fuel						

- B. Each factory “packaged” boiler shall be complete with all components and accessories necessary for a complete and operable boiler as hereinafter specified. Each boiler shall be furnished factory assembled with the required wiring and piping as a self-contained unit. Each boiler shall be readily transported and ready for installation.
- C. All “Approved Equal” or “Approved Alternate” boilers must demonstrate compliance with the requirements of this specification.

2.02 COMPONENTS

A. CABINET ENCLOSURE

- 1. Each boiler shall feature a fully assembled cabinet enclosure fabricated from Carbon Steel or Aluminum sheet metal (minimum 16 Gauge) with powder coat finish.
- 2. The boiler’s cabinet enclosure shall not exceed 32” in width and the completed boiler shall fit through a standard 32” wide doorway.
- 3. **(C1500H through C4000 Only)** The boiler’s cabinet enclosure shall feature two removable 6” rubber wheels which can be used to assist the initial maneuvering into the mechanical room.
- 4. The boiler’s cabinet enclosure shall feature removable access panels / doors with quarter-turn type latches that can be easily opened with a coin or flathead screwdriver.
- 5. The boiler’s cabinet enclosure shall eliminate the use of refractory or other insulating materials by baffling the combustion air around the heat exchanger and the outer surface temperature shall not exceed 20°F above ambient temperature.
- 6. The boiler’s cabinet enclosure shall prominently display all required safety, instruction, compliance and factory runout labels.

B. HEAT EXCHANGER

- 1. Each hot water boiler shall contain an ASME Section IV heat exchanger with an “H” stamp designed for a maximum allowable working temperature of 220°F and a maximum allowable working pressure of:
 - a. 80 PSIG **(MACH CM300 through C1050)**
 - b. 125 PSIG **(MACH C1500H through C4000)**
- 2. The boiler’s completed heat exchanger shall be cast from an Aluminum alloy (AC43000 / EN ALSi10Mg or approved equal) that is suitable to resist the corrosive gases produced from flue gas condensation. The casting shall be a counter-flow design to maximize heat transfer with multiple flow paths arranged in a reverse-return configuration to ensure balanced flow through each section. Boiler designs that incorporate a primary and secondary heat exchanger assembly are not acceptable.

- a. **(MACH CM300 through CM500 Only)** Each completed heat exchanger shall be of the “Mono-Block” type, consisting of a single, contiguous Aluminum casting. In addition, each completed heat exchanger shall include a molded PolyPropylene condensate pan/collector, condensate drain, removable burner assembly, inlet temperature sensor, outlet temperature sensor, flue gas temperature sensor, heat exchanger temperature sensor, automatic air vent, low water cutoff probe, thermowell for high temperature limit capillary, and all necessary assembly hardware.
 - b. **(MACH C1500H through C4000 Only)** Each completed heat exchanger shall consist of several Aluminum castings assembled together with hydronic water supply manifold, hydronic water return manifold, sealant, gaskets, o-rings, condensate pan/collector, condensate drain, removable fireside inspection covers, removable condensate pan access cover, inlet temperature sensor, outlet temperature sensor, flue gas temperature sensor, heat exchanger temperature sensor, low water cutoff probe, thermowell for high temperature limit capillary, and all necessary assembly hardware.
3. The boiler’s completed heat exchanger shall be of the water tube style and incorporate thousands of extended fireside surface area “pins” in order to maintain flue gas turbulence across the entire firing range and provide no less than the total fireside heating surface area defined in the table below:

CM300	CM399	CM500	C750	C900	C1050	C1500H	C2000H	C2500	C3000	C4000
41.8 ft ²	55.7 ft ²	55.7 ft ²	67.2 ft ²	80.6 ft ²	94 ft ²	136.6 ft ²	191.8 ft ²	225.4 ft ²	225.4 ft ²	251.4 ft ²

4. Each Aluminum casting shall incorporate waterside geometry designed to maintain water turbulence at the full published range of acceptable flow rates at various boiler conditions as described below:
 - a. The maximum allowable flow rate will generate a 20°F ΔT when the boiler is operating at full capacity.
 - b. The minimum allowable flow rate at full boiler capacity will generate a 40°F ΔT.
 - c. The minimum allowable flow rate at ignition will generate a 40°F ΔT.
 - d. The minimum allowable flow rate will generate a 20°F ΔT at low fire.
5. The boiler’s completed heat exchanger shall be capable of operating with a minimum outlet water temperature of 42°F.
6. Each heat exchanger must be hydrostatically tested by the manufacturer to a minimum of 1-1/2 times the maximum allowable working pressure for a minimum of 5 minutes. During this hydrostatic pressure test, the operator will inspect the pressure gauge and visually verify there are no water leaks.
7. Each completed heat exchanger shall be assembled and tested by the boiler manufacturer. Heat exchangers assembled by a 3rd party are not acceptable.

C. MAIN GAS TRAIN

1. Boilers configured for single fuel operation shall be equipped with an integral main gas valve train capable of burning either Natural Gas or Propane Gas.
2. Each single fuel gas valve train shall include at least the following:
 - a. One (1) upstream manual shutoff valve for field-connection.
 - b. One (1) combination Air-Gas ratio control and safety shutoff valve with dual solenoids (in-series) that can be independently energized for leak testing and integrated into a single body design. The combination gas valve shall operate as a "Zero Governor" and control to a neutral gas pressure inside the gas valve.
 - c. One (1) low gas pressure switch (manual reset).
 - d. One (1) high gas pressure switch (manual reset).
 - e. Two (2) gas pressure test ports.
 - f. One (1) downstream manual shutoff valve.
3. Boilers configured for dual fuel operation shall be equipped with two integral gas valve trains; the first capable of burning Natural Gas and the second capable of burning Propane Gas. Dual fuel boiler types shall feature a NG / LP toggle switch allowing the user to quickly change between the two fuel types. Operation of this switch shall not require the boiler to be powered off prior to changeover.
4. Each gas train shall be completely independent and include dedicated safety devices, shutoff valves, etc. Each gas train shall be individually identified by the manufacturer with labels and dedicated paint colors (Yellow = Natural Gas & Red = Propane Gas).
5. Each dual fuel gas valve train shall include at least the following:
 - a. One (1) upstream manual shutoff valve for field-connection to Natural Gas.
 - b. One (1) upstream manual shutoff valve for field-connection to Propane Gas.
 - c. One (1) Natural Gas combination Air-Gas ratio control and safety shutoff valve with dual solenoids (in-series) that can be independently energized for leak testing and integrated into a single body design. The combination gas valve shall operate as a "Zero Governor" and control to a neutral gas pressure inside the gas valve.
 - d. One (1) Propane Gas combination Air-Gas ratio control and safety shutoff valve with dual solenoids (in-series) that can be independently energized for leak testing and integrated into a single body design. The combination gas valve shall operate as a "Zero Governor" and control to a neutral gas pressure inside the gas valve.
 - e. One (1) low gas pressure switch (manual reset) for Natural Gas.

- f. One (1) low gas pressure switch (manual reset) for Propane Gas.
 - g. One (1) high gas pressure switch (manual reset) for Natural Gas.
 - h. One (1) high gas pressure switch (manual reset) for Propane Gas.
 - i. Two (2) gas pressure test ports for Natural Gas.
 - j. Two (2) gas pressure test ports for Propane Gas.
 - k. One (1) downstream manual shutoff valve for Natural Gas.
 - l. One (1) downstream manual shutoff valve for Propane Gas.
6. The main gas valve train(s) shall be factory assembled, piped, and wired and allow for operation at full rated boiler capacity from 4.0" W.C. up to the maximum inlet gas pressure of 14.0" W.C.
 7. If the supplied gas pressure exceeds 14" W.C., the contractor shall supply a suitable intermediate gas pressure regulator of the lock-up type to reduce the gas pressure to acceptable levels.

D. POWER BURNER

1. The boiler manufacturer must furnish an integral power type fuel burner with each boiler. The complete power fuel burner assembly must consist of a gas burner, combustion air blower, main gas valve train, and ignition system. The burner manufacturer must fully coordinate the burner design with the boiler's heat exchanger and the boiler control system in order to provide the required capacities, efficiencies, and performance specified. Boilers shipped without a power burner and field-equipped with a 3rd party power burner are not acceptable.
2. Each burner must be installed horizontally inside the combustion chamber with combustion gases flowing downward through the heat exchanger. The burner must consist of a stainless steel flange and woven fiber mesh cylindrical design.
3. The burner must incorporate fuel/air ratio control system to preserve exhaust oxygen levels as per boiler schedule, maintaining consistent flue dew point.
4. The system must be linkage-less without the use of electronic control loops and electronic oxygen sensors requiring calibration and renewal.
5. Low NOx burner must be certified by SCAQMD for NOx levels listed on schedule when O2 is corrected to 3%. No additional setup or adjustment, such as increasing excess air, will be necessary to achieve level listed
6. Each boiler must be equipped with direct spark ignition. Main flame must be monitored and controlled by a flame rod / ionization probe (rectification) system.

E. BOILER SAFETY and TRIM DEVICES

1. The boiler manufacturer shall furnish and test the following safety and trim devices with each boiler:
 - a. Safety relief valve shall be provided in compliance with the ASME code. Contractor is required to pipe the relief valve discharge piping to an acceptable drain.

- b. Water pressure/temperature gauge.
 - c. Low Water / Flow cutoff.
 - d. Manual reset high limit water temperature controller.
 - e. Operating temperature control to control the sequential operation of the burner.
 - f. High and Low Gas Pressure switches.
 - g. Flame rod / ionization probe (rectification) system.
2. The boiler manufacturer shall provide a CSD-1 form identifying each safety and trim device.
 3. The boiler shall be capable of interfacing with the following external safety devices:
 - a. Auxiliary Low Water Cutoff device.
 - b. Combustion Air Damper End Limit Switch.
 - c. Emergency Stop (E-Stop) switch.
 - d. External Safety Device w/ contact closure.

F. BOILER CONTROL SYSTEM

1. Each boiler shall be provided with all necessary controls, all necessary programming sequences, and all safety interlocks. Each boiler control system shall be properly interlocked with all safeties.
2. Each boiler shall be provided with a "Full Modulating" firing control system whereby the firing rate is infinitely proportional at any firing rate between low fire and high fire as determined by the pulse width modulation input control signal. Both fuel input and air input must be sequenced in unison to the appropriate firing rate without the use of mechanical linkage.
3. The boiler's control system shall provide the minimum capabilities:
 - a. 7" color touchscreen display with one or more USB ports.
 - b. Standard on-board Ethernet port for wired internet connectivity and embedded wireless driver for optional wireless internet connectivity to remote monitoring and software update services.
 - c. Parameter uploads and downloads via external USB flash drive.
 - d. Software updates via external USB flash drive.
 - e. Capture screen shots from the control's display by saving digital image files to external USB flash drive.
 - f. Local Representative Screen can be programmed to provide contact information for the local boiler manufacturer's representative.
 - g. Programmable Relay Outputs for direct control of pumps, control valves, dampers and other auxiliary devices.

- h. Multiple boiler “cascade” network up to 24 boilers without any external control panel. The installation of external sequencing control panels is not acceptable.
- i. Automatic hybrid system control for multiple boiler “cascade” systems with both condensing and non-condensing boilers. This control logic prioritizes condensing boilers at low water temperatures and prioritizes non-condensing boilers at high water temperatures.
- j. Auxiliary Boiler Relay for multiple boiler “cascade” systems which can be used to enable a 3rd party boiler platform in the event the “cascade” system is unable to satisfy the heating load.
- k. Programmable Boiler and System pump control for multiple boiler “cascade” systems installed in a Primary-Secondary piping arrangement.
- l. Programmable Control Valve logic for multiple boiler “cascade” systems installed in a Primary-Only piping arrangement.
- m. Integration with external Building Management Systems (BMS) via MODBUS® RTU protocol. **NOTE:** Optional Protocol Converter for communication via LONWORKS® and BACnet® must be available for purchase from the boiler manufacturer.
- n. Hardwire integration with Building Management Systems (BMS) via 4-20mA analog control signal for temperature or firing rate control.
- o. Intuitive “Setup Wizards” ask the user a series of questions and allow for step-by-step configuration of the boiler control.
- p. On-Screen error notifications with a comprehensive description of all alarm conditions and several troubleshooting steps.
- q. Automatic flue gas temperature and outlet (supply) temperature compensation to prevent over-firing of the boiler equipment.
- r. Automatic differential temperature compensation to prevent over-firing of the boiler equipment in a low flow condition.
- s. Automatically adjust the temperature set point and shutdown the boiler based on the outdoor air temperature conditions.
- t. Night Setback functionality via external point of closure (or BMS integration) for unique “Occupied” and “Unoccupied” temperature setpoint values.
- u. Maintain single temperature set point with a minimum outlet (supply) water temperature of 42°F up to a maximum outlet (supply) water temperature of 194°F.
- v. On-Board DHW Priority capable of seamless transition between Comfort Heat (CH) and Domestic Hot Water (DHW) operation.
- w. On-Board CH&DHW operation for simultaneous Comfort Heat (CH) and Domestic Hot Water (DHW) operation.
- x. Alarm Relay Output to announce alarm conditions which require manual reset.

- y. Programmable Low Fire Delay to prevent excessive short-cycling of the boiler equipment.
 - z. Local Manual Operation.
2. The boiler control system shall be capable of interfacing with the following external control devices:
- a. Building Management System (MODBUS®). **NOTE:** Optional Protocol Converter for communication via LONWORKS® and BACnet® must be available for purchase from the boiler manufacturer.
 - b. Domestic Hot Water Break-on-Rise Aquastat (Normally Closed).
 - c. Domestic Hot Water Tank Temperature Sensor (12kΩ).
 - d. External Header Temperature Sensor (12kΩ).
 - e. Outdoor Air Temperature Sensor (12kΩ).

Part 3 – Execution

3.01 INSTALLATION

- A. Installation shall be performed by the contractor in accordance with the requirements of the applicable codes. Contractor shall review the boiler and installation for compliance with requirements and/or issues that may affect boiler performance. Installation should not proceed until unsatisfactory conditions have been corrected.
- B. The contractor shall mount the equipment as described below:
 - 1. Install boilers on cast-in-place concrete equipment base in compliance with the requirements for equipment bases and foundation specified in Section 03 30 00 "Cast-in-Place Concrete."
 - 2. If required by the local code, install vibration isolation devices in compliance with Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment."
- C. The contractor shall install gas-fired boilers in accordance with NFPA 54/ANSI Z223.1 (United States), or CAN/CSA B/149.1 (Canada).
- D. The contractor shall install gas-fired boilers in accordance with NBIC – Part 1 (Installation), or another installation code having local jurisdiction.
- E. The contractor shall assemble and install any external boiler safety/trim devices.
- F. The contractor shall install any electrical devices furnished with the boiler, but not specified to be factory-mounted.
- G. The contractor shall install control wiring to field mounted electrical devices in accordance with the requirements of NFPA 70.
- H. The contractor shall install electrical (power) wiring to the boiler in accordance with the requirements of NFPA 70.

3.02 CONNECTIONS

A. GAS PIPING

- 1. Each boiler shall be provided with all necessary gas connections. Refer to the boiler's specification sheet or manual for connection sizes.
- 2. Install gas piping in accordance with NFPA 54/ANSI Z223.1 (United States), or CAN/CSA B/149.1 (Canada).
- 3. For boilers configured for Natural Gas or Dual Fuel, refer to the requirements of Section 23 11 23 "Facility Natural-Gas Piping".
- 4. For boilers configured for Propane Gas or Dual Fuel, refer to the requirements of Section 23 11 26 "Facility Liquefied-Petroleum Gas Piping".

B. HYDRONIC PIPING

1. Each boiler shall be provided with all necessary inlet (supply) and outlet (return) connections. Refer to the boiler's specification sheet or manual for connection sizes.
2. Check manufacturer's installation manual for clearance dimensions and install piping that will allow for service and ease of maintenance.
3. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection and adhere to proper codes for neutralization.
4. The hydronic piping and related components shall comply with the requirements of 23 21 00 "Hydronic Piping and Pumps".
5. All meters and gages in the hydronic piping shall comply with the requirements of Section 23 05 19 "Meters and Gages for HVAC Piping".
6. All instrumentation and controls in the hydronic piping shall comply with the requirements of Section 23 09 13 "Instrumentation and Control Devices for HVAC".
7. All valves in the hydronic piping shall comply with the requirements of Section 23 05 23 "General-Duty Valves for HVAC Piping".
8. All expansion fittings shall comply with the requirements of Section 23 05 16 "Expansion Fittings and Loops for HVAC Piping".
9. Any pipe hangers or supports shall comply with the requirements of Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment".
10. Any vibration isolation devices on the hydronic piping shall comply with the requirements of Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment."
11. The feedwater piping shall comply with the requirements of Section 23 53 00 "Heating Boiler Feedwater Equipment".
12. The hydronic piping shall be insulated in accordance with the requirements of Section 23 07 19 "HVAC Piping Insulation".
13. After insulation, all hydronic piping shall be identified in accordance with the requirements of Section 23 05 53 "Identification for HVAC Piping and Equipment".
14. Any water treatment of the hydronic system shall be in accordance with the boiler manufacturer's requirements and/or Section 23 25 13 "Water Treatment for Closed-Loop Hydronic Systems".

C. EXHAUST VENTING

1. The boilers shall be dual certified as Category II or IV appliances and are capable of operating with slightly negative to slightly positive exhaust vent pressure, and the vent gas temperature is likely to cause condensate production in the vent.
2. Install the exhaust/flue venting system in accordance with NFPA 54/ANSI Z223.1 (United States), or CAN/CSA B/149.1 (Canada) and per the manufacturer's recommendations in the installation manual.
3. All exhaust venting components shall comply with the requirements of Section 23 51 00 "Breechings, Chimneys and Stacks."

D. AIR INLET

1. The boilers shall be certified for Direct Vent / Sealed Combustion installations where the combustion air is supplied directly to the boiler through ductwork.
2. Install the air inlet system in accordance with NFPA 54/ANSI Z223.1 (United States), or CAN/CSA B/149.1 (Canada) and per the manufacturer's recommendations in the installation manual.
3. All air inlet components shall comply with the requirements of Section 23 37 00 "Air Outlets and Inlets".

E. ELECTRICAL

1. Install an external disconnect and overload protection for each boiler in accordance with the requirements of NFPA 70.
2. The voltage requirements for each boiler model is described below:
 - a. **(MACH CM300 through C2500 Only)** The boilers shall be configured for 110-120VAC, Single Phase (w/ Neutral), 60 Hz.
 - b. **(MACH C3000 & C4000 Only)** The boilers shall be configured for either 208-240VAC, Three Phase, 60 Hz **—or—** 440-480VAC, Three Phase, 60 Hz.
3. The amperage requirements for each boiler is described in the table below:

	CM300	CM399	CM500	C750	C900	C1050	C1500H	C2000H	C2500	C3000	C4000
Internal Overload Protection	5 Amps	5 Amps	5 Amps	6 Amps	6 Amps	6 Amps	15 Amps	15 Amps	15 Amps	20 Amp	20 Amps
Recommended Circuit Capacity	10 Amps	10 Amps	10 Amps	10 Amps	10 Amps	10 Amps	20 Amps	20 Amps	20 Amps	20 Amps	20 Amps