

SECTION 23 52 33.19 SAMPLE SPECIFICATION FOR COPPER WATER-TUBE BOILERS
PATTERSON-KELLEY **MODU-FIRE FORCED DRAFT NON-CONDENSING BOILERS W/
NURO® 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, non-condensing hot water finned copper tube boilers.
- 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 heat exchanger and 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.

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 85% efficiency based on operating conditions specified for testing under ANSI Z21.13 / CSA 4.9.
 - 5. The boiler shall be AHRI certified for at least 85% efficiency based on operating conditions specified for testing under BTS-2000.
 - 6. The boiler shall be in compliance with ASME Section IV (latest edition).
 - 7. The boiler shall be in compliance with ASME CSD-1 (latest edition).
 - 8. The boiler's H-3 form shall be registered with the National Board.
- 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	Vent Category	Max Input High Fire (BTU/Hr)	Min Input Low Fire (BTU/Hr)	Turndown Ratio	Max Output (BTU/Hr)	Efficiency
N750-MFD	II or IV	750,000	150,000	5:1	637,500	85%
N1000-MFD	II or IV	1,000,000	166,000	6:1	850,000	85%
N1500-MFD	II or IV	1,500,000	250,000	6:1	1,275,000	85%
N2000-MFD	II or IV	2,000,000	335,000	6:1	1,700,000	85%
N2500-MFD	II or IV	2,500,000	500,000	5:1	2,200,000	88%
N3000-MFD	II or IV	3,000,000	500,000	6:1	2,640,000	88%

- 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. HEAT EXCHANGER

1. Each water-tube boiler shall contain an ASME Section IV heat exchanger with an "H" stamp designed for a maximum allowable working pressure of 160 PSIG and a maximum allowable temperature of 250°F.
2. The boiler's completed heat exchanger shall provide no less than the total fireside heating surface area defined in the table below:

N750-MFD	N1000-MFD	N1500-MFD	N2000-MFD	N2500-MFD	N3000-MFD
116 ft ²	116 ft ²	206 ft ²	206 ft ²	357 ft ²	357 ft ²

3. Each heat exchanger shall consist of vertical, ASME SB-359 CDA 122 copper finned-tubes (or approved equal) installed in an evenly spaced circular arrangement around a cylindrical burner. The heat transfer fins on the O.D. of the tubing must be extruded from the same base copper as the tubing itself. Mechanically attached or welded heat transfer fins are not acceptable.
4. The copper finned-tubes shall be rolled into the upper and lower tubesheets, and shall maintain a minimum wall thickness of at least 0.063".
5. Each heat exchanger shall consist of two removable ASME SA 278 Class 35 Cast Iron headers/manifolds (or approved equal) with O-ring gaskets. Boilers that consist of a primary and secondary heat exchanger are not acceptable.
6. Each heat exchanger shall consist of two ASME SA516 Grade 70 Carbon Steel tubesheets (or approved equal) with machined grooves for O-ring gaskets and tapped holes for bolting the upper & lower Cast Iron headers/manifolds. In addition, the tubesheets shall feature tapped holes on the outer surface for bolting the combustion chamber jacket assembly.
7. Each heat exchanger shall feature a machined groove on the lower tubesheet which acts as a channel to collect and drain condensate from inside the heat exchanger and shall be connected to a minimum 3/4" steel drain pipe. This groove also assists drainage during annual heat exchanger cleaning.
8. 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.
9. Each heat exchanger shall be assembled, tested and certified by the boiler manufacturer. Heat exchangers assembled and certified by a 3rd party are not acceptable.
10. Each boiler is non-condensing and requires a minimum inlet (return) water temperature of 130°F to avoid excessive condensation within the heat exchanger. If the inlet (return) water temperature is expected to drop below 130°F, a temperature controlled 3-way valve shall be installed to blend the boiler's outlet (supply) water with the inlet (return) water.

B. MAIN GAS TRAIN

1. Each boiler shall be equipped with an integral main gas valve train capable of burning either Natural Gas or Propane Gas as defined in the table below:

N750-MFD	N1000-MFD	N1500-MFD	N2000-MFD	N2500-MFD	N3000-MFD
Natural Gas or Propane Gas	Natural Gas or Propane Gas	Natural Gas or Propane Gas	Natural Gas or Propane Gas	Natural Gas Only	Natural Gas Only

2. The main gas valve train 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. The boiler shall operate reliably down to an inlet gas pressure of 3.5" W.C. although the boiler may not be able to achieve full rated capacity at this pressure.
3. Each main 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.
4. 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.

C. POWER BURNER

1. The boiler manufacturer shall furnish an integral power type fuel burner with each boiler configured for 208 – 240 VAC, Single Phase, 60 Hz. The complete power fuel burner assembly shall consist of a gas burner, combustion air blower, main gas valve train, and ignition system. The burner manufacturer shall 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 shall be installed vertically inside the combustion chamber with combustion gases flowing radially across the copper finned tube heat exchanger. The burner shall consist of a stainless steel flange and a perforated stainless steel cylinder with a stainless steel outer knit mesh.

3. Each boiler shall be equipped with direct spark ignition. Main flame shall be monitored and controlled by a UV Scanner.

D. 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. UV Scanner type flame sensor.
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.

E. 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. Parameter uploads and downloads via external USB flash drive.
 - c. Software updates via external USB flash drive.
 - d. Capture screen shots from the control’s display by saving digital image files to external USB flash drive.
 - e. Local Representative Screen can be programmed to provide contact information for the local boiler manufacturer’s representative.
 - f. Programmable Relay Outputs for direct control of pumps, control valves, dampers and other auxiliary devices.
 - g. Multiple boiler “cascade” network up to 24 boilers without any external control panel. The installation of external sequencing control panels is not acceptable.
 - h. 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.
 - i. 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.
 - j. Programmable Boiler and System pump control for multiple boiler “cascade” systems installed in a Primary-Secondary piping arrangement.
 - k. Programmable Control Valve logic for multiple boiler “cascade” systems installed in a Primary-Only piping arrangement.
 - l. 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.
 - m. Hardwire integration with Building Management Systems (BMS) via 4-20mA analog control signal for temperature or firing rate control.
 - n. Intuitive “Setup Wizards” ask the user a series of questions and allow

for step-by-step configuration of the boiler control.

- o. On-Screen error notifications with a comprehensive description of all alarm conditions and several troubleshooting steps.
 - p. Automatic anti-condensing control to minimize the amount of operation in the condensing mode when inlet (return) temperature drops below 130°F.
 - 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 140°F up to a maximum outlet (supply) water temperature of 220°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, refer to the requirements of Section 23 11 23 "Facility Natural-Gas Piping".
- 4. For boilers configured for Propane Gas, 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 boilers shall be configured for 208-240 VAC, Single Phase (w/ Neutral), 60Hz. The amperage requirements for the boilers models are defined in the table below:

	N750-MFD	N1000-MFD	N1500-MFD	N2000-MFD	N2500-MFD	N3000-MFD
Internal Overload Protection	5 Amps	5 Amps	10 Amps	10 Amps	15 Amps	15 Amps
Recommended Circuit Capacity	10 Amps	10 Amps	15 Amps	15 Amps	20 Amps	20 Amps