

SECTION 22 34 36.23 SAMPLE SPECIFICATION FOR COMMERCIAL HIGH EFFICIENCY GAS DOMESTIC WATER HEATERS

HARSCO INDUSTRIAL, PATTERSON-KELLEY HiDRA CONDENSING WATER HEATERS W/ NURO® CONTROL

PART 1 - GENERAL

1.01. RELATED DOCUMENTS

- A. ASME Boiler and Pressure vessel code, section IV, Part HLW
- B. ANSI Z21.10.3 /CSA 4.3 “Gas Water Heaters”
- C. ASHRAE/IES 90.1
- D. DOE/EPA Energy Star
- E. ISO 9001 Quality Management System
- F. CSD-1 “Controls and Safety Devices for Automatically Fired Boilers”
- G. NFPA 70- National Electric Code
- H. NFPA 54- National Fuel Gas Code
- I. NSF/ANSI Standard 61- Drinking Water System Components
- J. NSF/ANSI Standard 372 – Drinking Water System Components – Lead Content
- K. NSF 5 – Water Heaters, Hot Water Supply Boilers and Heat Recovery Equipment
- L. ASTM G123 - 00(2005) “Standard Test Method for Evaluating Stress-Corrosion Cracking of Stainless Alloys with Different Nickel Content in Boiling Acidified Sodium Chloride Solution.”

1.02. SUMMARY

- A. This section includes condensing gas-fired storage water heaters for potable water.
- B. Related Sections include, but are not limited to, the following:
 - 1. Section 03 30 00 “Cast-in-Place Concrete”
 - 2. Section 22 01 10 “Operation and Maintenance of Plumbing, Piping & Pumps”
 - 3. Section 22 05 16 “Expansion Fittings and Loops for Plumbing Piping”
 - 4. Section 22 05 19 “Meters and Gages for Plumbing Piping”
 - 5. Section 22 05 23 “General-Duty Valves for Plumbing Piping”
 - 6. Section 22 05 29 “Hangers and Supports for Plumbing, Piping & Equipment”
 - 7. Section 22 05 48 “Vibration and Seismic Controls for Plumbing, Piping...”
 - 8. Section 22 05 53 “Identification for Plumbing, Piping, and Equipment”
 - 9. Section 22 07 00 “Plumbing Insulation”
 - 10. Section 22 09 00 “Instrumentation and Control for Plumbing”
 - 11. Section 22 11 00 “Facility Water Distribution”

12. Section 22 12 00 "Facility Potable-Water Storage Tanks"
13. Section 22 31 00 "Domestic Water Softeners"
14. Section 22 32 00 "Domestic Water Filtration Equipment"
15. Section 22 34 36.16 "Commercial, Power-Burner, Gas Dom. Water Heaters"
16. Section 23 11 23 "Facility Natural-Gas Piping"
17. Section 23 11 26 "Facility Liquefied-Petroleum Gas Piping"
18. Section 23 37 00 "Air Outlets and Inlets"
19. Section 23 51 00 "Breechings, Chimneys, and Stacks"

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 water heater including product description, model number, dimensions, clearances, weights, service sizes, etc.
 2. Schematic flow diagram of the water heater's gas valve train(s).
 3. Schematic wiring diagram of the water heater'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 water heater'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. Water Heater shall bear an ASME "HLW" stamp in accordance with ASME Section IV.
- D. Water Heater shall be CSA certified to the ANSI Z21.10.3 / CSA 4.4 standard for Gas Fired Water Heaters and shall bear an authorized CSA rating label.
- E. Water Heater shall be SCAQMD certified (*relevant jurisdictions*).
- F. Water Heater shall undergo a Full Function Factory Fire Test and bear a fire test label.

- G. Water Heater shall be registered through the National Board from the factory.
- H. The manufacturer shall make available, upon request, all quality assurance documentation and results of Full Function Factory Fire Test based on the water heater's serial number.
- I. Water heaters with full rated input of 1,000,000 BTU or 800,000 BTU will operate at a minimum 95% thermal efficiency at full firing rate when tested to the ANSI Z21.10.3 thermal efficiency test protocol (DOE 10 CFR 431).
- J. The water heater will comply with current ASHRAE 90.1 requirements.

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, domestic water piping, exhaust venting & electrical.

1.06. WARRANTY

- A. The water heater manufacturer shall warrant the water heater's heat exchanger and fuel burner for a period of fifteen (15) years (8 years non-prorated, 7 years prorated) from date of startup, provided 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. Warranties must be directly provided from the water heater manufacturer. Warranties provided by distributors, contractors, sales representatives or third-party insurers will not be accepted.
- B. The water heater manufacturer shall warrant each water heater, including water heater, trim, water heater 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.

PART 2 - PRODUCT

2.01. MANUFACTURERS

- A. Furnish and install factory "packaged" low pressure hot water heater(s) as manufactured by Harsco Industrial, 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 (Standard)	Recovery Rate (GPH) 40°F to 140°F	Efficiency
HC800	II or IV	800,000	160,000	5:1	864	94%
HC1000	II or IV	1,000,000	200,000	5:1	1140	95%

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

2.02. COMPONENTS

A. HEAT EXCHANGER

- The water heater will be a vertical fire tube, design and shall contain an ASME Section IV heat exchanger with an “HLW” stamp designed for a maximum allowable working pressure of 160 PSIG and a maximum allowable temperature of 210°F.
- The water heater’s completed heat exchanger shall provide no less than the total fireside heating surface area defined in the table below:

HC800	HC1000
107.81 ft ²	132.96 ft ²

- Water heater will be a single-pass, down-fired, fire tube design contained within an integral storage tank.
- Tank, combustion chamber and fire tubes will be unlined. Lined or plated water heaters will not be acceptable.
- Tank, combustion chamber and fire tubes will be constructed from phase-balanced austenitic and ferritic duplex stainless steel (S32101) mill certified per ASTM A 923 Methods A to ensure that the product is free of detrimental chemical precipitation that affects corrosion resistance. The material selected shall be tested and certified to pass stress chloride cracking test protocols.
- Tank will be welded utilizing joint designs to minimize volume of weld deposit and heat input. All heat affected zones (HAZ) shall be processed after welding to ensure the HAZ corrosion resistance is consistent with the mill condition base metal chemical composition. Weld procedures (amperage, volts, welding speed, filler metals and shielding gases) utilized shall result in a narrow range of austenite-ferrite microstructure content consistent with phase balanced objectives for welds, HAZ and the base metal.
- All internal and external tank surfaces shall undergo full immersion passivation processing to meet critical temperature, duration and chemical

- concentration controls required to complete corrosion resistance restoration of pressure vessel surfaces.
8. Materials shall meet ASME Section II material requirements and be accepted by NSF 61 for municipal potable water systems.
 9. All water contacting tank surfaces will be non-porous and exhibit 0% water absorption.
 10. All tank connections/fittings will be of stainless steel construction.
 11. To preserve thermal resolution, the water heater will require a circulation line piped from near top to near bottom of vessel for temperature control during normal operation. A temperature probe shall be installed in the recirculation line to anticipate changes in flow and temperature demand from the system.
 12. Connection for a building return circulation line will be made to a dedicated hot return fitting at the center of the storage vessel and not the cold inlet piping. Connection to a sidearm tank, if used, will be made to a dedicated hot return fitting at the center of the storage vessel and not the cold inlet piping.
 13. Finished vessel will not require sacrificial or impressed current anodes and none will be used. Water heaters or sidearm storage tanks that employ anode rods of any type will not be acceptable.
 14. Combustion will be provided by a premix, fan-assisted surface burner with a gas train meeting UL, ANSI and FM standards for the input specified.
 15. Burner will be stainless steel.
 16. The burner will employ non-linkage modulation utilizing only a VFD drive to vary gas and air.
 17. Burner NOx emissions will be less than 20 ppm when corrected to 3% oxygen.
 18. Water heater will be a category IV or category II, condensing appliance and vent through CPVC, Polypropylene, or Stainless Steel. Water heater will satisfy requirements for sealed combustion. Vents for inlet air and exhaust can terminate in different pressure zones. All category II rated installations shall require a motorized combustion air damper.

C. MAIN GAS TRAIN

1. The main gas valve train shall be factory assembled, piped, and wired and allow for operation at full rated water heater capacity from 4.0" W.C. up to the maximum inlet gas pressure of 14.0" W.C. The water heater shall operate reliably down to an inlet gas pressure of 3.5" W.C. although the water heater may not be able to achieve full rated capacity at this pressure.
2. 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.

D. WATER HEATER SAFETY and TRIM DEVICES

1. The water heater manufacturer shall furnish and test the following safety and trim devices with each water heater:
 - 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 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 water heater manufacturer shall provide a CSD-1 form identifying each safety and trim device.
3. The water heater 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. WATER HEATER CONTROL SYSTEM

1. Each water heater shall be provided with all necessary controls, all necessary programming sequences, and all safety interlocks. Each water heater control system shall be properly interlocked with all safeties.
2. Each water heater 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 water heater'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 water heater manufacturer's representative.
 - f. Programmable Relay Outputs for direct control of pumps, control valves, dampers and other auxiliary devices.
 - g. Multiple water heater "cascade" network up to 24 water heaters without any external control panel. The installation of external sequencing control panels is not acceptable.
 - h. Auxiliary Water Heater Relay for multiple water heater "cascade" systems which can be used to enable a 3rd party water heater platform in the event the "cascade" system is unable to satisfy the heating load.
 - i. Programmable Water Heater and System pump control for multiple water heater "cascade" systems installed in a Primary-Secondary piping arrangement.
 - j. Programmable Control Valve logic for multiple water heater "cascade" systems installed in a Primary-Only piping arrangement.
 - k. 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 water heater manufacturer.
 - l. Hardwire integration with Building Management Systems (BMS) via 4-20mA analog control signal for temperature or firing rate control.
 - m. On-Screen error notifications with a comprehensive description of all alarm conditions and several troubleshooting steps.
 - n. Automatic flue gas temperature and outlet (supply) temperature compensation to prevent over-firing of the water heater equipment.
 - o. Automatic differential temperature compensation to prevent over-firing of the water heater equipment in a low flow condition.
 - p. Scheduling functionality via external point of closure (or BMS integration) for unique sanitizing temperature setpoint values.
 - q. Maintain single temperature set point with a minimum outlet (supply) water temperature of 100°F up to a maximum outlet (supply) water temperature of 180°F.
 - r. Alarm Relay Output to announce alarm conditions which require manual reset.
 - s. Programmable Low Fire Delay to prevent excessive short-cycling of the water heater equipment.
 - t. Local Manual Operation.
2. The water heater 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 water heater manufacturer.
- b. Domestic Hot Water Break-on-Rise Aquastat (Normally Closed).
- c. Domestic Hot Water Tank Temperature Sensor (12kΩ).

F. PERFORMANCE

1. Water heaters with full rated input will operate at a minimum 95% thermal efficiency at full firing rate when tested to the ANSI Z21.10.3 thermal efficiency test protocol (DOE 10 CFR 431).
2. Water heater will meet the thermal efficiency and standby heat loss requirements of the latest version of the ASHRAE 90.1 standard.
3. Water heater will be certified by the DOE/EPA Energy Star program for commercial water heaters, whereby standby loss and thermal efficiency are independently tested and certified.
4. Water heaters shall meet NSF/ANSI 372 standard for lead content.

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 water heater and installation for compliance with requirements and/or issues that may affect water heater performance. Installation should not proceed until unsatisfactory conditions have been corrected.
- B. The contractor shall mount the equipment as described below:
 1. Install water heaters 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 22 05 48 "Vibration and Seismic Controls for Plumbing, Piping, and Equipment".
- C. The contractor shall install gas-fired water heaters in accordance with NFPA 54/ANSI Z223.1 (United States), or CAN/CSA B/149.1 (Canada).
- D. The contractor shall install gas-fired water heaters in accordance with NBIC – Part 1 (Installation), or another installation code having local jurisdiction.
- E. The contractor shall install a thermostatic mixing valve in the domestic water piping to ensure the Domestic Hot Water supply temperature to the building does not reach scalding temperatures.
- F. The contractor shall assemble and install any external water heater safety/trim devices.
- G. The contractor shall install any electrical devices furnished with the water heater, but not specified to be factory-mounted.

- H. The contractor shall install control wiring to field mounted electrical devices in accordance with the requirements of NFPA 70.
- I. The contractor shall install electrical (power) wiring to the water heater in accordance with the requirements of NFPA 70.

1.02. CONNECTIONS

A. GAS PIPING

- 1. Each water heater shall be provided with all necessary gas connections. Refer to the water heater'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 water heaters configured for Natural Gas, refer to the requirements of Section 23 11 23 "Facility Natural-Gas Piping".

B. DOMESTIC WATER PIPING

- 1. Each water heater shall be provided with all necessary inlet (supply) and outlet (return) connections. Refer to the water heater'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 domestic water piping and related components shall comply with the requirements of Section 22 11 00 "Facility Water Distribution".
- 5. All meters and gages in the domestic water piping shall comply with the requirements of Section 22 05 19 "Meters and Gages for Plumbing Piping".
- 6. All instrumentation and controls in the domestic water piping shall comply with the requirements of Section 22 09 00 "Instrumentation and Control for Plumbing".
- 7. All valves in the domestic water piping shall comply with the requirements of Section 22 05 23 "General-Duty Valves for Plumbing Piping".
- 8. All expansion fittings shall comply with the requirements of Section 22 05 16 "Expansion Fittings and Loops for Plumbing Piping".
- 9. Any pipe hangers or supports shall comply with the requirements of Section 22 05 29 "Hangers and Supports for Plumbing, Piping and Equipment".
- 10. Any vibration isolation devices on the hydronic piping shall comply with the requirements of Section 22 05 48 "Vibration and Seismic Controls for Plumbing, Piping, and Equipment".
- 11. All domestic water piping shall be insulated in accordance with the requirements of Section 22 07 00 "Plumbing Insulation".

12. After insulation, all domestic water piping shall be identified in accordance with the requirements of Section 22 05 53 "Identification for Plumbing, Piping and Equipment".
13. The domestic water storage tank(s) shall comply with the requirements of Section 22 12 00 "Facility Potable-Water Storage Tanks".
14. The domestic water softening equipment (if applicable) shall comply with the requirements of Section 22 31 00 "Domestic Water Softeners".
15. The domestic water filtration equipment (if applicable) shall comply with the requirements of Section 22 32 00 "Domestic Water Filtration Equipment".

C. EXHAUST VENTING

1. The water heaters shall be certified as Category 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 water heaters shall be certified for Direct Vent / Sealed Combustion installations where the combustion air is supplied directly to the water heater 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 water heater in accordance with the requirements of NFPA 70.
- 2. The water heaters shall be configured for 110/120 VAC, Single Phase (w/ Neutral), 60Hz. The amperage requirements for the water heaters models are defined in the table below:

	H800	H1000
Internal Overload Protection	7 Amps	10 Amps
Recommended Circuit Capacity	10 Amps	10 Amps