+SECTION 223436.23 – CENTURION HIGH EFFICIENCY GAS DOMESTIC WATER HEATERS

1. GENERAL
	* + 1. RELATED DOCUMENTS
				1. Drawings and general provisions of the Contract apply to this Section, including General and Supplementary Conditions and Division 01 Specification Sections.
			2. SUMMARY
				1. This Section includes packaged, factory-fabricated and -assembled, gas-fired, high efficiency condensing domestic water heaters, trim and accessories for generating hot potable water.
			3. REFERENCES
				1. ASME Boiler and Pressure vessel code, section IV, Part HLW
				2. UL 795 “Commercial-Industrial Gas Heating Equipment”
				3. ANSI Z21.10.3 /CSA 4.3 “Gas Water Heaters”
				4. ASHRAE/IES 90.1
				5. CSD-1 “Controls and Safety Devices for Automatically Fired Boilers”
				6. NFPA 70- National Electric Code
				7. NFPA 54- National Fuel Gas Code
				8. NSF/ANSI Standard 61- Drinking Water System Components
				9. NSF/ANSI Standard 372 – Drinking Water System Components – Lead Content
				10. 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.”
			4. SUBMITTALS
				1. Product Data: Include performance data, operating characteristics, furnished specialties and accessories.

Prior to flue vent installation, engineered calculations and drawings must be submitted to Architect/Engineer to thoroughly demonstrate that size and configuration conform to recommended size, length and footprint for each submitted water heater.

* + - * 1. Pressure Drop Curve: Submit pressure drop curve for flows ranging from 0 GPM to maximum value of water heater.
				2. Shop Drawings: For water heaters, water heater trim and accessories, include:

Plans, elevations, sections, details and attachments to other work

Wiring Diagrams for power, signal and control wiring

* + - * 1. Source Quality Control Test Reports: Reports shall be included in submittals.
				2. Field Quality Control Test Reports: Reports shall be included in submittals.
				3. Operation and Maintenance Data: Data to be included in water heater emergency, operation and maintenance manuals.
				4. Warranty: Standard warranty specified in this Section.
				5. Other Informational Submittals.

ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to water heater.

* + - 1. QUALITY ASSURANCE
				1. Electrical Components, Devices and Accessories: Condensing water heaters must be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
				2. ASME Compliance: Condensing water heaters must be constructed in accordance with ASME Water heater and Pressure Vessel Code, Section IV (HLW) Potable Water Heaters.
				3. DOE Compliance: Minimum thermal efficiency of 96% at full firing rate shall be achieved when tested to 10 CFR Part 431, Subpart G, Appendix C, "Uniform Test Method for the Measurement of Thermal Efficiency and Standby Loss of Gas-Fired and Oil-Fired Instantaneous Water Heaters and Hot Water Supply Boilers (Other Than Storage-Type Instantaneous Water Heaters)”
				4. AHRI Performance Compliance: Condensing water heaters must be rated in accordance with applicable federal testing methods and is capable of achieving the energy efficiency and performance ratings within prescribed tolerances
				5. Compliance. Condensing water heaters must be tested for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment" or ANSI Z21.10.3 /CSA 4.3 “Gas Water Heaters”. Condensing water heaters shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
				6. NOx Emission Standards. When installed and operated in accordance with manufacturer’s instructions, condensing water heaters hall comply with the NOx emission standards outlined in South Coast Air Quality Management District (SCAQMD), Rule 1146.2; and the Texas Commission on Environmental Quality (TCEQ), Title 30, Chapter 117, Rule 117.465.
				7. Low Lead Compliance: Condensing water heaters must be third party classified to meet the requirements of ANSI/NSF 372, hence that the weighted average of the wetted surface area in contact with potable water must be no greater than 0.25% lead content.
				8. The water heater will comply with current ASHRAE 90.1 requirements.
			2. COORDINATION
				1. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement and formwork requirements are specified in Division 03.
			3. WARRANTY
				1. Standard Warranty: Water heaters shall include manufacturer's standard form in which manufacturer agrees to repair or replace components of water heaters that fail in materials or workmanship within specified warranty period.

Warranty Period for Fire-Tube Condensing Water heaters:

1. The pressure vessel shall carry a will have a manufacturer’s 15-year warranty (8 years non-prorated, 7 years prorated) covering manufacturing or material defects, waterside or fire side corrosion, leaks, and/or the production of rusty water. 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.
2. Manufacturer labeled control panels are conditionally warranted against failure for two (2) years from shipment.
3. All other components, except for the igniter and flame detector, are conditionally guaranteed against any failure for 1 year from shipment.
	* + - 1. The water heater shall have a first year service policy, which shall cover labor and freight costs under certain conditions for warranty covered services for a period of 1 year from date of startup.
				2. <OPTIONAL> The water heater shall have an extended service policy which shall cover labor and freight costs under certain conditions for warranty covered services for a period of 2 years from date of startup.
4. PRODUCTS
	* + 1. MANUFACTURERS
				1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
				2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
				3. Basis-of-Design Product: Subject to compliance with requirements, provide PVI CENTURION Model: \_\_CEN01600; \_\_CEN02000; or a comparable product by one of the following:

PVI Industries

* + - 1. CONSTRUCTION
				1. General: The water heating plant shall have a total recovery of ­­\_\_\_\_\_\_\_ GPH, (\_\_\_\_\_ GPM) at a \_\_\_\_\_oF temperature rise. Each water heater shall be UL Listed; ASME Section IV (HLW) coded and stamped and shall incorporate anFM compliant gas train. System shall consist of a quantity of Water Heaters Model:

\_\_\_CEN 1600 each with an input of 1600 MBH, output of 1504 MBH, 1806 GPH, (30.1 GPM) at 40-140 oF when fired with \_\_natural gas or \_\_propane, turndown ratio up to 16:1, NOx emissions of less than 20 ppm.)

 \_\_\_CEN 2000 each with an input of 2000 MBH, output of 1920 MBH, 2304 GPH, (38.4 GPM) at 40-140 oF when fired with \_\_natural gas or \_\_propane, turndown ratio up to 20:1, NOx emissions of less than 20 ppm.)

* + - * 1. Description: Water heater shall be direct fired, fully condensing, single-pass, down-fired, fire-tube design. Power burner shall have full modulation. The minimum firing rate at 100,000 BTU/HR input shall be possible. Water heaters that have an input greater than 100,000 BTU/HR at minimum fire will not be considered equal. The water heater shall have the capability of discharging into a positive pressure vent. Water heater thermal efficiency shall increase with decreasing load (output), while maintaining setpoint. Water heater shall have an operational setpoint capability of 50 ºF to 190 ºF and shall maintain the outlet temperature within an accuracy of +/- 4 oF during load changes of up to 50% rated capacity. Water heater shall be factory-fabricated, factory-assembled and factory-tested, fire-tube condensing water heater with heat exchanger sealed pressure-tight, built on a steel base, including a sealed insulated sheet metal enclosure that acts as combustion-air intake plenum, flue-gas vent, water supply, return and condensate drain connections, and controls. Each water heater shall have an ASME approved temperature/pressure relief valve with a setting of 150 PSIG and 210 oF.
				2. Pressure vessel, combustion chamber and fire tubes will be constructed from phase-balanced austenitic and ferritic duplex steel with a chemical structure containing a minimum of 21% chromium to prevent corrosion and 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 as defined in ISO 3651-2and 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.” The pressure vessel shall be ASME Sect IV (HLW) stamped for a working pressure not less than 160 PSIG.
				3. Pressure vessel 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.
				4. All internal and external pressure vessel surfaces shall undergo full immersion passivation and pickling processing to meet critical temperature, duration and chemical concentration controls required to complete corrosion resistance restoration of pressure vessel surfaces. Other passivation and pickling methods are not accepted. Immersion passivation and pickling certification documents are required and shall be provided with each product.
				5. Materials shall meet ASME Section II material requirements and be accepted by NSF 61 for municipal potable water systems. Pressure vessel materials shall contain more than 80% post- consumer recycled materials and be 100% recyclable.
				6. All water contacting pressure vessel surfaces will be non-porous and exhibit 0% water absorption.
				7. All pressure vessel connections/fittings will be non-ferrous or stainless steel.
				8. 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.
				9. 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.
				10. Modulating Air/Fuel Valve and Burner: The water heater burner shall be capable of \_\_16-to-1(CEN 1600, \_\_20‑to‑1(CEN 2000) turndown ratio of the firing rate without loss of combustion efficiency or staging of gas valves. The burner shall produce less than 20 ppm of NOx corrected to 3% excess oxygen. The unit shall be certified by the South Coast Air Quality Management District (SCAQMD) as compliant with Rule 1146.2 for water heaters and water heaters less than or equal to 2 MBTUs, and the Texas Commission on Environmental Quality (TCEQ) as being compliant with Section 117.465 for water heaters and water heaters less than or equal to 2 MBTUs. The burner shall be metal‑fiber mesh covering a stainless steel body with spark ignition and flame rectification. All burner material exposed to the combustion zone shall be of stainless steel construction. There shall be no moving parts within the burner itself. A modulating air/fuel valve shall meter the air and fuel input. The modulating motor must be linked to both the gas valve body and air valve body with a single linkage. The linkage shall not require any field adjustment. A variable frequency drive (VFD), controlled cast aluminum pre-mix blower shall be used to ensure the optimum mixing of air and fuel between the air/fuel valve and the burner.
				11. The exhaust manifold shall be of corrosion resistant steel with a 8‑inch diameter flue connection. The exhaust manifold shall have a collecting reservoir and a gravity drain for the elimination of condensation.
				12. Blower. The water heater shall include a variable-speed, DC centrifugal fan to operate during the burner firing sequence and pre-purge the combustion chamber.

Motors: Blower motors shall comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require a motor to operate in the service factor range above 1.0.
	* + - 1. Ignition: Ignition shall be via spark or proven pilot ignition with 100 percent main-valve shutoff and electronic flame supervision.
				2. Combustion Air: The water heater shall be designed such that the combustion air is drawn from the inside of the boiler enclosure, decoupling it from the combustion air supply and preheating the air to increase efficiency.
				3. Combustion Air Filter: The water heater shall be equipped with an automotive high flow air filter to ensure efficient combustion and unhindered burner components operation.
				4. Enclosure: The plastic and sheet metal enclosure shall be fully removable, allowing for easy access during servicing.
				5. O2 sensor located in the Combustion Chamber: The water heater shall be equipped with an Oxygen sensor. The sensor shall be located in the water heater combustion chamber. Water heaters without Oxygen sensor or water heaters with an Oxygen sensor in the exhaust shall not be acceptable due to measurement estimation and performance accuracy.
			1. CONTROLS
				1. Refer to Division 23, Section “Instrumentation and Control of HVAC.”
				2. The water heater shall have an integrated water heating control that is capable of operating the unit and associated accessories including but not limited to: its pumps, valves and dampers.

The control shall have a 4.5 inch color touch screen display as well as six function buttons that are separate from the display. User shall have the ability to navigate the menus via touchscreen or navigation buttons. Controls not equipped with navigation button options shall not be permitted.

The control shall be equipped with a multi-color linear LED light to indicate the level of firing and/or air/fuel valve position.

The control shall display two temperatures using two dedicated three-digit seven-segment displays.

The control shall offer an Enable/Disable toggle switch as well as two buttons for Testing and Resetting the Low Water Cutoff.

* + - * 1. The water heater control system shall be segregated into three components: “Edge” Control Panel, Power Box and Input/Output Connection Box. The entire system shall be Underwriters Laboratories recognized.
				2. The control panel shall consist of seven individual circuit boards using state-of-the-art surface-mount technology in a single enclosure. These circuit boards shall include:
1. A microcontroller board with integrated 4.5 inch touchscreen color display providing the user interface.
2. A 7-segment display board. This board includes two 3-digit 7-segment displays. These displays shall be used to view a variety of temperature sensor values and operating and startup function status.
3. An Interface board connects the microcontroller board to internal components using ribbon cables.
4. An electric low-water cutoff board connects with microcontroller board for the test and manual reset functions.
5. A power supply board is designed to provide the various DC voltages required by control system boards. It also acts as voltage regulator and reduce power noise.
6. An ignition and combustion board. This board controls the air/fuel valve and Safety Shutoff Valve, flame status and ignition transformer
7. A connector board used to connect all external electrical connection.

Each board shall be individually field replaceable.

* + - * 1. The combustion safeguard/flame monitoring system shall use spark ignition and a rectification-type flame sensor.
				2. The control panel hardware shall have native support for both RJ-45 and RS-485 remote communications.
				3. The controls shall annunciate water heater and sensor status and include comprehensive self-diagnostic capabilities that incorporate a minimum of eight separate status messages and 52 separate fault messages.
				4. Copy and download control settings using USB: To significantly reduce installation time by reducing long repetitive work, during unit startup the control shall have the capability to save units settings to a USB flash drive. Installers shall have the ability to select preconfigured unit settings from USB flash drive and download to a new unit.
				5. Software update: The control shall be capable of field software updates without a need for hardware component(s) replacement. This shall be performed either using software on a USB flash drive or via Internet connection. The software update shall not require a trained technician. The software update menus shall be secured using a password level. After the software update, the control shall retain all of its prior field settings.
				6. Combustion calibration: The control shall offer at least 6 calibration points. The use of less than 5 calibration points is not permitted to improve overall system efficiency under all firing rates. Each combustion calibration point shall operate with 5% to 7% O2 levels to improve operating efficiency. Deviating away from these values shall not be acceptable.
				7. The control panel shall incorporate four self-governing features designed to enhance operation in modes where it receives an external control signal by eliminating nuisance faults due to over-temperature, improper external signal or loss of external signal. These features include:

Setpoint High Limit: Setpoint high limit allows for a selectable maximum water heater outlet temperature and acts as temperature limiting governor. Setpoint limit is based on a PID function that automatically limits firing rate to maintain outlet temperature within a 0 to 10 degrees selectable band from the desired maximum water heater outlet temperature.

Setpoint Low Limit: Setpoint low limit allows for a selectable minimum operating temperature.

Failsafe Mode: Failsafe mode allows the water heater to switch its mode to operate from an internal setpoint if its external control signal is lost, rather than shut off. This is a selectable mode, enabling the control can to shut off the unit upon loss of external signal, if so desired.

Freeze Protection: Protection mode that fires the unit and activates pump controls to prevent freezing of water volume within pressure vessel. Control system continually monitors water temperatures within vessel to prevent reaching freezing conditions when unit is enabled.

* + - * 1. The water heater control system shall incorporate the following additional features for enhanced external system interface:

System start temperature feature

Pump delay timer

Auxiliary start delay timer

Auxiliary temperature sensor

Analog output feature to enable simple monitoring of temperature setpoint, outlet temperature or fire rate

Remote interlock circuit

Delayed interlock circuit

Fault relay for remote fault alarm

* + - * 1. Water Heater Management: the water heater control system shall incorporate native sequencing logic that would allow lead-lag functionality & sequencing between multiple water heaters operating in parallel and must have the following capabilities:

Efficiently sequence 2 up to 16 units on the same system to meet the load requirement.

Individual unit feed-forward logic will still be enabled for accurate temperature control equal to individual unit’s specification.

Operate one motorized valve per unit as an element of the load sequencing, Valves shall close with decreased load as heaters turn off, minimum of one (quantity must be selectable) must always stay open for recirculation.

Automatically rotate lead/lag amongst the units on the chain and monitor run hours per unit and balance load in an effort to equalize unit run hours.

Automatic bump-less transfer of manager function to next unit on the chain in case of designated manager unit failure; manager/client status should be shown on the individual unit displays.

Units will default to individual control upon failure of the communications chain.

Night temperature setback.

Designated manager control, used to display and adjust key system parameters.

* + - * 1. Building Automation: The control shall be able to communicate to Building Management Systems using BACnet and Modbus without the use of external gateways. The control shall be able to communicate over each of the two protocols using IP as well as RS485. The use of external gateways is not acceptable. The control shall be able to communicate to the building management system using:

BACnet MS/TP and BACnet IP/Ethernet. When communicating over BACnet IP, the control shall offer an additional layer of IP security by mapping all control BACnet IP communication to the BACnet server’s IP and MAC addresses. Not having this level of security shall deem the IP communication insecure and shall not be acceptable.

Modbus RTU and Modbus IP.

* + - * 1. Unit and Plant Status: The control shall provide a quick view of the unit status and plant status.

The unit status screen shall provide temperature setpoint, all water inlet and outlet and supply air and exhaust temperature sensors’ values. It shall also provide unit current and target firing rates. Additional screens shall display unit run hours, cycle count and average cycles per hour.

The plant status screens shall provide plant temperature setpoint, plant water supply and current temperatures. Additionally, a status screen shall show the water heater status of each plant unit, plant firing rate.

Unit and Plant event history: The manager control shall display the last 500 historical events per plant or 200 historical events for single unit installations.

* + - * 1. Each water heater shall be supplied with a factory packaged and pre-wired motorized ball valve. This valve shall be controlled by the water heater control system as an element of the integrated water heater management.
				2. Each water heater shall include an electric, single-seated combination safety shutoff valve/regulator with proof of closure switch in its gas train. Each water heater shall incorporate dual over-temperature protection with manual reset, in accordance with ASME Section IV and CSD‑1.
				3. O2-Trim: Each water heater shall be equipped with the patented advanced O₂-trim system for condensing water heater applications. The system shall utilize a low cost reliable automotive O₂ sensor that measures and monitors the oxygen content of the exhaust gases. The system shall adjust the blower speed to maintain optimal air-fuel ratios in the event of any site condition changes (air density, gas pressure, BTU content, etc.). The system shall have the following capabilities:

Self-Diagnostics

System Status and Error Messages

When excessive trimming is occurring

When O₂ sensor has fallen out of calibration

Adjustable parameter settings

O₂ target and range to meet site requirements

Schedule daily or weekly self-diagnostics

Output of O₂ information shall be displayed on the Edge [ii] control panel.

The O₂ sensor shall be installed through the unit’s burner plate and measure the oxygen content directly within the unit’s combustion chamber.

Water heaters without an equivalent O₂ trim will be deemed unacceptable. Due to the moisture content of flue gases from condensing boilers, placing the O₂ sensor in the exhaust manifold or stack will be deemed unacceptable.

* + - * 1. Water heaters which require their O2 sensor be changed annually will be deemed unacceptable.
			1. ELECTRICAL POWER
				1. Controllers, Electrical Devices and Wiring: Electrical devices and connections are specified in Division 26 sections.
				2. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers and other electrical devices shall provide a single-point field power connection to the water heater.
				3. Electrical Characteristics:

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| --- | --- |
| **Electrical****Specifications** | **Models** |
| CEN 1600/2000 | CEN 1600/2000 |
| Voltage | 208 V | 460 V |
| Phase | 3 | 3 |
| Frequency | 60 Hz | 60 Hz |
| Full Load Current | 10-23 Amps | 5-12Amps |

* + - 1. CONDENSATE
				1. Low-profile condensate neutralizing tubes. Each tube shall be suitable for no less than 12 months continuous operation at full condensing rate. Tubes shall be refillable;
				2. Condensate traps, manufactured from only non-corrosive materials. In order to guarantee flue gasses cannot leak into the mechanical room, the traps shall be float-type traps NO EXCEPTIONS.
			2. VENTING
				1. The exhaust vent must be UL Listed for use with Category II, III and IV appliances and compatible with positive pressure, condensing flue gas service. UL‑ listed vents of PVC, CPVC, Polypropylene, stainless steel, or Al 29-4C stainless steel must be used with water heaters.
				2. The minimum exhaust vent duct size for each water heater is eight-inch diameter.
				3. Combustion-Air Intake: Water heaters shall be capable of drawing combustion air from the outdoors via a metal or PVC duct connected between the water heater and the outdoors.
				4. The minimum ducted combustion air duct size for each water heater is six-inch diameter.
				5. Common Vent and Common Combustion Air must be an available option for water heater installation. Consult manufacturer for common vent and combustion air sizing.
				6. Follow guidelines specified in manufacturer’s venting guide.
			3. SOURCE QUALITY CONTROL
				1. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions and carbon monoxide in flue gas, and to achieve combustion efficiency. Perform hydrostatic testing.
				2. Test and inspect factory-assembled water heaters, before shipping, according to ASME Boiler and Pressure Vessel Code.

If water heaters are not factory assembled and fire-tested, the local vendor is responsible for all field assembly and testing.

* + - * 1. Allow Owner access to source quality-control testing of water heaters. Notify Architect fourteen days in advance of testing.
1. EXECUTION
	* + 1. EXAMINATION
				1. Before water heater installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations. Examine piping and electrical connections to verify actual locations, sizes and other conditions affecting water heater performance, maintenance and operations.

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

* + - * 1. Examine mechanical spaces for suitable conditions where water heaters will be installed.
				2. Proceed with installation only after unsatisfactory conditions have been corrected.
			1. WATER HEATER INSTALLATION
				1. Install water heaters level on concrete bases. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.
				2. Install gas-fired water heaters in accordance with

Local, stats provincial, and national codes, laws, regulations, and ordinances.

National Fuel Gas Code, ANSI Z223.1/NFPA 54 – latest edition.

National Electrical Code, ANSI/NFPA 70 - latest edition.

Canada only: CAN/CGA B149 Installation Code and CSA C22.1 CEC Part 1.

Manufacturer’s installation instructions, including required service clearances and venting guidelines.

* + - * 1. Assemble and install water heater trim.
				2. Install electrical devices furnished with water heater but not specified to be factory mounted.
				3. Install control wiring to field-mounted electrical devices.
			1. CONNECTIONS
				1. Piping installation requirements are specified in other Division 23 sections. Drawings indicate general arrangement of piping, fittings and specialties.
				2. Install piping adjacent to water heater to permit service and maintenance.
				3. 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.
				4. Connect gas piping to water heater gas-train inlet with unions. Piping shall be at least full size of gas train connection. Provide a reducer if required.
				5. Connect hot-water piping to supply and return water heater connections with shutoff valve and union or flange at each connection.
				6. Multiple heaters shall be piped in reverse return or provided with balancing valves on hot water outlet. Each water heater shall have individual isolation valves for servicing and a hot water hose connection for start-up and field testing.
				7. Install piping from safety relief valves to nearest floor drain.
				8. Water heater Venting

Install flue venting kit and combustion-air intake.

Connect venting full size to water heater connections. [Comply with requirements in Division 23 Section "Breechings, Chimneys and Stacks."]

* + - * 1. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
				2. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
			1. FIELD QUALITY CONTROL
				1. Perform tests and inspections and prepare test reports.

Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies and equipment installations, including connections, and to assist in testing.

* + - * 1. Tests and Inspections

Installation and Startup Test: Perform installation and startup checks according to manufacturer's written instructions.

Leak Test: Perform hydrostatic test. Repair leaks and retest until no leaks exist.

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

Controls and Safeties: Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

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

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

* + - * 1. Remove and replace malfunctioning units and retest as specified above.
				2. Occupancy Adjustments: When requested within 2 months of date of Substantial Completion, provide on-site assistance adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.
				3. Water Quality: The following water quality guidelines shall be adhered to. Water heaters requiring more stringent water quality guidelines shall not be permitted.

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| **Table 1.1: Water Quality Guidelines** |
| Total Dissolved Solids: | 500 PPM |
| Chlorides: | 250 PPM |
| Free Chlorine: | 0.5 PPM |
| Hardness (CaCO3): | Up To 15 grains/gal\*\* |
| \*\* Adhere to maintenance schedule required based on water hardness level and operating temperature specified in equipment manual. >15 grains/gal possible based on guidelines specified in equipment manual. |

END OF SECTION 223436.23