

# HIGH EFFICIENCY GAS DOMESTIC WATER HEATERS

## PART 1 - GENERAL

### 1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract apply to this Section, including General and Supplementary Conditions and Division 01 Specification Sections.

### 2 SUMMARY

- A. 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 SUBMITTALS

- A. Product Data: Include performance data, operating characteristics, furnished specialties and accessories.
- B. Pressure Drop Curve: Submit pressure drop curve for flows ranging from 0 GPM to maximum value of water heater.
- C. Shop Drawings: For water heaters, water heater trim and accessories, include:
  - 1. Elevations, sections, details
  - 2. Wiring Diagrams for power
- D. Operation and Maintenance Data: Data to be included in water heater emergency, operation and maintenance manuals.
- E. Warranty: Standard warranty specified in this Section.
- F. Made in America Certification
- G. Other Informational Submittals.
  - 1. ASME Stamp Certification and Report

### 4 QUALITY ASSURANCE

- A. ASME Compliance: Condensing water heaters must be constructed in accordance with ASME Water heater and Pressure Vessel Code, Section IV (HLW) Potable Water Heaters.
- B. ETL Compliance. Condensing water heaters must be tested for compliance with ETL, "Commercial-Industrial Gas Heating Equipment." Condensing water heaters shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

- C. CO Emission Standards. When installed and operated in accordance with manufacturer's instructions.

5 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement and formwork requirements are specified in Division 03.

6 WARRANTY

- A. 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.

- 1. Warranty Period for Condensing Water heaters:

- a. The heat exchanger coil shall carry a 10 year from commissioning, non-prorated, limited warranty against any failure due to waterside corrosion, mechanical defects, or workmanship. The heat exchanger coil shall carry a 10 year from commissioning, non-prorated, limited warranty against any failure due to condensate corrosion, thermal stress, mechanical defects, or workmanship.
- b. Manufacturer labeled control panels are conditionally warranted against failure for two (2) years from commissioning.
- c. All other components, including the electronic igniter and electrode, are conditionally guaranteed against any failure for 24 months from commissioning.
- d. Optional extended service for manufacturer to provide factory monitoring of water heater performance and parts via integrated 3G/4G. Factory diagnostics and predictive maintenance in the optional service

PART 2 - PRODUCTS

1 MANUFACTURERS

- A. 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:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide Intellihot Model iN401 or a comparable product by one of the following:
  - 1. \_\_\_\_\_
  - 2. \_\_\_\_\_

3. \_\_\_\_\_

## 2 CONSTRUCTION

- A. General: The water heating plant shall have a recovery of \_\_\_\_\_ GPH, (\_\_\_\_\_ GPM) at a \_\_\_\_\_°F temperature rise. Each water heater shall be ETL Listed; ASME Section IV (HLW) coded and stamped and shall incorporate a negative Pressure gas valve on each exchanger capable of full fire operation at of 2.5" WC of Gas pressure. Each unit shall achieve a minimum turn down of 6.7 per 200,000 BTU of input . The total water content in the system shall be less than 2 Gallons per 200,000 BTU/hr of input. System shall consist of a quantity of \_\_\_ Water Heaters Model:\_\_\_\_\_
- \_\_\_\_\_IN 401 each with an input of 399,999 MBH, output of 376 MBH, 456 GPH, (7.6 GPM) at 40-140 °F when fired with natural gas, turndown ratio 13.3:1, CO emissions of less than 400 PPM.) 2 – 200MBH (approx.) Heat Exchangers
- B. Description: Water heater shall be direct fired, fully condensing, water-tube design. Power burner shall have full modulation. The minimum firing rate shall not exceed 30,000 BTU/HR input. Water heaters that have an input greater than 30,000 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 set point. Water heater shall have an operational set point capability of 100 °F to 190 °F and shall maintain the outlet temperature within an accuracy of +/- 4 °F during load changes of up to 30% rated capacity. Water heater shall be factory-fabricated, factory-assembled and factory-tested, water-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 with a built in serviceable air filter
- C. Heat Exchanger: The heat exchanger shall be constructed with 316L stainless steel helical water tube, fully floating with no welded joints in the exchanger. The exchanger will have a single-pass unitary design (no separate primary and secondary heat exchanger). The water tubes shall be 0.75" ID, with no less than 0.0472" wall thickness. The heat exchanger shall be ASME Sect IV (HLW) stamped for a working pressure not less than 160 psig.
- D. Modulating Air/Fuel Valve and Burner: The water heater burner shall be capable of a – 13.3-to-1, turndown ratio of the firing rate without loss of combustion efficiency or staging of gas valves. The burner shall be stainless 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. A variable frequency drive (VFD), controlled pre-mix blower shall be used to ensure the optimum mixing of air and fuel between the air/fuel valve and the burner.
- E. The exhaust manifold shall be of polypropylene with a 4" diameter flue connection.
- F. Ignition: Ignition shall be via spark ignition with 100 percent main-valve shutoff and dual electronic flame supervision.

### 3 CONTROLS

- A. Refer to Division 23, Section "Instrumentation and Control of HVAC."
- B. The water heater control system shall be a Masterless Cascading design with no-master - slave designation. The entire system shall have built-in usage optimization routine.
- C. The control panel shall consist of one individual circuit. The circuit boards shall include:
  - 1. A Digital touch display to indicate temperature and status
  - 2. A CPU board housing all control functions

Each board shall be individually field replaceable.

- D. The combustion safeguard/flame monitoring system shall use spark ignition and a rectification-type flame sensor.
- E. The unit shall have a selectable exhaust temperature limit suitable for venting with PVC or CPVC/Polypropylene/Stainless Steel (AL29-4C).
- F. The controls shall annunciate water heater and sensor status and include extensive self-diagnostic capabilities.
  - 1. Set point High Limit: Set point high limit allows for a selectable maximum water heater outlet temperature and acts as temperature limiting governor. Setpoint limit is based on a closed loop function that automatically limits firing rate to maintain outlet temperature.
- G. The water heater control system shall incorporate the following additional features for enhanced external system interface:
  - 1. Temperature set point
  - 2. High Exhaust temp monitor and control. Turn down the Gas valve until the exhaust temp is kept below selected material (PVC or CPVC).
  - 3. Cascading via RS232
  - 4. Error Code Display / Error Code History
    - a. Blower Fault
    - b. Blocked Flue Fault
    - c. Ignition Failure
    - d. Temp Sensor Short
    - e. Temp Sensor Wiring Fault
    - f. Flue Temp Fault
    - g. Heat Exchanger Temp Fault
    - h. Cascading Fault
    - i. Water Valve Fault
    - j. Pump Fault
    - k. Software Fault

5. Monitor and access to daily, weekly, monthly water usages data.
  6. Monitor inlet/outlet temperatures, flow rates, flue gas temperatures, combustion rates via onboard touchscreen and via IoT app.
- H. Water Heater Management: the water heater control system shall incorporate onboard multi-unit sequencing logic that would allow Masterless Cascading (Not Lead/Lag) functionality & sequencing between multiple water heaters operating in parallel and must have the following capabilities:
- a. Efficiently sequence 2 up to 8 (~1,600,000 Btu) heat exchangers on the same system to meet the load requirement.
  - b. Individual heat exchanger logic to enable accurate temperature control.
  - c. Operate one motorized valve per heat exchanger as an element of the load sequencing, Valves shall close with decreased load as heaters turn off, minimum of one (depending upon Mode selection) must always stay open for recirculation.
  - d. Automatically rotate Start/Stop amongst the heat exchangers in the chain based upon an internal calculation of run hours, water through put, burner starts and stops and length of time each burner has been firing. Sequencing is not based upon next in line (Lead/Lag), it is based upon the most logical (least used) heat exchanger in an effort to equalize unit run hours.
  - e. Automatic bump-less transfer of sequencing in case of heat exchanger failure. All systems must be able to fail all but one heat exchanger in any order or for any reason and the last will continue to operate.
  - f. Each heat exchanger will default to individual control upon failure of the sequencing chain.
  - g. Automatic isolation of heat exchanger module from water circuit in case of failure and prevention of cold water from exiting the system
  - h. Masterless control, change any parameter in any one of the units and all the rest in the series will automatically adjust to the most recent parameter change.

#### 4 ELECTRICAL POWER

- A. Controllers, Electrical Devices and Wiring: Electrical devices and connections are specified in Division 26 sections.
- B. 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.
- C. Electrical Characteristics:
  1. Voltage: 120 V

2. Phase: Single
3. Frequency: 60 Hz
4. Full-Load Current 5 Amps or less per 200,000 BTU of heat input

## 5 CONDENSATE

- A. Condensate traps, manufactured from only non-corrosive materials.
- B. Optional Accessory: Smart condensate neutralizer with capability of monitoring pH levels through included IoT app. Smart Neutralizer to also include
  1. Monitor water temperatures
  2. CO detection, flue gas detection, water leak detection of boiler room w/ audible/visual alarms and alerts via app.
  3. Water flow recording/monitoring
  4. View history of above parameters via app.

## 6 VENTING

- A. The exhaust vent must be PVC, CPVC, Polypropylene, Stainless Steel (AL29-4C) compatible with positive pressure, condensing flue gas service.
- B. The minimum exhaust vent duct size for each water heater is six-inch diameter.
- C. 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.
- D. The minimum sealed combustion air duct size for each water heater is 4" diameter.
- E. Common Vent and Common Combustion Air up to 4 units. Consult manufacturer for common vent and combustion air sizing.

## 7 SOURCE QUALITY CONTROL

- A. 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.
- B. Live-fire Test and inspect factory-assembled water heaters, before shipping.,
- C. Allow Owner access to source quality-control testing of water heaters.

## PART 3 - EXECUTION

### 1 EXAMINATION

- A. 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.
  - 1. Final water heater locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where water heaters will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 2 WATER HEATER INSTALLATION

- A. 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.
- B. Install gas-fired water heaters in accordance with
  - 1. Local, states, provincial, and national codes, laws, regulations, and ordinances.
  - 2. National Fuel Gas Code, ANSI Z223.1/NFPA 54 – latest edition.
  - 3. National Electrical Code, ANSI/NFPA 70 - latest edition.
  - 4. Canada only: CAN/CGA B149 Installation Code and CSA C22.1 CEC Part 1.
  - 5. Manufacturer's installation instructions, including required service clearances and venting guidelines.
- C. Assemble and install water heater trim.
- D. Install electrical devices furnished with water heater but not specified to be factory mounted.
- E. Install control wiring to field-mounted electrical devices.

### 3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 sections. Drawings indicate general arrangement of piping, fittings and specialties.
- B. Install piping adjacent to water heater to permit service and maintenance.
- C. 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.
- D. Connect gas piping to water heater gas valve with unions. Piping shall be at least full size of gas train connection. Provide a reducer if required.

- E. Connect hot-water piping to supply and return water heater tapplings with shutoff valve and union or flange at each connection.
- F. Multiple heaters shall be piped such that all cold water entering the system will go through the heat exchanger first. A series of approved piping installation examples are shown in the installation and maintenance manuals provided with the unit. Each water heater shall have individual isolation valves for servicing and a hot water hose connection for start-up and field testing.
- G. Install piping from safety relief valves to nearest floor drain.
- H. Water heater Venting
  - 1. Install flue venting kit and combustion-air intake.
  - 2. Connect venting full size to water heater connections. [Comply with requirements in Division 23 Section "Breechings, Chimneys and Stacks."]
- I. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- J. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

#### 4 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections
  - 1. Installation and Startup Test: Perform installation and startup checks according to manufacturer's written instructions.
  - 2. Leak Test: Perform hydrostatic test. Repair leaks and retest until no leaks exist.
  - 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion, if necessary.
  - 4. 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.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. 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.



## E. Performance Tests

The water heater manufacturer is expected to provide partial load thermal efficiency curves. These thermal efficiency curves must include at least three separate curves at various BTU input levels. If these curves are not available, it is the responsibility of the water heater manufacturer to complete the following performance tests:

1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
2. Water heaters shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
3. Perform field performance tests to determine capacity and efficiency of water heaters.
  - a. Test for full capacity.
  - b. Test for water heater efficiency at [low fire, 20, 40, 60, 80, 100, 80, 60, 40 and 20] percent of full capacity. Determine efficiency at each test point.
4. Repeat tests until results comply with requirements indicated.
5. Provide analysis equipment required to determine performance.
6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
7. Notify Architect in advance of test dates.
8. Document test results in a report and submit to Architect.

END OF SECTION