[6450-01-P]

DEPARTMENT OF ENERGY

Office of Energy Efficiency and Renewable Energy

[Case No. WH-004]

Notice of Petition for Waiver of Raypak Inc. from the Department of Energy Commercial Water Heater Test Procedure

AGENCY: Office of Energy Efficiency and Renewable Energy, Department of Energy.

ACTION: Notice of Petition for Waiver and Request for Public Comments.

SUMMARY: This notice announces receipt of and publishes a petition for waiver from Raypak Inc. (Raypak) seeking an exemption from specified provisions applicable to standby loss of the U.S. Department of Energy (DOE) test procedure for commercial water heating equipment. The waiver request pertains to Raypak's specified models of commercial instantaneous water heaters containing 10 gallons or more of water. In its petition, Raypak contends that its specified water heater models that employ tube-type heat exchangers and are designed to be flow activated cannot be accurately tested using the currently applicable DOE test procedure. Consequently, Raypak seeks to use an alternate test procedure to address certain issues involved in testing the specific basic models identified in its petition. DOE solicits comments, data, and information concerning Raypak's petition and its suggested alternate test procedure.

DATES: DOE will accept comments, data, and information with respect to the Raypak Petition until **[INSERT DATE 30 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]**.

ADDRESSES: You may submit comments, identified by case number WH-004, by any of the following methods:

- Federal eRulemaking Portal: http://www.regulations.gov. Follow the instructions for submitting comments.
- E-mail: AS_Waiver_Requests@ee.doe.gov Include the case number [Case No. WH-004] in the subject line of the message. Submit electronic comments in WordPerfect, Microsoft Word, PDF, or ASCII file format, and avoid the use of special characters or any form of encryption.
- Postal Mail: Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Office, Mailstop EE-5B, Petition for Waiver Case No. WH-004, 1000 Independence Avenue, SW, Washington, DC 20585-0121. Telephone: (202) 586-2945. If possible, please submit all items on a compact disc (CD), in which case it is not necessary to include printed copies.
- Hand Delivery/Courier: Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Office, 950 L'Enfant Plaza SW, Suite 600, Washington, DC 20024. If possible, please submit all items on a CD, in which case it is not necessary to include printed copies.

Docket: The docket, which includes Federal Register notices, comments, and other supporting documents/materials, is available for review at www.regulations.gov. All documents in the docket are listed in the www.regulations.gov index. However, some documents listed in the index, such as those containing information that is exempt from public disclosure, may not be publicly available.

For further information on how to submit a comment, or review other public comments and the docket, contact Ms. Brenda Edwards at (202) 586-2945 or by email: Brenda.Edwards@ee.doe.gov.

FOR FURTHER INFORMATION CONTACT: Mr. Bryan Berringer, U.S. Department of Energy, Building Technologies Office, Mail Stop EE-5B, 1000 Independence Avenue, SW., Washington, DC 20585-0121. Telephone: (202) 586-0371. E-mail: Bryan.Berringer@ee.doe.gov.

Mr. Eric Stas, U.S. Department of Energy, Office of the General Counsel, GC–33, 1000 Independence Avenue, SW., Washington, DC 20585-0121. Telephone: (202) 586-9507. E-mail: Eric.Stas@hq.doe.gov.

For information on how to submit or review public comments, contact Ms. Brenda Edwards, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Office, Mailstop EE-5B, 1000 Independence

Avenue, S.W., Washington, DC 20585-0121. Telephone: (202) 586-2945. Email: Brenda.Edwards@ee.doe.gov.

SUPPLEMENTARY INFORMATION:

I. Background and Authority

Title III, Part C[1] of the Energy Policy and Conservation Act of 1975 (EPCA), Pub. L. 94-163 (42 U.S.C. 6311-6317, as codified), added by Pub. L. 95-619, established the Energy Conservation Program for Certain Industrial Equipment, which includes commercial water heaters, the focus of this notice.[2] Part C specifically includes definitions (42 U.S.C. 6311), energy conservation standards (42 U.S.C 6313), test procedures (42 U.S.C. 6314), labeling provisions (42 U.S.C. 6315), and the authority to require information and reports from manufacturers. (42 U.S.C. 6316) With respect to test procedures, Part C authorizes the Secretary of Energy (the Secretary) to prescribe test procedures that are reasonably designed to produce results that measure energy efficiency, energy use, and estimated annual operating costs during a representative average-use cycle, and that are not unduly burdensome to conduct. (42 U.S.C. 6314(a)(2)) EPCA also directs DOE to consider amending the existing test procedure for each type of equipment listed each time the industry test procedure is amended for such equipment. (42 U.S.C. 6314(a)(4)) The test procedure for commercial water heaters is contained in the Code of Federal Regulations (CFR) at 10 CFR part 431, subpart G.

[1] For editorial reasons, upon codification in the U.S. Code, Part C was re-designated Part A-1.
[2] All references to EPCA in this document refer to the statute as amended through the Energy Efficiency Improvement Act of 2015 (EEIA 2015), Pub. L. 114-11 (April 30, 2015).

DOE's regulations set forth at 10 CFR 431.401 contain provisions that permit a person to seek a waiver from the test procedure requirements for covered equipment if at least one of the following conditions is met: (1) the basic model contains one or more design characteristics that prevent testing according to the prescribed test procedures; or (2) the prescribed test procedures may evaluate the basic model in a manner so unrepresentative of its true energy consumption as to provide materially inaccurate comparative data. 10 CFR 431.401(a)(1). A petitioner must include in its petition any alternate test procedures known to the petitioner to evaluate the basic model in a manner representative of its energy consumption. 10 CFR 431.401(b)(1)(iii). DOE may grant a waiver subject to conditions, including adherence to alternate test procedures. 10 CFR 431.401(f)(2). As soon as practicable after the granting of any waiver, DOE will publish in the Federal Register a notice of proposed rulemaking to amend its regulations so as to eliminate any need for the continuation of such waiver. As soon thereafter as practicable, DOE will publish in the Federal Register a final rule. 10 CFR 431.401(l).

II. Petition for Waiver of Test Procedure

On May 5, 2015, Raypak filed a petition for waiver from the DOE test procedure at 10 CFR 431.106 to measure standby loss of commercial water heating equipment. This petition addresses Raypak's specified models of commercial instantaneous water heaters containing 10 gallons or more of water. The current DOE efficiency test procedure for commercial water heaters incorporates by reference the relevant industry test standard for measuring thermal efficiency and standby loss, as specified in American National Standards Institute (ANSI) ANSI Z21.10.3-2011, Gas-Fired Water Heaters,

Volume III, Storage Water Heaters, With Input Ratings Above 75,000 Btu Per Hour, Circulating and Instantaneous. In its petition, Raypak contends that its identified basic models rely on flow of water through the heater to activate the burner, but because the current DOE test procedure does not take into account such units, it does not provide a proper representation of the standby loss of these models. The current standby loss test procedure is designed to test tank-type water heaters which are thermostatically operated. The models for which Raypak is seeking this test procedure waiver employ tube-type heat exchangers and are designed to be flow activated. To address the apparent shortcomings of ANSI Z21.10.3-2011, Raypak has submitted to DOE an alternate test procedure for measuring the standby loss of tube-type instantaneous water heaters, as addressed in sections E.1 and E.3 of ANSI Z21.10.3-2012, Gas-Fired Water Heaters, Volume III, Storage Water Heaters, With Input Ratings Above 75,000 Btu Per Hour, Circulating and Instantaneous. Raypak believes this alternative provides a representative measure of the standby loss of these models.

III. Alternate Test Procedure

EPCA requires that manufacturers use DOE test procedures when making representations about the energy consumption and energy consumption costs of products and equipment covered by the statute. (42 U.S.C. 6293(c); 6314(d)) Consistent representations about the energy efficiency of covered products and equipment are important for consumers evaluating products when making purchasing decisions and for manufacturers to demonstrate compliance with applicable DOE energy conservation standards. Pursuant to its regulations applicable to waivers and interim waivers from

applicable test procedures at 10 CFR 431.401, DOE will consider setting an alternate test procedure for Raypak in a subsequent Decision and Order.

Raypak has submitted to DOE an alternate test procedure for measuring the standby loss of tube-type instantaneous water heaters as addressed in ANSI Z21.10.3-2012 sections E.1 and E.3. Specifically, Raypak has submitted the following alternate test procedure to accurately represent the standby loss of its commercial instantaneous water heaters containing 10 gallons or more of water:

Z21.10.3-2012

Exhibit E Efficiency Test Procedures

E.1 Method Of Test For Measuring Thermal Efficiency

A water heater for installation on combustible floors shall be placed on ¾ in (1.9 cm) plywood platform supported by three 2 x 4 runners. If the water heater is for installation on noncombustible floors, suitable noncombustible material shall be placed on the platform. When the use of the platform for a large water heater is not practical, the water heater may be placed on any suitable flooring. A wall mounted water heater shall be mounted to a simulated wall section.

Placement in the test room shall be in an area protected from drafts.

Inlet and outlet piping shall be immediately turned vertically downward from the connections on a tank-type water heater so as to form heat traps. Any factory supplied heat traps shall be installed per the installation instructions. Thermocouples for measuring inlet and outlet water temperatures shall be installed before the inlet heat trap piping and after the outlet heat trap piping.

Water-tube water heaters shall be installed as shown in Figure 3, Arrangement for Testing Water-tube Type Instantaneous and Circulating Water Heaters.

a. Piping Insulation

Insulate the water piping, including heat traps, for a length of 4 ft (1.22 m) from the connection at the appliance with material having a thermal resistance (R) value of not less than 4 [F·ft ·hr/Btu (0.7 K·m /W)]. Care should be taken so the insulation does not contact any appliance surface except at the location where the pipe connections penetrate the appliance jacket.

b. Temperature and Pressure Relief Valve Insulation

If the manufacturer has not provided a temperature and pressure relief valve, one shall be installed and insulated as specified above.

c. Vent Requirements

1. Appliance Equipped With Draft Hoods

All tests shall be conducted with the natural draft established by the following vent pipe arrangements:

A vertically discharging vent connection shall have attached to and vertically above it, 5 ft (1.52 m) of vent pipe the same size as the outlet. If the vent does not discharge vertically, a suitable elbow shall be installed first.

2. Direct Vent Appliances and Mechanically Vented

The appliance shall be installed with the venting arrangement specified in the manufacturer's instructions. The water heater shall be installed with the manufacturer's specified minimum venting length venting arrangement.

d. Water Supply

During conduct of this test, the temperature of the supply water shall be maintained at 70 ± 2°F (21 ± 1°C). The pressure of the water supply shall be maintained between 40 psi (275.8 kPa) and the maximum pressure specified by the manufacturer for the appliance under test. The accuracy of the pressure measuring devices shall be ±1.0 psi

(6.9 kPa). For a water-tube water heater, the inlet water temperature shall be maintained at the supply water temperature or as specified by the manufacturer (see 2.1.8).

A tank-type water heater shall be isolated by use of a shutoff valve in the supply line with an expansion tank installed in the supply line downstream of the shutoff valve. There shall be no shutoff means between the expansion tank and the appliance inlet.

e. Gas Supply

The gas rate shall be adjusted as specified in 2.3.3. The outlet pressure of the gas appliance pressure regulator shall be within ± 10 percent of that recommended by the manufacturer. The higher heating value of the gas burned shall be obtained.

f. Installation of Temperature Sensing Means

For tank-type water heaters, six (6) temperature sensing means shall be installed inside the storage tank on the vertical center of each of 6 nonoverlapping sections of approximately equal volume from the top to the bottom of the tank. Each temperature sensing means is to be located as far as possible from any heat source or other irregularity, anodic protective device, or water tank or flue wall. The anodic protective device may be removed in order to install the temperature sensing means and all testing may be carried out with the device removed.

If the temperature sensing means cannot be installed as specified above, placement of the temperature sensing means shall be made at the discretion of the testing agency so comparable water temperature measurements may be obtained.

A temperature sensing means, shielded against direct radiation and positioned at the vertical midpoint of the water heater at a perpendicular distance of approximately 24 in (610 mm) from the surface of the jacket, shall be installed in the test room.

g. Setting Tank Thermostat

Before starting testing of a tank-type water heater, the setting of the thermostat shall first be obtained by starting with the water in the system at 70 ± 2°F (21 ± 1°C) and noting the maximum mean temperature of the water after the thermostat reduces the gas supply to a minimum. The temperature shall be 140 ± 5°F (60 ± 3°C).

h. Energy Consumption

Instrumentation shall be installed which determines, within ± 1 percent:

1. The quantity and rate of gas consumed.

2. The quantity of electricity consumed by factory supplied water heater components, and of the test loop recirculating pump, if used.

i. Room Ambient Temperature

The ambient air temperature of the test room shall be maintained at 75 ± 10°F (24 ± 5.5°C), as measured by the test room temperature sensing means described in "-f" above.

The ambient air temperatures shall be measured at 15 minute intervals during conduct of this test. The room temperature shall not vary more than ± 7.0°F (± 4°C) from the average during the test, temperature readings being taken by means of a recording thermometer at 15 minute intervals and averaged at the end of the test.

j. Efficiency Measurement

The outlet water temperature shall be adjusted by varying the rate of flow until temperature is constant at 70 ± 2°F (21 ± 1°C) above the supply temperature. After the outlet temperature has become constant, as indicated by no variation in excess of 2°F (1°C) over a 3 minute period, the outlet water

shall be diverted from the waste line to a weighing container. A scale with an error no greater than 1 percent of the total draw shall be used. Water shall be allowed to flow into the weighing container for exactly 30 minutes. The gas consumption and electrical power consumption of factory supplied heater components and of the test loop-recirculating pump, if used, shall be measured for the 30 minute period. At this time, the outlet water shall be diverted back into the waste line, the meter readings noted, and the weight of heater water recorded. Throughout the period of test, supply and outlet water temperatures shall be recorded every minute. The temperature, pressure and heating value of the gas metered and barometric pressure shall be obtained.

A water meter with an error no greater than 1 percent of the total draw may be used instead of the scale and weighing container.

Thermal efficiency, Et, shall be computed by use of the following formula:

$$E_t = (KW(\theta_2 - \theta_1) / [(CF \times Q \times H) + E_c]) \times 100$$

Where:

K	=	1.004 Btu per pound mass degree F (4184 J/kg °C), nominal specific heat of water at 105°F;
W	=	total weight of water heated, lbs. (kg);
θ_1	=	average temperature of supply water, °F (°C);
θ_2	=	average temperature of outlet water, °F (°C);
Q	=	total gas consumed as metered, cu. ft. (m^3);

C_s = correction applied to the heating value H, when it is metered at temperature and/or pressure conditions other than the standard conditions. At which the heating value of gas is specified [normally 30 inches mercury column (101.3 kPa) and 60°F (15.5°C)];

H = total heating value of gas, Btu per cu. ft. (MJ/m_3); and

E_c = electrical consumption of the water heater and, when used, the test setup recirculating pump, specified in Btu (kJ).

Standby Loss for tank type water heaters shall be determined using Appendix E.2

Standby Loss for tube type water heaters that contain 10 or more gallons within the water heater, as determined under 5.27, shall be determined using Appendix E.3

E.3 Method Of Test For Measuring Standby Loss For Tube Type Instantaneous Water Heaters With 10 or Greater Gallons of Storage

The appliance shall be installed as specified in G.1, Method of Test for Measuring Thermal Efficiency. This test may be conducted immediately following the thermal efficiency test. In this case, start the test after the main burner(s) has shut down and, if applicable, the water pump has shut down. Otherwise, the water heater shall be put into operation under the same test conditions specified in G.1, and the outlet water temperature shall be adjusted by varying the rate of flow until temperature is constant at 70 ± 2°F (21 ± 1°C) above the supply temperature. After the outlet temperatures becomes constant, as indicated by no variation in excess of

2°F (1°C) over a 3 minute period, shut down the main burner(s) and, if applicable, wait for the water pump to shut down, and then start the test.

At the start of the test, record the time, ambient temperature, outlet water temperature, supply water temperature, and begin measuring the fuel and electric consumption.

During the first hour, outlet water temperature, supply water temperature and the ambient air temperature shall be measured at the end of each 5 minute interval. For the remainder of the test, these measurements shall be made at the end of every 15 minute interval. The duration of this test shall be 24 hours. If the main burner is firing at 24 hours, continue the test until the main burner and the water pump, if applicable, have shut down.

Immediately after the conclusion of the test, record the total fuel flow and electrical energy consumption, the final ambient air temperature, and the final outlet water temperature.

Calculate the average of the ambient air temperatures and the supply water temperatures taken at the end of each time interval, including the initial and final values.

The average hourly standby loss, S, rounded to the nearest Btu per hour, shall be determined by the formula:

$$S = [(Cs(Qs)(H) + Ec) / t] – [(\Delta T4) / (\Delta T3)(t)Et]$$

Where:

Cs = correction applied to the heating value of a gas H, when it is metered at temperature and/or pressure conditions other than the standard conditions for which the value of H is based;

H = higher heating value of gas, Btu per cu. ft. (MJ/m3);

Qs = total fuel flow as metered, cu. ft. (m3);

$\Delta T3$ = difference between the outlet temperature and the average value of the ambient air temperature, °F (°C);

$\Delta T4$ = difference between the average supply water temperature and the outlet temperature, °F (°C);

t = duration of test, hrs.;

Ec = electrical energy consumption expressed in Btu (kJ); and

Et = thermal efficiency as determined under G1, Method of Test for Measuring Thermal Efficiency

If the main burner(s) does not cycle on during this test, the hourly average standby loss calculation simplifies to:

$$S = \{(K(Va)(\Delta T4) / Et) + Ec \} / t$$

For water heaters that will not initiate or cause actions that will initiate burner operation, the following simplified procedure may be used to measure the hourly standby loss.

This test may be conducted immediately following the thermal efficiency test. In this case, start the test after the main burner(s) has shut down and, if applicable, the water pump has shut down. Otherwise provide the electrical connection as specified in G.1, Method of Test for Measuring Thermal Efficiency, and start the test.

At the start of the test, record the time and begin measuring the electric consumption for one hour. Record the duration of the test and the total electrical consumption during the test.

The average hourly standby loss, S, rounded to the nearest Btu per hour, shall be determined by the formula:

$$S = [((\Delta T5\ k\ Va\ /\ Et)/24) + Ec]$$

Where:

$\Delta T5$ = 70°F (38.9°C), difference between the supply and outlet water temperatures;

k= 8.25 Btu/gallon °F (4147.6331 J/l°C), the nominal specific heat of water;

Va = water contained in the water heater expressed in gallons (L), as determined under 5.27;

Ec = electrical energy consumption expressed in Btu (kJ); and

Et = thermal efficiency as determined under G1, Method of Test for Measuring Thermal Efficiency.

The following basic models are included in Raypak's petition:

XTherm Model WH7-1005*

XTherm Model WH7-1505*

XTherm Model WH7-2005*

XTherm Model WH7-2505*

XTherm Model WH7-3005*

XTherm Model WH7-3505*

XTherm Model WH7-4005*

MVB Model WH7-2503*

MVB Model WH7-3003*

MVB Model WH7-3503*

MVB Model WH7-4003*

IV. Summary and Request for Comments

Through this notice, DOE announces receipt of and is publishing Raypak's petition for waiver from the DOE test procedure for commercial water heaters for its above-referenced commercial instantaneous water heater models, which contain 10 gallons or more of water. The petition contains no confidential information. The petition

includes a suggested alternate test procedure to determine the thermal efficiency and standby loss of Raypak's specified basic models of commercial instantaneous water heaters containing 10 gallons or more of water. DOE is considering including this alternate test procedure in its subsequent Decision and Order.

DOE solicits comments from interested parties on all aspects of the petition, including the suggested alternate test procedure and calculation methodology. Pursuant to 10 CFR 431.401(d), any person submitting written comments to DOE must also send a copy of such comments to the petitioner. The contact information for the petitioner is: Mr. Robert Glass, Sr. Staff Engineer, Raypak Inc., 2151 Eastman Avenue, Oxnard, CA 93030. All submissions received must include the agency name and case number for this proceeding. Submit electronic comments in WordPerfect, Microsoft Word, Portable Document Format (PDF), or text (American Standard Code for Information Interchange (ASCII)) file format and avoid the use of special characters or any form of encryption. Wherever possible, include the electronic signature of the author. DOE does not accept telefacsimiles (faxes).

Pursuant to 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit two copies: one copy of the document marked "confidential" with all of the information believed to be confidential included, and one copy of the document marked "non-confidential" with all of the information believed to be confidential deleted. DOE will make its own determination about the confidential status of the information and treat it according to its determination.

Issued in Washington, DC, on May 31, 2016.

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Kathleen B. Hogan
Deputy Assistant Secretary for Energy Efficiency
Energy Efficiency and Renewable Energy

Raypak, A Rheem Company

May 5, 2015

U.S. Department of Energy
Building Technologies Program, MS EE-2J
Test Procedure Waiver
1000 Independence Avenue, S.W.
Washington, D.C. 20585-0121

Re: Waiver for Test Procedure for Commercial Water Heating Equipment

To Whom It May Concern:

Pursuant to the provisions of 10 C.F.R. § 431.401, Raypak Inc. is hereby applying for a waiver of the standby loss test procedure of 10 C.F.R. §.431.106 for the following basic model(s) of commercial instantaneous water heaters containing 10 gallons or more of water:

Model	**Water Capacity (Gal.)**
XTherm Model WH7-1005*	11.8
XTherm Model WH7-1505*	12.4
XTherm Model WH7-2005*	15.6
XTherm Model WH7-2505*	25.0
XTherm Model WH7-3005*	26.0
XTherm Model WH7-3505*	26.9
XTherm Model WH7-4005*	33.8
MVB Model WH7-2503*	10.9
MVB Model WH7-3003*	11.6
MVB Model WH7-3503*	12.2
MVB Model WH7-4003*	12.8

The current Department of Energy efficiency test procedure for commercial water heaters references the relevant test procedures for measuring thermal efficiency and standby loss specified in the standard, ANSI Z21.10.3-2011. The identified basic models rely on flow of water through the heater to activate the burner. As will be explained below, the current test procedure does not provide a proper representation of the standby loss of these models.

The current standby loss test procedure is included as Attachment A. This procedure is designed to test tank-type water heaters which are thermostatically operated. The basic steps of the procedure are to heat the water within the water heater, turn off the burner or element and then measure all the energy consumption that occurs while the water heater is "standing by" for approximately 24 hours with no water being withdrawn from it. The key measurement of the test procedure is the energy consumed by the burner or heating element

when the thermostat senses that the water in the tank has cooled down to the point where it needs to be reheated. The current test does not address water heaters that have no means to activate the burner or heating element if no heated water is being drawn from the unit, i.e. the standby condition.

The models for which Raypak Inc. is seeking this test procedure waiver employ tube type heat exchangers and are designed to be flow activated. That is, the burner does not come on until water flow through the unit is sensed. Under the current standby loss test procedure, the burner on these models will not fire at any time during the test and the resulting standby loss measurement would be nearly zero. That measurement is not representative of the standby loss characteristics of these models. Raypak Inc. believes that the current test procedure evaluates the standby loss of the identified basic models in a manner so unrepresentative of the true energy consumption as to provide materially inaccurate comparative data.

The manufacturers of other basic models marketed in the United States known to Raypak Inc. to incorporate similar design characteristics is included as Attachment B.

An alternative procedure for measuring the standby loss of tube type instantaneous water heater is included as Attachment C. Raypak Inc. believes this alternative provides a representative measure of the standby loss of these models. Raypak Inc. requests that DOE grant it a waiver to use this alternative procedure in lieu of the standby loss procedure specified in the current DOE efficiency test procedures for commercial water heaters.

Respectfully submitted,

Robert Glass
Sr. Staff Engineer
Raypak Inc.
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Oxnard, CA 93030
(805) 278-5300
FAX (800) 872-9725
www.raypak.com

Attachments – Attachment A – Current Standby Loss Test Procedure
Attachment B – Other Affected Manufacturers
Attachment C – Proposed Alternative Procedure for Measuring the Standby Loss of Tube Type Instantaneous Water Heaters Containing More than 10 Gallons

C: Karen Meyers – Rheem Manufacturing Co.
Russell Pate – Rheem Manufacturing Co.

Attachment A: Current Standby Loss Test Procedure

E.2 Method of test for measuring standby loss

The appliance shall be installed as specified in E.1, Method of test for measuring thermal efficiency. The gas to the main burner(s) shall be turned on and the appliance put into operation. After the first cutout, allow the water heater to remain in the standby mode until the next cutout. At this time record the time, ambient temperature and begin measuring the fuel and electric consumption. Record the maximum mean tank temperature that occurs after cutout.

At the end of the first 15 minute interval and at the end of each subsequent 15 minute interval, the mean tank temperature and the ambient air temperature shall be recorded. The duration of this test shall be until the first cutout that occurs after 24 hours or 48 hours, whichever comes first.

Immediately after the conclusion of the test, record the total fuel flow and electrical energy consumption, the final ambient air temperature, and the time duration of the standby loss test (t) in hours rounded to the nearest one hundredth of an hour and the maximum mean tank temperature that occurs after cutout. Calculate the average of the recorded values of the mean tank temperatures and of the ambient air temperatures taken at the end of each time interval, including the initial and final values.

Determine the difference (ΔT_3) between these two averages by subtracting the latter from the former, and the differences (ΔT_4) between the final and initial mean tank temperatures by subtracting the latter from the former.

The ratio of the average hourly energy consumption to the heat content of the stored water above room temperatures, in percent, rounded to the nearest one hundredth shall be determined by the formula:

$$S = \left\{ \left[\frac{(Cs)(Qs)(H) + Ec}{(K)(Va)(\Delta T3)(t)} \right] - \left[\frac{(\Delta T4)}{(\Delta T3)(t)\left(\frac{Et}{100}\right)} \right] \right\} x\ 100$$

Where

Cs = correction applied to the heating value of a gas H, when it metered at temperature and/or pressure conditions other than the standard conditions for which the value of H is based;

K = 8.25 Btu per gallon °F (4147.6331 J/I°C), the nominal specific heat of water;

Va = tank capacity expressed in gallons (L), as determined under 5.26, Capacities of storage vessels;

H = higher heating value of gas, Btu per cu. Ft. (MJ/m^3);

Qs	=	total fuel flow as metered, cu. Ft. (m^3);
ΔT3	=	difference between the average value of the mean tank temperature and the average value of the ambient air temperature, °F (°C);
ΔT4	=	difference between the final and initial mean tank temperature, °F (°C);
t	=	duration of test, hrs.;
Ec	=	electrical energy consumption expressed in Btu (kJ); and
Et	=	thermal efficiency as determined under E.1, Method of test for measuring thermal efficiency.

Attachment B:

Manufacturers of Commercial Tube Type Water Heaters containing 10 gallons or more

A.O. Smith Corporation
11270 W Park Place
PO Box 245008
Milwaukee, WI 53224-3623

HTP, Inc.
120 Braley Rd
P.O. Box 429
East Freetown, MA 02717-1125

Laars Heating Systems Company
20 Industrial Way
Rochester, NH 03867-4296

Lochinvar LLC
300 Maddox Simpson Pkwy
Lebanon, TN 37090-5366

Thermal Solutions Products, LLC, a
Subsidiary of Burnham Holdings
PO BOX 3244
Lancaster, PA 17604-3244

Attachment C

AHRI Recommended Standby Loss Test Procedure For Commercial Tube-Type Instantaneous Water Heaters And Hot Water Supply Boilers That Contain At Least 10 Gallons Of Water

Z21.10.3-2012

Exhibit E Efficiency Test Procedures

E.1 Method Of Test For Measuring Thermal Efficiency

A water heater for installation on combustible floors shall be placed on ¾ in (1.9 cm) plywood platform supported by three 2 x 4 runners. If the water heater is for installation on noncombustible floors, suitable noncombustible material shall be placed on the platform. When the use of the platform for a large water heater is not practical, the water heater may be placed on any suitable flooring. A wall mounted water heater shall be mounted to a simulated wall section.

Placement in the test room shall be in an area protected from drafts.

Inlet and outlet piping shall be immediately turned vertically downward from the connections on a tank-type water heater so as to form heat traps. Any factory supplied heat traps shall be installed per the installation instructions. Thermocouples for measuring inlet and outlet water temperatures shall be installed before the inlet heat trap piping and after the outlet heat trap piping.

Water-tube water heaters shall be installed as shown in Figure 3, Arrangement for Testing Water-tube Type Instantaneous and Circulating Water Heaters.

a. Piping Insulation

Insulate the water piping, including heat traps, for a length of 4 ft (1.22 m) from the connection at the appliance with material having a thermal resistance (R) value of not less than 4 [F·ft ·hr/Btu (0.7 K·m /W)]. Care should be taken so the insulation does not contact any appliance surface except at the location where the pipe connections penetrate the appliance jacket.

b. Temperature and Pressure Relief Valve Insulation

If the manufacturer has not provided a temperature and pressure relief valve, one shall be installed and insulated as specified above.

c. Vent Requirements

1. Appliance Equipped With Draft Hoods

All tests shall be conducted with the natural draft established by the following vent pipe arrangements:

A vertically discharging vent connection shall have attached to and vertically above it, 5 ft (1.52 m) of vent pipe the same size as the outlet. If the vent does not discharge vertically, a suitable elbow shall be installed first.

2. Direct Vent Appliances and Mechanically Vented

The appliance shall be installed with the venting arrangement specified in the manufacturer's instructions. The water heater shall be installed with the manufacturer's specified minimum venting length venting arrangement.

d. Water Supply

During conduct of this test, the temperature of the supply water shall be maintained at 70 ± 2°F (21 ± 1°C). The pressure of the water supply shall be maintained between 40 psi (275.8 kPa) and the maximum pressure specified by the manufacturer for the appliance under test. The accuracy of the pressure measuring devices shall be ±1.0 psi (6.9 kPa). For a water-tube water heater, the inlet water temperature shall be maintained at the supply water temperature or as specified by the manufacturer (see 2.1.8).

A tank-type water heater shall be isolated by use of a shutoff valve in the supply line with an expansion tank installed in the supply line downstream of the shutoff valve. There shall be no shutoff means between the expansion tank and the appliance inlet.

e. Gas Supply

The gas rate shall be adjusted as specified in 2.3.3. The outlet pressure of the gas appliance pressure regulator shall be within ± 10 percent of that recommended by the manufacturer. The higher heating value of the gas burned shall be obtained.

f. Installation of Temperature Sensing Means

For tank-type water heaters, six (6) temperature sensing means shall be installed inside the storage tank on the vertical center of each of 6 nonoverlapping sections of approximately equal volume from the top to the bottom of the tank. Each temperature sensing means is to be located as far as possible from any heat source or other irregularity, anodic protective device, or water tank or flue wall. The anodic protective device may be removed in order to install the temperature sensing means and all testing may be carried out with the device removed.

If the temperature sensing means cannot be installed as specified above, placement of the temperature sensing means shall be made at the discretion of the testing agency so comparable water temperature measurements may be obtained.

A temperature sensing means, shielded against direct radiation and positioned at the vertical midpoint of the water heater at a perpendicular distance of

approximately 24 in (610 mm) from the surface of the jacket, shall be installed in the test room.

g. Setting Tank Thermostat

Before starting testing of a tank-type water heater, the setting of the thermostat shall first be obtained by starting with the water in the system at 70 ± 2°F (21 ± 1°C) and noting the maximum mean temperature of the water after the thermostat reduces the gas supply to a minimum. The temperature shall be 140 ± 5°F (60 ± 3°C).

h. Energy Consumption

Instrumentation shall be installed which determines, within ± 1 percent:

1. The quantity and rate of gas consumed.

2. The quantity of electricity consumed by factory supplied water heater components, and of the test loop recirculating pump, if used.

i. Room Ambient Temperature

The ambient air temperature of the test room shall be maintained at 75 ± 10°F (24 ± 5.5°C), as measured by the test room temperature sensing means described in "-f" above.

The ambient air temperatures shall be measured at 15 minute intervals during conduct of this test. The room temperature shall not vary more than ± 7.0°F (± 4°C) from the average during the test, temperature readings being taken by means of a recording thermometer at 15 minute intervals and averaged at the end of the test.

j. Efficiency Measurement

The outlet water temperature shall be adjusted by varying the rate of flow until temperature is constant at 70 ± 2°F (21 ± 1°C) above the supply temperature. After the outlet temperature has become constant, as indicated by no variation in excess of 2°F (1°C) over a 3 minute period, the outlet water shall be diverted from the waste line to a weighing container. A scale with an error no greater than 1 percent of the total draw shall be used. Water shall be allowed to flow into the weighing container for exactly 30 minutes. The gas consumption and electrical power consumption of factory supplied heater components and of the test loop-recirculating pump, if used, shall be measured for the 30 minute period. At this time, the outlet water shall be diverted back into the waste line, the meter readings noted, and the weight of heater water recorded. Throughout the period of test, supply and outlet water temperatures

shall be recorded every minute. The temperature, pressure and heating value of the gas metered and barometric pressure shall be obtained.

A water meter with an error no greater than 1 percent of the total draw may be used instead of the scale and weighing container.

Thermal efficiency, Et, shall be computed by use of the following formula:

$$E_t = (KW(\theta_2 - \theta_1) / [(CF \times Q \times H) + E_c]) \times 100$$

where

K = 1.004 Btu per pound mass degree F (4184 J/kg °C), nominal specific heat of water at 105°F;

W = total weight of water heated, lbs. (kg);

θ_1 = average temperature of supply water, °F (°C);

θ_2 = average temperature of outlet water, °F (°C);

Q = total gas consumed as metered, cu. ft. (m^3);

C_s = correction applied to the heating value H, when it is metered at temperature and/or pressure conditions other than the standard conditions. At which the heating value of gas is specified [normally 30 inches mercury column (101.3 kPa) and 60°F (15.5°C)];

H = total heating value of gas, Btu per cu. ft. (MJ/m_3); and

E_c = electrical consumption of the water heater and, when used, the test setup recirculating pump, specified in Btu (kJ).

Standby Loss for tank type water heaters shall be determined using Appendix E.2

Standby Loss for tube type water heaters that contain 10 or more gallons within the water heater, as determined under 5.27, shall be determined using Appendix E.3

E.3 Method Of Test For Measuring Standby Loss For Tube Type Instantaneous Water Heaters With 10 or Greater Gallons of Storage

The appliance shall be installed as specified in G.1, Method of Test for Measuring Thermal Efficiency. This test may be conducted immediately following the thermal efficiency test. In this case, start the test after the main burner(s) has shut down and, if applicable, the water pump has shut down. Otherwise, the water heater shall be put into operation under the same test conditions specified in G.1, and the outlet water temperature shall be adjusted by varying the rate of flow until temperature is constant at 70 ± 2°F (21 ± 1°C) above the supply temperature. After the outlet temperatures becomes constant, as indicated by no variation in excess of

2°F (1°C) over a 3 minute period, shut down the main burner(s) and, if applicable, wait for the water pump to shut down, and then start the test.

At the start of the test, record the time, ambient temperature, outlet water temperature, supply water temperature, and begin measuring the fuel and electric consumption.

During the first hour, outlet water temperature, supply water temperature and the ambient air temperature shall be measured at the end of each 5 minute interval. For the remainder of the test, these measurements shall be made at the end of every 15 minute interval. The duration of this test shall be 24 hours. If the main burner is firing at 24 hours, continue the test until the main burner and the water pump, if applicable, have shut down.

Immediately after the conclusion of the test, record the total fuel flow and electrical energy consumption, the final ambient air temperature, and the final outlet water temperature.

Calculate the average of the ambient air temperatures and the supply water temperatures taken at the end of each time interval, including the initial and final values.

The average hourly standby loss, S, rounded to the nearest Btu per hour, shall be determined by the formula:

$$S = [(Cs(Qs)(H) + Ec) / t] – [(\Delta T4) / (\Delta T3)(t)Et]$$

where

Cs = correction applied to the heating value of a gas H, when it is metered at temperature and/or pressure conditions other than the standard conditions for which the value of H is based;

H = higher heating value of gas, Btu per cu. ft. (MJ/m3);

Qs = total fuel flow as metered, cu. ft. (m3);

$\Delta T3$ = difference between the outlet temperature and the average value of the ambient air temperature, °F (°C);

$\Delta T4$ = difference between the average supply water temperature and the outlet temperature, °F (°C);

t = duration of test, hrs.;

Ec = electrical energy consumption expressed in Btu (kJ); and

Et = thermal efficiency as determined under G1, Method of Test for Measuring Thermal Efficiency

If the main burner(s) does not cycle on during this test, the hourly average standby loss calculation simplifies to:

$$S = \{(K(Va)(\Delta T4) / Et) + Ec \} / t$$

For water heaters that will not initiate or cause actions that will initiate burner operation, the following simplified procedure may be used to measure the hourly standby loss.

This test may be conducted immediately following the thermal efficiency test. In this case, start the test after the main burner(s) has shut down and, if applicable, the water pump has shut down. Otherwise provide the electrical connection as specified in G.1, Method of Test for Measuring Thermal Efficiency, and start the test.

At the start of the test, record the time and begin measuring the electric consumption for one hour. Record the duration of the test and the total electrical consumption during the test.

The average hourly standby loss, S, rounded to the nearest Btu per hour, shall be determined by the formula:

$$S = [((\Delta T5\ k\ Va / Et)/24) + Ec]$$

Where:

$\Delta T5$ = 70°F (38.9°C), difference between the supply and outlet water temperatures;

k= 8.25 Btu/gallon °F (4147.6331 J/l°C), the nominal specific heat of water;

Va = water contained in the water heater expressed in gallons (L), as determined under 5.27;

Ec = electrical energy consumption expressed in Btu (kJ); and

Et = thermal efficiency as determined under G1, Method of Test for Measuring Thermal Efficiency.

[FR Doc. 2016-13252 Filed: 6/3/2016 8:45 am; Publication Date: 6/6/2016]