TAB 6

Item No. FE-2009-2
(For NSF International internal use)

Joint Committee Issue Document

NOTE: An issue document may be submitted at any time – it comprises two parts: the cover sheet (this page) and a description of the issue to be submitted to the Joint Committee (following page). A separate issue form is required for each issue submitted. Issue papers include proposals for modification of a standard, information reports and (of current research, etc.). An issue paper shall be categorized as being for ACTION or for INFORMATION. Submitters should limit the Issue Paper to 1 or 2 pages – attachments detailing full recommendations or background information may be attached with supplementary information. The Chairperson of the appropriate Joint Committee will respond within 30 days of receipt of the issue document advising what steps will be taken. Any issue document intended for discussion at a Joint Committee meeting must be received at least 21 days prior to the meeting to ensure inclusion in the agenda.

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Please insert a check (X) in the appropriate place to indicate if you wish the item to be considered as an action item or as an information item.

Action X Information

NSF Standard(s) Impacted**:**

NSF/ANSI 5

Issue Statement:

Provide a concise statement of the issue, which reference as appropriate any specific section(s) of the standard(s) that are related to the issue.

Section 6.1 Recovery Rate Verification requires testing for gas and electric water heaters. Recovery Rate, as defined by ANSI Z21.10.3 and per ASHRAE 118.1 is *calculated* as follows:

R = ((Rated Input x Thermal Efficiency)***/***(Temp Rise x 8.25))

Gas Water heaters should be excluded from this test, due to the fact that they have already met the Federally Mandated performance requirements (for thermal efficiency) and ANSI Z21.10.3 safety requirements (for input rate) which are the two variables involved for this testing.

Electric Water Heaters, with immersion type elements, should be excluded from this test in that they are assumed to have a Thermal Efficiency of 98% and therefore exempt from the thermal efficiency test procedure. This is consistent in DOE and ASHRAE requirements. NSF 5, Annex B would also appear to support this by stating, "T*hermal efficiency is based on a minimum rating of 75% for gas equipment and* ***98% for electrical equipment***".

Background:

Provide a brief background statement indicating the cause and nature of concern, the impacts identified relevant to public health, public understanding, etc, and any other reason why the issue should be considered by the Committee.

Certifying agencies, per the standard, are requiring this test be performed and that the test results be used in the Product Manual.

The test is redundant, for gas heaters, in that the two variables of the test (thermal efficiency and input rate) have already been covered in the initial certification process.

The test is not needed, for immersion type, electric heaters in that there is only one variable (Input) and it is covered in the safety testing as well. (Thermal Efficiency is assumed to be 98%.)

Hypothetically, performing this test creates the potential for conflicting information to be released to the general public, should the water heaters Input Rate and/or Thermal Efficiency fluctuate during this testing and have an adverse effect on the test results.

In this hypothetical case, if the agency certifying the sanitation approval is different from the agency doing the initial certification (NSF and CSA/UL), which agency directive is the manufacturer supposed to comply with?

Also, It potentially puts the manufacturer in a position of having to publish information contrary to Federal Guidelines.

It also potentially places an added financial burden on the manufacturer, in that Product manuals are developed and released during the Safety Certification process. A recovery rate chart is

included in the manual. That chart is calculated using the Thermal Efficiency data obtained during the product development and is reported/published via the AHRI/GAMA directory. Again, if the Certifying Agency requires this test and the data is different, the manufacturer will have to make changes to their product manuals.

This, in turn, has the potential of putting conflicting information out to the general public by having the new manual in new products and the original manual in previously sold products.

Recommendation:

If action by the Joint Committee is being requested, clearly state what action is needed: e.g., recommended changes to the standard(s) including the current text of the relevant section(s) indicating deletions by use of ~~strike-out~~ and additions by highlighting or underlining; e.g., reference of the issue to a Task Force for detailed consideration; etc. If recommended text changes are more than a half page, please attach a separate document.

Our First Recommendation is that section 6.1 Recovery Rate Verification be removed from the standard.

Our Second Recommendation, if the first is denied, is to specifically exclude Water Heaters, covered under DOE 10 CFR, Part 431 from this test, as follows:

6.1 Recovery rate verification (Water heaters covered under DOE 10 CFR, Part 431)

6.1.1 Performance requirement

The water heater shall be capable of providing quantities of water at the manufacturers rated temperature rise and flow rate while not exceeding the rated power input to the device. Water heaters covered under DOE 10 CFR, Part 431 (EPACT) are exempt from this requirement.

Note: This test is specifically labeled as a "*Performance Test*". Therefore, omitting this test would not constitute a safety risk to the general public.

Supplementary Materials (photographs, diagrams, reports, etc.):

If not provided electronically, the submitter will be responsible to have sufficient copies to distribute to committee members.

1) ASHRAE 118.1, pages, defining Recovery Rate calculation.
2) ANSI Z21.10.3 – 1998, Recovery Rate definition. (See Note 1.)
3) ANSI Z21.10.3 – 1998, thermal efficiency test method. (See Note 1.)
4) NSF/ANSI 5, Annex B, page B1, assuming thermal efficiency.
5) Federal Register, 10 CFR, Part 431, Pages 61984-61985, showing efficiency requirements.

Note 1: The ANSI Z21.10.3 -1998 edition was supplied, due to DOE requirement specifying 1998 standard for efficiency testing.

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nearest tenth for the 30-minute test period. Calculate the quantity of energy consumed, in Btu (J), during the test as follows:

For electric,

$$Q_{te} = C_{ge} \times Z_t \quad (10\text{-}1a)$$

$$[Q_{te} = C_{WJ} \times Z_t] \quad (10\text{-}1b)$$

For gas,

$$Q_{tg} = Vol_t \times H \times C_s \quad (10\text{-}2a)$$

$$[Q_{tg} = Vol_t \times H \times C_s] \quad (10\text{-}2b)$$

For oil,

$$Q_{to} = W_{ft} \times H_o \quad (10\text{-}3a)$$

$$[Q_{to} = W_{ft} \times H_o] \quad (10\text{-}3b)$$

If a flowmeter is used to measure the volume of water, calculate W_t, the weight of water, using Equation 10-4.

$$W_t = \frac{FR \times (t_{ft} - t_{ot})}{C_{fg} \times v} \quad (10\text{-}4)$$

Calculate the thermal efficiency, E_t, a dimensionless quantity, as follows:

$$E_t = \frac{W_t \times C_p \times (T_{om} - T_{sm})}{Q_{te} + Q_{tg} + Q_{to}} \quad (10\text{-}5)$$

10.2.2 Reduced Input Rating. Utilize the data recorded in Section 9.1.2. From the supply and outlet water temperatures recorded, calculate their means, T_{sm} and T_{om}, in degrees to the nearest tenth for the 30-minute test period. Calculate the quantity of energy consumed, in Btu (J), during the test as follows:

For electric,

$$Q_{tep} = C_{ge} \times Z_{tp} \quad (10\text{-}6a)$$

$$[Q_{tep} = C_{WJ} \times Z_{tp}] \quad (10\text{-}6b)$$

For gas,

$$Q_{tgp} = Vol_{tp} \times H \times C_s \quad (10\text{-}7a)$$

$$[Q_{tgp} = Vol_{tp} \times H \times C_s] \quad (10\text{-}7b)$$

For oil,

$$Q_{top} = W_{ftp} \times H_o \quad (10\text{-}8a)$$

$$[Q_{top} = W_{ftp} \times H_o] \quad (10\text{-}8b)$$

If a flowmeter is used to measure the volume of water, calculate W_{tp}, the weight of water, using Equation 10-9.

$$W_{tp} = \frac{FR_p \times (t_{ftp} - t_{0tp})}{C_{fg} \times v} \quad (10\text{-}9)$$

Calculate the thermal efficiency, E_{tp}, a dimensionless quantity, as follows:

$$E_{tp} = \frac{W_{tp} \times C_p \times (T_{om} - T_{sm})}{Q_{te} + Q_{tg} + Q_{to}} \quad (10\text{-}10)$$

10.2.3 Recovery Rating. Calculate the recovery rate, R, in gallons (liters) per hour to the nearest tenth using Equation 10-11.

$$R = \frac{I \times E_t}{T_d \times C_{pg}} \quad (10\text{-}11)$$

where

I = input rating in Btu/h (for electric models multiply the kWh rating by C_{ge} = 3,412 Btu/kWh),

E_t = thermal efficiency as determined by Section 10.2.1 or 10.2.2 (for electric models with immersion heating elements use E_t = 0.98),

T_d = temperature difference, 100°F,

C_{pg} = a nominal specific heat for water of 8.25 Btu/gal·°F.

10.3 Heat Pump Water Heater Water-Heating Output and Coefficient of Performance (COP). The water-heating capacity and COP of Type IV and Type V heat pump water heaters are determined using data collected with the applicable test method at each set of operating conditions specified in Section 9.4.1. Repeat the following calculations for each test run.

10.3.1 Type IV Test Method. Use the data recorded in Section 9.4.4. Water-heating capacity in Btu/h (kW) shall be calculated for each of the 31 readings made during the 30-minute test period.

For readings n = 0 to 30:

$$Q_{hm} = FR_{hn} \times 60 \times (T_{ohn} - T_{ihn}) \times \frac{C_p}{C_{fg} \times v} \quad (10\text{-}12a)$$

$$\left[Q_{hn} = FR_{hn} \times 60 \times (T_{ohn} - T_{ihn}) \times C_p \times \frac{1}{C_{WJ}}\right] \quad (10\text{-}12b)$$

Calculate the average of these 31 values, Q_h, as follows:

$$Q_h = \frac{\sum_{0}^{30} Q_{hn}}{31} \quad (10\text{-}13)$$

Calculate the average electric power input, in Btu/h (kW), during the test as follows:

$$Q_{he} = \frac{C_{ge} \times (Z_h + Z_{pc})}{(t_{fh} - t_{0h})} \quad (10\text{-}14a)$$

$$\left[Q_{he} = \frac{(Z_h + Z_{pc})}{(t_{fh} - t_{0h})}\right] \quad (10\text{-}14b)$$

Calculate the average coefficient of performance, COP_h, a dimensionless quantity, as follows:

$$COP_h = \frac{Q_h}{Q_{he}} \quad (10\text{-}15)$$

Repeat the calculations for each set of test conditions in Section 9.4.1.

(f) **Water Heaters**.

(1) **Small Water Heaters**. The test methods for small water heaters are shown in Table F-1.

Table F-1
Small Water Heater Test Methods

Appliance	*Test Method*
Small water heaters that are federally-regulated consumer products	10 CFR Section 430.23(e) (2005)
Small water heaters that are not federally-regulated consumer products	
Gas and oil storage-type < 20 gallons rated capacity	ANSI/ASHRAE 118.2-1993
Booster water heaters	ANSI/ASTM F2022-00 (for all matters other than volume) ANSI Z21.10.3-1998 (for volume)
Hot water dispensers	Test Method in 1604(f)(4)
Mini-tank electric water heaters	Test Method in 1604(f)(5)
All others	10 CFR Section 430.23(e) (2005)

(2) **Large water heaters**. The test method for large water heaters is: for booster water heaters ANSI/ASTM F2022-00, and for all others ANSI Z21.10.3-1998, modified as follows:

(A) When testing an electric storage-type water heater for standby loss using Section 2.10 of ANSI Z21.10.3-1998:

1. the electrical supply voltage shall be maintained within ± 1 percent of the center of the voltage range specified on the water heater nameplate; and

2. when needed for calculations, the thermal efficiency (E_t) shall be 98 percent.

(B) When testing an oil water heater using Sections 2.9 and 2.10 of ANSI Z21.10.3-1998:

1. vertical length of flue pipe, of sufficient height to establish the minimum draft specified in the manufacturer's installation instructions, shall be connected to the flue gas outlet;

(ii) U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Hearings and Dockets, ''Test Procedures and Efficiency Standards for Commercial Water Heaters, Hot Water Supply Boilers, and Unfired Hot Water Storage Tanks,'' Docket No. EE–RM/TP–99–480, Forrestal Building, 1000 Independence Avenue, SW., Washington, DC 20585.

(2) *Obtaining copies of Standards.* Anyone can purchase a copy of the standard incorporated by reference from Global Engineering Documents, 15 Inverness Way West, Englewood, CO 80112, or *http://global.ihs.com/*, or *http://webstore.ansi.org/ansidocstore/*.

(d) *Reference standards.*—(1) *General.* The standards listed in this paragraph are referred to in the Department test procedures in this subpart, but they are not incorporated by reference. These sources are given here for information and guidance.

(2) *List of References.* (i) ASTM Standard Test Method C518–91, ''Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.''

(ii) ASTM Standard Test Method C177–97, ''Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.''

(iii) ASTM Standard Test Method D2156–80, ''Method for Smoke Density in Flue Gases from Burning Distillate Fuels.''

§ 431.106 Uniform test method for the measurement of energy efficiency of commercial water heaters and hot water supply boilers (other than commercial heat pump water heaters).

(a) *Scope.* This section covers the test procedures you must follow if, pursuant to EPCA, you are measuring the thermal efficiency or standby loss, or both, of a storage or instantaneous water heater or hot water supply boiler (other than a commercial heat pump water heater).

(b) *Testing and Calculations.* Determine the energy efficiency of each covered product by conducting the test procedure(s), set forth in the two rightmost columns of the following table, that apply to the energy efficiency descriptor(s) for that product:

Product	Energy efficiency descriptor	Use test setup, equipment and procedures in subsection labeled ''Method of Test'' of	With these additional stipulations
Gas-fired Storage and Instantaneous Water Heaters and Hot Water Supply Boilers*.	Thermal Efficiency	ANSI Z21.10.3–1998, § 2.9**	A. For all products, the duration of the standby loss test shall be until whichever of the following occurs first after you begin to measure the fuel and/or electric consumption: (1) The first cutout after 24 hours or (2) 48 hours, if the water heater is not in the heating mode at that time.
	Standby Loss	ANSI Z21.10.3–1998, § 2.10**.	B. For oil and gas products, the standby loss in Btu per hour must be calculated as follows: SL (Btu per hour) = S (% per hour) × 8.25 (Btu/gal–F) × Measured Volume (gal) × 70 (degrees F). C. For oil-fired products, apply the following in conducting the thermal efficiency and standby loss tests: (1) Venting Requirements—Connect a vertical length of flue pipe to the flue gas outlet of sufficient height so as to meet the minimum draft specified by the manufacturer.
Oil-fired Storage and Instantaneous Water Heaters and Hot Water Supply Boilers*.	Thermal Efficiency	ANSI Z21.10.3–1998, § 2.9**	(2) Oil Supply—Adjust the burner rate so that: (a) The hourly Btu input rate lies within ±2 percent of the manufacturer's specified input rate, (b) the CO_2 reading shows the value specified by the manufacturer, (c) smoke in the flue does not exceed No. 1 smoke as measured by the procedure in ASTM–D–2156–80, and (d) fuel pump pressure lies within ±10 percent of manufacturer's specifications.
	Standby Loss	ANSI Z21.10.3–1998, § 2.10**.	D. For electric products, apply the following in conducting the standby loss test: (1) Assume that the thermal efficiency (Et) of electric water heaters with immersed heating elements is 98 percent. (2) Maintain the electrical supply voltage to within ±5 percent of the center of the voltage range specified on the water heater nameplate.
Electric Storage and Instantaneous Water Heaters.	Standby Loss	ANSI Z21.10.3–1998, § 2.10**.	(3) If the set up includes multiple adjustable thermostats, set the highest one first to yield a maximum water temperature in the specified range as measured by the topmost tank thermocouple. Then set the lower thermostat(s) to yield a maximum mean tank temperature within the specified range.

*As to hot water supply boilers with a capacity of less than 10 gallons, these test methods become mandatory on October 21, 2005. Prior to that time, you may use for these products either (1) these test methods if you rate the product for thermal efficiency, or (2) the test methods in Subpart E if you rate the product for combustion efficiency as a commercial packaged boiler.

**Incorporated by reference, *see* § 431.105.

§ 431.107 Uniform test method for the measurement of energy efficiency of commercial heat pump water heaters [Reserved].

Energy Conservation Standards

§ 431.110 Energy conservation standards and their effective dates.

Each commercial storage water heater, instantaneous water heater, unfired hot water storage tank and hot water supply boiler [1] must meet the applicable energy conservation standard level(s) as follows:

Product	Size	Energy conservation standard [a] (products manufactured on and after October 29, 2003) [b]	
		Minimum thermal efficiency	Maximum standby loss [c]
Electric storage water heaters	All	N/A	0.30 + 27/V_m (%/hr)
Gas-fired storage water heaters	≤155,000 Btu/hr	80%	Q/800 + 110(V_r) $^{1/2}$ (Btu/hr)
	>155,000 Btu/hr	80%	Q/800 + 110(V_r) $^{1/2}$ (Btu/hr)
Oil-fired storage water heaters	≤155,000 Btu/hr	78%	Q/800 + 110(V_r) $^{1/2}$ (Btu/hr)
	>155,000 Btu/hr	78%	Q/800 + 110(V_r) $^{1/2}$ (Btu/hr)
Gas-fired instantaneous water heaters and hot water supply boilers.	<10 gal	80%	N/A
	≥10 gal	80%	Q/800 + 110(V_r) $^{1/2}$ (Btu/hr)
Oil-fired instantaneous water heaters and hot water supply boilers.	<10 gal	80%	N/A
	≥10 gal	78%	Q/800 + 110(V_r) $^{1/2}$ (Btu/hr)

Product	Size	Minimum thermal insulation
Unfired hot water storage tank	All	R–12.5

[a] V_m is the measured storage volume and V_r is the rated volume, both in gallons. Q is the nameplate input rate in Btu/hr.

[b] For hot water supply boilers with a capacity of less than 10 gallons: (1) the standards are mandatory for products manufactured on and after [Insert date one year after date the rule is published], and (2) products manufactured prior to that date, and on or after October 23, 2003, must meet either the standards listed in this table or the applicable standards in Subpart E of this Part for a ''commercial packaged boiler.''

[c] Water heaters and hot water supply boilers having more than 140 gallons of storage capacity need not meet the standby loss requirement if (1) the tank surface area is thermally insulated to R–12.5 or more, (2) a standing pilot light is not used and (3) for gas or oil-fired storage water heaters, they have a fire damper or fan assisted combustion.

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BILLING CODE 6450–01–P

[1] Any packaged boiler that provides service water, that meets the definition of ''commercial packaged boiler'' in subpart E of this part, but does not meet the definition of ''hot water supply boiler'' in subpart G, must meet the requirements that apply to it under subpart E.

Annex B[8]
(informative)

Technical information

B.1 Sizing water heaters for dishwashing machines

NSF/ANSI 3, *Commercial warewashing equipment,* specifies a minimum flow pressure of 15 psi (103 kPa) for the rinse water. To ensure the adequate temperature of the required volume of rinse water, heating capacity of water heating equipment covered by this Standard is determined by an optimum flow pressure of 20 psi (138 kPa). Flow pressure should be adjusted and regulated at 20 psi (138 kPa). Rinse volume requirements for specific dishwashing machines selected by model number should be used to determine the equipment necessary for any particular installation.

Peak hourly demand of hot water includes initial tank filling volume at 140 °F (60 °C), hourly 180 °F (83 °C) rinse water, and make-up water for multiple tank machines. Storage capacities will compensate for water required for initial tank fill, if the water heating equipment is sized for continuous operation.

No attempt has been made to consider overall efficiency of heating fuels. Local electric power and gas companies should be contacted for this information.

Minimum power inputs for water heating equipment are determined as follows:

minimum power input = (flow rate x temperature rise x water density x specific heat of water)) thermal efficiency

minimum power input = Btu/h (kW)

flow rate = gal (L)/h

water density = lb/gal (g/L)

specific heat = 1.00 Btu/(lb•°F) (4.19 J/[g•°K])

Thermal efficiency is based on a minimum rating of 75% for gas equipment and 98% for electrical equipment.

EXAMPLE – Assume a 20 in x 20 in (51 cm x 51 cm) single-tank dishwasher requires 104 gal (394 L) rinse water per hour. If the water supply temperature varies between 130 and 140 °F (55 and 60 °C), a heater should be selected to deliver water for the 50 °F (28 °C) rise requirement. Assume a specific heat capacity of 1.00 Btu/(lb•°F) (4.19 J/[g•°K]).

English:

Btu rating = 104 x 8.33 x 50 °F ÷ 0.75 = 57755 Btu/h

Metric:

kW rating = 394 x 998 x 4.19 x 28 °C ÷ 0.75 = 61 MJ/h = 17 kW

[8] The information contained in this Annex is not part of this American National Standard (ANS) and has not been processed in accordance with ANSI's requirements for an ANS. Therefore, this Annex may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to the Standard.

NONCOMBUSTIBLE MATERIAL. For the purpose of this standard, material which is not capable of being ignited and burned, such as materials consisting entirely of, or a combination of, steel, iron, brick, tile, concrete, slate, asbestos, glass and plaster.

NORMAL BUTANE (n-BUTANE), TECHNICAL GRADE. A liquefied petroleum gas composed of a minimum of 95 percent n-butane (C_4H_{10}) which may contain other impurities such as isobutane, butylenes and propane not in excess of 5 percent.

NORMAL INLET TEST PRESSURES. Those pressures specified for testing purposes at which adjustment of burner ratings and primary air adjustments are made.

ORIFICE. The opening in an orifice spud or other device whereby the flow of gas is limited and through which the gas is discharged.

ORIFICE SPUD. A removable plug or cap containing an orifice which permits adjustment of the flow of gas by substitution of a spud with a different size orifice.

PIEZO-ELECTRIC. A characteristic of some material by which electrical energy is generated as a result of an application of a pressure or impact to the material.

PIEZO-ELECTRIC SPARK GAS IGNITION SYSTEM. A combination of a piezo-electric spark generator, high voltage lead(s) and a spark electrode(s) designed to ignite pilot burner gas at an appliance burner.

PILOT. A small gas flame utilized to ignite gas at a main burner(s).

PILOT SHUTOFF DEVICE. A device capable of shutting off the pilot gas that is not intended for frequent usage. It may also be capable of adjusting pilot gas flow.

PORT. Any opening in a burner head through which gas or a gas-air mixture is discharged for ignition.

PRIMARY AIR. The air which, when introduced into a burner, mixes with the gas before it reaches the port(s).

PRIMARY AIR INLET. The opening(s) through which primary air is admitted into a burner.

PROPANE HD-5. A special grade of liquefied petroleum gas composed of a minimum of 90 percent liquid volume of propane (C_3H_8) and a maximum of 5 percent liquid volume of propylene (C_3H_6).

RACEWAY. A channel for holding wires, cables or bus bars, which is designed expressly for, and used solely for, this purpose. Raceways may be of metal or insulating material and the term includes metal conduit, flexible metal conduit, and wireways.

RATED VOLUME. The water storage capacity of a water heater as specified by the manufacturer.

RECOVERY RATING. As used in this standard, the quantity of water obtained by multiplying the manufacturer's input rating in Btu per hour by the thermal efficiency and dividing the product by 825 Btu per gallon. This is based on a 100°F temperature rise, and a nominal specific heat for water of 8.25 Btu per gallon per degree F.

RECREATIONAL VEHICLE. A vehicular type unit primarily designed as temporary living quarters for recreational, camping, or travel use, which either has its own motive power or is mounted on or drawn by another vehicle. The basic entities are as follows:

1. Camping Trailer. A vehicular portable unit mounted on wheels and constructed with collapsible partial side walls which fold for towing by another vehicle and unfold at the camp site.

2. Motor Home. A vehicular unit built on or permanently attached to a self-propelled motor vehicle chassis, or on a chassis cab or van which is an integral part of the completed vehicle.

3. Travel Trailer. A vehicular portable unit, mounted on wheels, of such a size or weight as not to require special highway movement permits when drawn by a motorized vehicle and having a living area of less than 220 square feet, excluding built-in equipment (such as wardrobes, closets, cabinets, kitchen units or fixtures) and bath and toilet rooms.

4. Truck Camper. A portable unit consisting of a roof, floor and sides, designed to be loaded onto and unloaded from the bed of a pickup truck.

REGULATOR, GAS APPLIANCE PRESSURE. A device for controlling a selected gas pressure.

In each case the direct ignition system shall ignite main burner gas within 4 seconds after gas reaches the main burner port(s).

2.8.5 **With the water heater at equilibrium temperatures while operating at normal inlet test pressure, the time required for the main burner gas supply to be shut off in the event of flame outage during an operational cycle shall not exceed 90 seconds.**

If the ignition means is reactivated, it shall be reenergized in not more than 0.8 second following flame outage and the ignition means shall reignite the main burner gas without flame flashout or damage to the appliance. On appliances where all air for combustion is supplied by mechanical means, the ignition means may be reactivated after a purge period sufficient to provide a minimum of four air changes of the combustion chamber and flue passages. For purposes of this test, the control manufacturer's specified maximum flame failure response time shall be used.

If the ignition means is reactivated, the control manufacturer's specified maximum flame failure reignition time and minimum recycle time shall be used.

2.8.6 **The construction of the water heater and the arrangement of the ignition system shall be such that in the event of a delay in ignition of the main burner gas such, as might be caused by foreign debris or electrical shorting of the ignition means, the appliance will vent itself without excessive flame flashout or damage.**

For the purposes of this test, the control manufacturer's specified maximum trial for ignition period shall be used. For systems which deactivate the ignition means prior to the end of the trial for ignition period, the test shall be conducted using the control manufacturer's specified maximum ignition activation period timing.

Method of Test

With the appliance at room temperature, the appliance shall be placed into operation at normal inlet test pressure with the ignition means temporarily circumvented for varying intervals of time up to the control manufacturer's maximum specified trial for ignition period or maximum specified ignition activation period, whichever is shorter. For multitry systems, attempts to ignite shall be made for varying intervals of time for each trial for ignition period and any time the ignition means is activated throughout the total operating sequence up to lockout. The resulting ignition for each time shall be observed for flame flashout or damage to the appliance.

2.8.7 **Temperatures of automatic burner ignition and safety shutoff devices shall not exceed those for which the device is designed when tested in accordance with the Method of Test specified in 2.6.12.**

2.9 THERMAL EFFICIENCY

The thermal efficiency of a storage water heater shall not be less than 78 percent. The thermal efficiency of an instantaneous water heater which contains less than 10 gallons of water shall not be less than 80 percent. The thermal efficiency of an instantaneous water heater which contains 10 gallons or more of water shall be not less than 77 percent.

Method of Test

A water heater for installation on combustible floors shall be placed on 3/4 inch plywood platform supported by three 2 x 4 runners. If the water heater is for installation o 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.

a. Piping Insulation

Insulate the water piping, including heat traps, for a length of 4 feet (1.22 m) from the connection at the appliance with material having a thermal resistance (R) value of not less than 4 [F·ft²·hr/Btu (0.7 K·m²/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 feet (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 pound per square inch. For 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 a tank-type water heater at a perpendicular distance of approximately 24 inches (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 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 (71 ± 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 may 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, inlet 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 shall be computed by use of the following formula:

$$E_t = \frac{KW(\theta_2 - \theta_1)}{(CF \times Q \times H) + E_c} \times 100$$

where

E_t = thermal efficiency, percent,

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).