

Attached is a June 10, 1993 letter to Chairman Hosler from Mr. John F. McGraw, Atwood Mobile Products. (See Attachment V.)

In his June 10 letter, Mr. McGraw concurs with Chairman Hosler's decision to withhold action on adopting the ASHRAE standards into the Z21 water heater standards pending further review by the subcommittee.

Mr. McGraw indicated that there is no reason why small capacity water heaters should be included under the ASHRAE standard when most are manufactured for installation in Recreational Vehicles, and a small number of electric units for Marine use. He noted that the added cost to comply with the National Appliance Energy Conservation Act (NAECA) cannot be justified for these types of water heaters due to the limited time used and the very small amount of energy consumed. He requested that the subcommittee consider this aspect when deciding whether or not to incorporate the ASHRAE standard as proposed in the Z21.10.1 standard if his recommended changes attached to his June 10 letter are not made. Mr. McGraw's recommended changes to ASHRAE 118.2 are to make it compatible with the U.S. Department of Energy's (DOE) test procedure, which he notes does not include storage water heaters with capacities less than 20 gallons. Mr. McGraw has also attached to his June 10 letter a copy of the DOE's Appendix E to Subpart B of Part 430, Uniform Test Method for Measuring the Energy Consumption of Water Heaters, 10 CFR, Chapter 11 (1/1/93 Edition).

HOWARD I. FORMAN, Chairman - P.O. Box 66, HUNTINGDON VALLEY, PA 19006 - (215) 947-4154  
THEODORE C. LEMOFF, Vice Chairman - 1 BATTERY MARCH PARK, QUINCY MA 02269-9101 - (617) 770-3000  
ALLEN J. CALLAHAN, Adm. Secy. - 8501 E. PLEASANT VALLEY RD., CLEVELAND, OH 44131 - (216) 524-4990

April 26, 1993

**TO MEMBERS OF Z21/CGA JOINT SUBCOMMITTEE  
ON STANDARDS FOR GAS WATER HEATERS:**

As many of you recall, at its September 21-22, 1992 meeting, the subcommittee considered issues regarding standards duplication between the Z21 water heater standards and proposed ASHRAE standards.

After discussion, the subcommittee agreed to revise the test methods for "Recovery Efficiency" and "Standby Loss," under 2.8 in Z21.10.1-1990, to be identical to the proposed ASHRAE 118.2 standard. In addition, the subcommittee agreed to revise the test methods for "Thermal Efficiency" and "Standby Loss" under 2.8 and 2.9, respectively, in Z21.10.3-1990, to be identical to the proposed ASHRAE 118.1 standard. It was agreed that the revised Z21 test methods would be distributed for industry review and comment, before recommending them to the Z21 Committee for approval.

By copy of this letter, I am directing the Z21 Secretariat to hold the above Z21 water heater standards proposals in abeyance pending further consideration at our next meeting, tentatively scheduled for September 23-24, 1993.

My reasons for this decision are as follows:

1. Currently, the proposed ASHRAE 118.1 and 118.2 standards are proposed, and have not been approved by either ASHRAE or ANSI. The Z21 Secretariat has indicated to ASHRAE that the issue of ANSI standards duplication appears to be resolved, based on the subcommittee's above actions. However, it is not known whether the proposed standards will be approved by ASHRAE during its Annual Meeting in June. Based on this, I feel that the subcommittee's adoption of the content of these proposed standards for review and comment may be premature. I recommend that the subcommittee review the status of the proposed ASHRAE standards at its September meeting, to determine if a "final" draft is available for use.

2. The Z21 Secretariat has informed me that revising the Z21 water heater standards' Method of Test to reflect the proposed ASHRAE standards does not pose a problem. However, since the proposed ASHRAE coverage is far more extensive than the Z21 coverage, it is necessary to reproduce most of the ASHRAE coverage, unchanged, in the Z21 standards. This aspect involves obtaining a copyright release from ASHRAE so that the Z21 revisions may be processed. It has been suggested that since so much of the actual ASHRAE standard would be reproduced in the Method of Test, that it should instead reference the ASHRAE standard, as shown in an added "Exhibit" to the standard. In this way, the ASHRAE standard's reference would be acknowledged for copyright purposes, and its appearance in an "Exhibit" would make it a mandatory part of the Z21 standard. I feel that this newly suggested option deserves consideration at our next meeting.
  
3. Regarding the Volume I water heater standard (Z21.10.1), it has been brought to my attention that the National Appliance Energy Conservation Act of 1987 established minimum efficiency requirements for all residential water heaters 75,000 Btu/hr input or less, regardless of the heater's storage volume. Based on this, it would appear appropriate for the subcommittee to consider revising the Z21.10.1 Scope to reflect this, in addition to considering the deletion of the efficiency performance coverage in Z21.10.1. However, I am not certain whether water heaters for installation in Recreational Vehicles would still require the Z21.10.1 efficiency coverage. I have directed staff to make this subject an item of business for the subcommittee's next meeting.

Based on the above, the proposals adopted at the subcommittee's September 1992 meeting will be processed without the ASHRAE revisions to the efficiency tests in Z21.10.1 and Z21.10.3.

If you have any questions or comments, please contact me.

Very truly yours,

  
DARYL L. HOSLER, Chairman  
Z21/CGA Joint Subcommittee on  
Standards for Gas Water Heaters

cc: Howard I. Forman  
J. P. Langmead  
Allen J. Callahan  
Ken Bales  
James Heldenbrand (Manager, ASHRAE Standards)  
E. Ross Deter (CEC)

HOWARD I. FORMAN, Chairman - P.O. Box 66, HUNTINGDON VALLEY, PA 19006 - (215) 947-4154  
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May 3, 1993

Mr. Steve Comstock, Director  
Communications/Publications  
American Society of Heating, Refrigerating,  
and Air-Conditioning Engineers  
1791 Tullie Circle, NE  
Atlanta, GA 30329

Dear Mr. Comstock:

The purpose of this letter is to request written permission to reproduce the following proposed ASHRAE standards:

*Method of Testing for Rating Commercial Gas, Electric, and Oil Water Heaters,*  
ASHRAE 118.1; and

*Method of Testing for Rating Residential Water Heaters [gas, electric & oil],*  
ASHRAE 118.2.

Pending written permission from ASHRAE, the above proposed standards will be reproduced in proposed revisions to the ANSI Z21.10.1 and Z21.10.3 water heater standards.

I would also like to request that ASHRAE provide a disk copy of the latest version of the above proposed standards to assist in facilitating the Z21 standards revision process. If this is acceptable, a 3.5-inch disk formatted for "convertability" to "Word-Perfect" Version 5.1 would be needed.

### Background

At its September 21-22, 1992 meeting, the Z21/CGA Joint Subcommittee on Standards for Gas Water Heaters considered issues regarding standards duplication between the above Z21 water heater standards and proposed ASHRAE standards.

After discussion, the subcommittee agreed to revise the test methods for "Recovery Efficiency" and "Standby Loss," under 2.8 in Z21.10.1-1990, to be identical to the proposed ASHRAE 118.2 standard. In addition, the subcommittee agreed to revise the test methods for "Thermal Efficiency" and "Standby Loss" under 2.8 and 2.9, respectively, in Z21.10.3-1990, to be identical to the proposed ASHRAE 118.1 standard. It was agreed that the revised Z21 test methods will be distributed for industry review and comment, before recommending them to the Z21 Committee for approval.

#### Additional Information

Mr. Daryl L. Hosler, Chairman of the Z21/CGA joint water heater subcommittee has directed me to hold the above Z21 water heater standards proposals in abeyance pending further consideration at the subcommittee's next meeting, tentatively scheduled for September 23-24, 1993.

Some of Mr. Hosler's reasons for this decision are as follows:

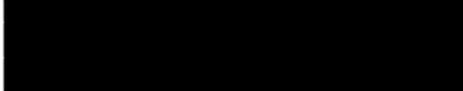
1. Currently, the proposed ASHRAE 118.1 and 118.2 standards are proposed, and have not been approved by either ASHRAE or ANSI. It is not known whether the proposed standards will be approved by ASHRAE during its Annual Meeting in June. Based on this, Mr. Hosler feels that the subcommittee's adoption of the content of these proposed standards for review and comment may be premature. The subcommittee is to review the status of the proposed ASHRAE standards at its September meeting, to determine if a "final" draft is available for use.
2. In revising the Z21 water heater standards' Method of Test to reflect the proposed ASHRAE standards, it is necessary to reproduce most of the ASHRAE coverage, unchanged, in the Z21 standards. Therefore, it is necessary to obtain a copyright release from ASHRAE so that the Z21 revisions may be processed. It has been suggested that since so much of the actual ASHRAE standard would be reproduced in the Method of Test, that it should instead reference the ASHRAE standard, as shown in an added "Exhibit" to the standard. In this way, the ASHRAE standard's reference would be acknowledged for copyright purposes, and its appearance in an "Exhibit" would make it a mandatory part of the Z21 standard. This suggested option will be considered at the subcommittee's next meeting.

Mr. Steve Comstock  
May 3, 1993

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If you have any questions, please contact me. I look forward to your reply.

Very truly yours,

A black rectangular redaction box covers the signature area. A small handwritten flourish is visible to the right of the box.

ALLEN J. CALLAHAN  
Manager, Standards

cc: James Heldenbrand  
Daryl L. Hosler


**ASHRAE**

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

1791 Tullie Circle, NE • Atlanta, Georgia 30329-2305 ☎ 404-636-8400, Ext. 600 • Fax 404-321-5478

**W. Stephen Comstock**

 Director  
 Communications & Publications

July 23, 1993

 Mr. Allen J. Callahan  
 Manager, Standards  
 Z21 Accredited Standards Committee  
 8501 E. Pleasant Valley Road  
 Cleveland, OH 44131

Dear Mr. Callahan:

I am responding to your letter of May 3.

If your proposal is to reproduce substantial portions or all of ASHRAE Standards 118.1 and 118.2 for inclusion in approved Z21 Standards, a royalty agreement will need to be negotiated. All ASHRAE Standards whether in proposed or final form are copyright protected by ASHRAE.

If your request is to reproduce drafts of ASHRAE Standards 118.1-1993 and 118.2-1993 in order to facilitate possible inclusion of these standards by reference in Z21 Standards through inclusion of them as temporary exhibits with circulation of committee drafts of Z21 standards, this request is granted.

I will be pleased to provide you with a WordPerfect 5.1 version of ASHRAE Standards 118.1 and 118.2 when you desire if your wish is proceed as described in the paragraph immediately above.

Sincerely,

W. Stephen Comstock

 WSC  
 /repmsn-stds

cc: Jim Heldenbrand, Manager of Standards, ASHRAE

CALIFORNIA ENERGY COMMISSION  
6 NINTH STREET  
SACRAMENTO, CA 95814-5512



November 13, 1992

David C. Bixby  
Z21 Accredited Standards Committee  
8501 E. Pleasant Valley Road  
Cleveland, OH 44131

Dear Mr. Bixby:

Thank you for your letter of November 3, 1992 in which you reported on the consideration of our three requests concerning water heater efficiency requirements in Standards Z21.10.1 and Z21.10.3.

1. We asked that you take action to eliminate any possible conflicts between the Z21 standards and the ASHRAE 118 standards. The actions you have taken resolve our concerns.
2. We asked that you consider changing the minimum thermal efficiency and standby loss standards in Standard Z21.10.3. Your subcommittee did not discuss this issue and we may wish to take this up with the full Z21 Committee when it meets in April 1993. We would note, however, that since the subcommittee had its meeting in September 1992, there has been a significant change in federal law which may well be reflected in US Department of Energy regulations by the time the Z21 Committee meets in April 1993. It would therefore be prudent for us to write you again on this subject in February or March 1993.
3. We asked you to consider adding wording to the marking requirements that would result in nationally uniform clear statements indicating the efficiency of commercial water heaters. We made the proposal because we felt that the current California requirements really should be national requirements, since the water heater manufacturing industry is national in scope. We do not plan to bring this issue before full Z21 Committee, but due to changing federal legislation and regulation, may bring it up again at the next subcommittee meeting.

Sincerely,

  
E. ROSS DETER  
Deputy Director for  
Energy Efficiency and Local Assistance



# Atwood Mobile Products

Engineered Systems & Components

Mr. Daryl L. Hosler, Chairman  
Z21/CGA Joint Subcommittee on  
Standards for Gas Water Heaters  
8501 E. Pleasant Valley Road  
Cleveland, Ohio 44131

10, 1993

Dear Mr. Hosler:

Reference your letter of April 26, 1993 to Members of Z21/CGA Joint Subcommittee on Standards for Gas Water Heaters, paragraph 3.

I have obtained a copy of the National Appliance Energy Conservation Act of 1987 and also a copy of Appendix E to Subpart B of Part 430 - Uniform Test Method for Measuring the Energy Consumption of Water Heaters as published by the Department of Energy, 10 CFR Ch.11 (1-1-93 Edition). A copy of the DOE document is enclosed.

I have also obtained a copy of ASHRAE proposed American National Standard "Method of Testing for Rating Residential Water Heaters". I have submitted proposed changes to this standard to make it compatible with the DOE test procedure. As you will note the DOE test procedure does not include storage water heaters with capacities less than twenty gallons. Copies of the recommended changes are attached.

I don't know why ASHRAE is going off on their own when a DOE standard already exists. I am not on ASHRAE's mailing list so I had to obtain a copy of the proposed standard from Ernie Wenczl of State Industries. I also do not see any rationale for including small capacity water heaters in the ASHRAE standard when most of them are manufactured for installation in a Recreational Vehicles and a small number of electric units for Marine use. The added cost to comply with the NAECA cannot be justified for these types of water heaters due to the limited time used and the very small amount of energy consumed. We need to consider this when deciding whether or not we should incorporate the ASHRAE Standard as proposed in the Z21.10.1 Standard if my recommended changes are not made.

In any case I agree with your decision to withhold any action on the ASHRAE standard until we have the opportunity to carefully review it and all its implications at our next meeting.

Sincerely,

  
John F. McGraw, P.E.  
Chief Engineer  
Gas Appliance Products

**FORM FOR COMMENTING ON  
PROPOSED ASHRAE STANDARDS AND GUIDELINES**  
(Please type or print)

1. Name John F. McGraw Date 6/10/93  
Affiliation Atwood Mobile Products  
Address 4750 Hiawatha Drive, Rockford, IL 61103  
Telephone (815 ) 877-5700 Fax (815 ) 877-7469

**Number and Title of Standard:**

BSR/ASHRAE 118.2P, Method of Testing for Rating Residential Water Heaters

**2. Section or Paragraph:**

3. Definitions,

**3. Recommended Changes:**

Delete the definition of residential water heater and storage water heater. Replace with the definition of a gas fueled storage water heater, electric storage water heater and oil storage water heater as they appear in appendix E to subpart B of part 430 - Uniform Test Method for Measuring the Energy Consumption of Water Heaters, 10 CFR Ch. II (1/1/93 Edition) page 56. (copy attached).

**4. Substantiating Statements:**

See attached

NOTE: Use separate form for each comment. (Name only needed in Section 1 of additional forms submitted; complete sections 2-4 for each comment.)

PLEASE RETURN BY JUNE 15, 1992, TO:

MANAGER OF STANDARDS  
ASHRAE  
1791 TULLIE CIRCLE, NE  
ATLANTA, GA 30329  
Phone (404) 636-8400 Fax (404) 321-5478

4. Substantiating Statement:

These are the official definitions used by the Department of Energy for the purpose of determining compliance with the National Appliance Energy Conservation Act of 1987. We do not see a need to substantially change the scope of the test procedures as formulated by the Department of Energy and published in the Federal Register. Storage water heaters of less than twenty gallons were purposely omitted from the test procedure for two reasons:

1. It is very difficult to obtain consistent and reliable data when attempting to determine the thermal efficiency of small storage water heaters.

2. The majority of small storage water heaters with capacities of 6 to 10 gallons are for recreational vehicle or marine use. A Recreational Vehicle is used approximately five weeks per year. Marine useage is slightly more. The amount of energy consumed is extremely small when compared to residential useage. It is not cost effective to design and manufactured a Recreational Vehicle or Marine storage water heater to comply with the efficiency requirementss of a Residential storage water heater. Because of the limited use and small amount of energy consumed there is no appreciable pay back over the life of the appliance. The customer would pay more without the opportunity to recoup the additional cost because of the insignificant energy savings.

**FORM FOR COMMENTING ON  
PROPOSED ASHRAE STANDARDS AND GUIDELINES**  
*(Please type or print)*

1. Name John F. McGraw Date 6/10/93  
Affiliation Atwood Mobile Products  
Address 4750 Hiawatha Drive, Rockford, IL 61103  
Telephone ( 815 ) 877-5700 Fax ( 815 ) 877-7469

**Number and Title of Standard:**

BSR/ASHRAE 118.2P, Method of Testing for Rating Residential Water Heaters

**2. Section or Paragraph:**

9.1

**3. Recommended Changes:**

Delete from paragraph "and 1.0 +/- 0.25 gallons per minute (0.06 +/- 0.015 liters per second) for units of less than 20 gallons (75.7 liters).

**4. Substantiating Statements:**

Same as statements for "Definitions".

NOTE: Use separate form for each comment. (Name only needed in Section 1 of additional forms submitted; complete sections 2-4 for each comment.)

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**FORM FOR COMMENTING ON  
PROPOSED ASHRAE STANDARDS AND GUIDELINES**  
*(Please type or print)*

1. Name John F. McGraw Date 6/10/93  
Affiliation Atwood Mobile Products  
Address 4750 Hiawatha Drive, Rockford, IL 61103  
Telephone ( 815 ) 877-5700 Fax ( 815 ) 877-7469

**Number and Title of Standard:**  
BSR/ASHRAE 118.2P, Method of Testing for Rating Residential Water Heaters

**2. Section or Paragraph:**

9.2

**3. Recommended Changes:**

Delete from paragraph "For units with a storage volume of less than 20 gallons (75.5 liters), the total quantity of water drawn and the quantity of each draw shall be as indicated in the following table:"

Delete Table.

**4. Substantiating Statements:**

Same as the state for "Definitions".

9.2

NOTE: Use separate form for each comment. (Name only needed in Section 1 of additional forms submitted; complete sections 2-4 for each comment.)

PLEASE RETURN BY JUNE 15, 1992, TO:

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$E_{cp} = E_{pw} \times (8760 - 140/416) \times GEF$   
 $E_{pw}$  = the energy recorded in 3.4.6.3  
 8760 = number of hours in a year  
 416 = representative average number of clothes dryer cycles in a year  
 140 = estimated number of hours that the continuously burning pilot light is on during the operation of the clothes dryer for the representative average use cycle for clothes dryers (416 cycles per year)

GEF as defined in 4.3

4.5 *Total per-cycle gas dryer gas energy consumption expressed in Btu's.* Calculate the total gas dryer energy consumption per cycle,  $E_c$ , expressed in Btu's per cycle and defined as:

$$E_c = E_{pw} + E_{st}$$

$E_{pw}$  as defined in 4.3

$E_{st}$  as defined in 4.4

4.6 *Total per-cycle gas dryer energy consumption expressed in kilowatt-hours.* Calculate the total gas dryer energy consumption per cycle,  $E_{cp}$ , expressed in kilowatt-hours per cycle and defined as:

$$E_{cp} = E_{cp} + (E_c / 3412 \text{ Btu/k Wh})$$

$E_{pw}$  as defined in 4.2

$E_c$  as defined in 4.5

[46 FR 27326, May 19, 1981]

#### APPENDIX E TO SUBPART B OF PART 430—UNIFORM TEST METHOD FOR MEASURING THE ENERGY CONSUMPTION OF WATER HEATERS

##### 1. Definitions

1.1. *Cut-in* means the time or water temperature when a water heater thermostat has acted to increase the energy or fuel input to the heating elements, compressor, or burner.

1.2. *Cut-out* means the time or water temperature when a water heater thermostat has acted to reduce to a minimum the energy or fuel input to the heating elements, compressor, or burners.

1.3. *Design Power Rating* means the nominal power rating that a water heater manufacturer assigns to a particular design of water heater, expressed in kilowatts or Btu per hour as appropriate.

1.4. *Energy Factor* means a measure of water heater overall efficiency.

1.5. *First Hour Rating* means the amount of hot water the water heater can supply in one hour of operation.

1.6. *Heat Trap* means a device which can be integrally connected, or independently attached, to the hot and/or cold water pipe connections of a water heater such that the device will develop a thermal or mechanical seal to minimize the recirculation of water

due to thermal convection between the water heater tank and its connecting pipes.

1.7. *Recovery Efficiency* means the ratio of energy delivered to the water to the energy content of the fuel consumed by the water heater.

1.8. *Standby* means the time during which water is not being withdrawn from the water heater. There are two standby time intervals used within this test procedure:  $t_{max}$  represents the elapsed time between the time at which the maximum mean tank temperature is observed after the sixth draw and the end of the 24 hour test;  $t_{total}$  represents the total time during the 24 hour simulated use test when water was not being withdrawn from the water heater.

1.9. *Gas fueled storage water heater* means a water heater which utilizes gas as the energy source and which is designed to heat and store water at a thermostatically controlled temperature of less than 180 °F with an input of 75,000 Btu per hour or less and a manufacturers specified storage capacity of not less than 20 gallons nor more than 100 gallons.

1.10. *Electric storage water heater* means a water heater which utilizes electricity as the energy source and which is designed to heat and store water at a thermostatically controlled temperature of less than 180 °F with an input of 12 kilowatts or less and a manufacturers specified storage capacity of not less than 20 gallons nor more than 120 gallons.

1.11. *Oil storage water heater* means a water heater which utilizes oil as the energy source and which is designed to heat and store water at a thermostatically controlled temperature of less than 180 °F with an energy input of 105,000 Btu per hour or less, and which has a manufacturers specified storage capacity of 50 gallons or less.

1.12. *Gas fueled instantaneous water heater* means a water heater which utilizes gas as the energy source controlled manually or automatically by a water flow activated control or a combination of water flow and thermostatic control, which is designed to deliver water at a controlled temperature of less than 180 °F, and which has an input greater than 50,000 Btu per hour and less than 200,000 Btu per hour, and a manufacturers specified storage capacity of less than 2 gallons.

1.13. *Heat pump water heater* means a water heater which utilizes electricity as the energy source with a maximum current rating of 24 amperes at a voltage no greater than 250 volts, and which is designed to transfer thermal energy from one temperature level to a higher temperature level for the purpose of heating water, including all auxiliary equipment such as fans, storage tanks, pumps, or controls necessary for the device to perform its function.

1.14. *ASHRAE Standard* means a standard published by the American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., Standard Measurement of Temperature Measurement.

1.15. *ASTM-D-21* means a standard published by the American Society of Testing and Materials, titled Method for Gases from Burning.

1.16. *Rated Storage Capacity* means the water storage capacity in gallons, as specified.

##### 2. Test

2.1. *Installation* means the water heater shall be performed with the instrumentation installation in section 4.

2.2. *Ambient Air Temperature* means the ambient air temperature shall be maintained between 65.0 °F and 75.0 °F on a continuous basis. For the purpose of this test, the dry bulb temperature shall be maintained between 65.0 °F and 75.0 °F. Additional heaters the relative humidity shall be maintained between 49 and 51 percent.

2.3. *Supply Water Temperature* means the supply water temperature of the water heater shall be maintained at 120 °F throughout the test.

2.4. *Storage Tank Temperature* means the storage tank temperature of the water heater shall be maintained at 120 °F.

2.5. *Supply Water Pressure* means the supply water pressure shall be maintained between 40 psig and 60 psig, or the pressure specified by the manufacturer.

2.6. *Electrical and Gas Supply* means the electrical supply voltage to the water heater shall be within 1 percent of the center of the voltage specified by the manufacturer and the gas supply pressure shall be within 1 percent of the manufacturer's specified pressure.

2.6.1. *Electrical Supply Voltage* means the supply voltage to the water heater shall be within 1 percent of the center of the voltage specified by the manufacturer and the gas supply pressure shall be within 1 percent of the manufacturer's specified pressure.

2.6.2. *Natural Gas Supply Pressure* means the natural gas supply pressure in accordance with the manufacturer's specification is not specified, the pressure of the natural gas supply to the water heater is equal to the manufacturer's specified pressure. If the manufacturer's specified pressure is not specified, the pressure shall be within 1 percent of the manufacturer's specified pressure.

2.6.3. *Propane Gas Supply Pressure* means the propane gas supply pressure in accordance with the manufacturer's specification is not specified, the pressure of the propane gas supply to the water heater is equal to the manufacturer's specified pressure. If the manufacturer's specified pressure is not specified, the pressure shall be within 1 percent of the manufacturer's specified pressure.

11.14. *ASHRAE Standard 41.1-86* means the standard published in 1986 by the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. and titled *Standard Measurement Guide: Section on Temperature Measurements*.

11.15. *ASTM-D-2156-80* means the test standard published in 1980 by the American Society of Testing and Measurements and titled *Method for Smoke Density in Flue Gases from Burning Distillate Fuels*.

11.16. "Rated Storage Volume" means the water storage capacity of a water heater, in gallons, as specified by the manufacturer.

## 2. Test Conditions

2.1. *Installation Requirements.* Tests shall be performed with the water heater and instrumentation installed in accordance with section 4.

2.2. *Ambient Air Temperature.* The ambient air temperature, shall be controlled to a value between 65.0 °F and 70.0 °F on a continuous basis. For heat pump water heaters maintain the dry bulb temperature at  $67.5 \pm 1$  °F. Additionally, for heat pump water heaters the relative humidity shall be maintained between 49 and 51 percent.

2.3. *Supply Water Temperature.* The temperature of the water being supplied to the water heater shall be maintained at  $58 \pm 2$  °F throughout the test.

2.4. *Storage Tank Temperature.* The average temperature of the water within the storage tank shall be set to  $135 \pm 5$  °F.

2.5. *Supply Water Pressure.* During the test when water is not being withdrawn, the supply pressure shall be maintained between 40 psig and the maximum allowable pressure specified by the water heater manufacturer.

2.6. *Electrical and/or Fossil Fuel Supply.*

2.6.1. *Electrical.* Maintain the electrical supply voltage to within  $\pm 1$  percent of the center of the voltage range specified by the water heater and/or heat pump manufacturer.

2.6.2. *Natural Gas.* Maintain the supply pressure in accordance with the manufacturer's specifications. If the supply pressure is not specified, maintain a supply pressure of 7 to 10 inches of water column. If the water heater is equipped with a gas appliance pressure regulator, the regulator outlet pressure shall be within  $\pm 10\%$  of the manufacturer's specified manifold pressure. Use natural gas with a higher heating value of approximately 1,025 Btu per standard cubic foot.

2.6.3. *Propane Gas.* Maintain the supply pressure in accordance with the manufacturer's specifications. If the supply pressure is not specified, maintain a supply pressure of 11 to 13 inches of water column. If the water heater is equipped with a gas appliance pressure regulator, the regulator outlet pressure shall be within  $\pm 10\%$  of the man-

ufacturer's specified manifold pressure. Use propane gas with a higher heating value of approximately 2,500 Btu per standard cubic foot.

2.6.4. *Fuel Oil Supply.* Maintain an uninterrupted supply of fuel oil. Use fuel oil with a heating value of approximately 138,700 Btu per gallon.

## 3. Instrumentation

3.1. *Pressure Measurements.* Pressure measuring instruments shall have an error no greater than the following values:

Item measured	Instrument accuracy	Instrument precision
Gas pressure	$\pm 0.1$ inch of water column	$\pm 0.05$ inch of water column
Atmospheric pressure	$\pm 0.1$ inch of mercury column	$\pm 0.05$ inch of mercury column
Water pressure	$\pm 1.0$ pounds per square inch.	$\pm 0.50$ pounds per square inch

## 3.2. Temperature Measurement

3.2.1. *Measurement.* Temperature measurements shall be made in accordance with the Standard Measurement Guide: Section on Temperature Measurements, ASHRAE Standard 41.1-86.

3.2.2. *Accuracy and Precision.* The accuracy and precision of the instruments, including their associated readout devices, shall be within the limits as follows:

Item measured	Instrument accuracy	Instrument precision
Air dry bulb temperature	$\pm 0.2$ °F	$\pm 0.1$ °F
Air wet bulb temperature	$\pm 0.2$ °F	$\pm 0.1$ °F
Inlet and outlet water temperatures	$\pm 0.2$ °F	$\pm 0.1$ °F
Storage tank temperatures	$\pm 0.5$ °F	$\pm 0.25$ °F

3.2.3. *Scale Division.* In no case shall the smallest scale division of the instrument or instrument system exceed 2 times the specified precision.

3.2.4. *Temperature Difference.* Temperature difference between the entering and leaving water may be measured with any of the following:

- A Thermopile
- Calibrated resistance thermometers
- Precision thermometers
- Calibrated thermistors
- Calibrated thermocouples
- Quartz thermometers

3.2.5. *Thermopile Construction.* If a thermopile is used, it shall be made from calibrated thermocouple wire taken from a single spool. Extension wires to the recording device shall also be made from that same spool.