DEPARTMENT OF ENERGY

Office of Energy Efficiency and Renewable Energy

10 CFR Part 430

[Docket No. EE-RM–94–230]

Energy Conservation Program for Consumer Products: Test Procedures for Water Heaters; Kitchen Ranges, Ovens, and Microwave Ovens; and Clothes Washers; and Reporting Requirements for Clothes Washers, Clothes Dryers, and Dishwashers

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

ACTION: Proposed Rule and Public Hearing.

SUMMARY: The Energy Policy and Conservation Act, as amended, requires the Department of Energy (DOE or the Department) to administer an energy conservation program for certain major household appliances and commercial equipment. Among other program elements, the Act requires that standard methods of testing be prescribed for each covered product. The purposes of this Proposed Rulemaking are to: propose amendments to clarify the water heater; kitchen range, oven, and microwave; and clothes washer test procedures, announce the Department's intentions to incorporate by reference test procedures adopted by the International Electrotechnical Commission (IEC), and request data, comments, and information regarding their applicability and workability. Today's amendments of the test procedures are not expected to alter the minimum energy conservation standards currently in effect, or those being proposed in the Eight Products Notice of Proposed Rulemaking, published March 4, 1994 (59 FR 10464).

DATES: Written comments in response to this notice must be received by August 31, 1995.

Oral views, data, and arguments may be presented at the public hearing to be held in Washington, DC, beginning at 9:30 a.m. on July 12, 1995. Requests to speak at the hearing must be received by the Department no later than 4 p.m., June 28, 1995. Ten (10) copies of statements to be given at the public hearing must be received by the Department no later than 4 p.m., July 5, 1995.

ADDRESSES: Written comments, and requests to speak at the public hearing are to be submitted to: U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Hearings and Dockets, Test Procedures for Water Heaters; Kitchen Ranges, Ovens, and Microwave Ovens; and Clothes Washers; and Reporting Requirements for Clothes Washers, Clothes Dryers, and Dishwashers,'' Docket No. EE–RM–94–230, Forrestal Building, 1000 Independence Avenue, SW., Washington, DC 20585.

The hearing will be held at the U.S. Department of Energy, Forrestal Building, Room 1E–245, 1000 Independence Avenue, SW., Washington, DC.

Requests may be hand delivered between the hours of 8 a.m. and 4 p.m., Monday through Friday, except Federal holidays. Requests should be labeled, ''Test Procedures for Water Heaters; Kitchen Ranges, Ovens, and Microwave Ovens; and Clothes Washers; and Reporting Requirements for Clothes Washers, Clothes Dryers, and Dishwashers,'' (Docket No. EE–RM–94–230), both on the document and on the envelope.

Copies of the transcript of the public hearing and public comments received may be read and/or photocopied at the Department of Energy Freedom of Information Reading Room, U.S. Department of Energy, Forrestal Building, Room 1E–190, 1000 Independence Avenue, SW., Washington, DC 20585, (202) 586–6020 between the hours of 9 a.m. and 4 p.m., Monday through Friday, except Federal holidays.

The Department will incorporate by reference test standards from the International Electrotechnical Commission upon publication of this rule as final. These standards are listed below:

International Electrotechnical Commission Publication 705, and Amendment 2–1993, ''Methods for Measuring the Performance of Microwave Ovens for Household and Similar Purposes,'' Section 4, Paragraph 12 ''Microwave Power Output Measurement,'' Paragraph 13 ''Electrical Power Output Measurement,'' and Paragraph 14 ''Efficiency.''

Copies of these standards may be viewed at the Department of Energy Freedom of Information Reading Room at the address stated above. Copies of the International Electrotechnical Commission Publication can be obtained from the American National Standards Institute, 11 West 42nd Street, New York, New York 10036, (212) 642–4936.

For more information concerning public participation in this rulemaking proceeding, see Section XI, ''Public Comment Procedures,'' of the **SUPPLEMENTARY INFORMATION** section.

FOR FURTHER INFORMATION CONTACT:

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SUPPLEMENTARY INFORMATION:

I. Introduction

A. Authority

Part B of Title III of the Energy Policy and Conservation Act, Pub. L. 94–163, as amended by the National Energy Conservation Policy Act, Pub. L. 95–619, the National Appliance Energy Conservation Act of 1987, Pub. L. 100–12, the National Appliance Energy Conservation Amendments of 1988, Pub. L. 100–357, and the Energy Policy Act of 1992, Pub. L. 102–486, created the Energy Conservation Program for Consumer Products other than Automobiles (Program).[1] The products currently subject to this Program (often referred to hereafter as ''covered products'') include water heaters; kitchen ranges, ovens, and microwaves; and clothes washers, the subjects of today's notice.

Under the Act, the Program consists essentially of three parts: Testing, labeling, and the Federal energy conservation standards. The Department, in consultation with the National Institute of Standards and Technology (formerly the National Bureau of Standards), is required to amend or establish new test procedures as appropriate for each of the covered products. EPCA, section 323. The purpose of the test procedures is to produce test results which measure energy efficiency, energy use, water use (in the case of showerheads, faucets, water closets and urinals), or estimated annual operating cost of a covered product during a representative average use cycle or period of use, and must not be unduly burdensome to conduct. EPCA, section 323(b)(3). A test

[1] Part B of Title III of Energy Policy and Conservation Act, as amended, is referred to in this final rule as ''EPCA'' or the ''Act.'' Part B of Title III is codified at 42 U.S.C. 6291–6309.

procedure is not required if DOE determines by rule that one cannot be developed. EPCA, section 323(d)(1). One hundred and eighty days after a test procedure for a product is adopted, no manufacturer may make representations with respect to energy use, energy efficiency or water use of such product, or the cost of energy consumed by such product, except as reflected in tests conducted according to the DOE procedure. EPCA, section 323(c)(2). Test procedures appear at 10 CFR part 430, subpart B.

However, the 180-day period referred to in section 323(c)(2) may be extended for a period of up to an additional 180 days if the Secretary determines that the requirements of section 323(c)(2) would impose undue burden. EPCA, section 323(c)(3).

Section 323(e) of the Act requires DOE to determine to what extent, if any, a proposed test procedure would alter the measured energy efficiency, measured energy use or measured water use of any covered product as determined under the existing test procedure. If DOE determines that an amended test procedure would alter the measured efficiency or measured use of a covered product, DOE is required to amend the applicable energy conservation standard accordingly. In determining the amended energy conservation standard, DOE is required to measure the energy efficiency or energy use of a representative sample of covered products that minimally comply with the existing standard. The average efficiency of these representative samples, tested using the amended test procedure, constitutes the amended standard. EPCA, section 323(e)(2).

B. Background

Today's notice proposes to modify the test procedures for water heaters; kitchen ranges, ovens, and microwave ovens; and clothes washers as follows:

(1) Water heaters.

(a) Revision of subpart B, appendix E.

1. Modify the test procedures to address electric and oil-fired instantaneous water heaters.

2. Include testing of storage-type water heaters having rated storage capacities less than 20 gallons (76 liters).

3. Revise the method used to calculate the first hour rating of storage-type water heaters.

4. Amend the extant definition for heat pump water heater, and add new definitions for heat pump water heater storage tank, add-on heat pump water heater, integral heat pump water heater, and solar water heater.

(2) Kitchen ranges, ovens, and microwaves.

(a) Revision of subpart B, section 430.22 to include test procedure changes.

(b) Revision of subpart B, appendix I.

1. Revise the annual useful energy output to reflect changes in the annual usage of ranges, ovens, cooktops, and microwave ovens.

2. Add definition for ''IEC 705.''

3. Eliminate the requirement to use a standard continuous flow calorimeter.

4. Incorporate by reference the International Electrotechnical Commission Publication 705 Amendment 2–1993, section 4, Paragraphs 12–14.

5. Include the clock energy in the calculation of annual energy consumption for microwave ovens.

6. Revise section 2.8 ''Test Beakers'' replace with new section 2.8 ''Microwave Oven Test Load.''

7. Revise section 2.9.3.4 ''Microwave Oven and Test Load Temperature,'' replace with new section 2.9.3.4 ''Test Load Temperature.''

8. Eliminate section 4.3 ''Conventional Range,'' and section 4.5 ''Microwave/Conventional Range.'' These two sections have been replaced with a new section 4.3 ''Combined Components'' in this proposed rule.

(3) Clothes washers.

(a) Revision of subpart B, § 430.22 to include test procedure changes and to revise the number of representative average-use cycles per year.

(b) Revision of subpart B, appendix J.

1. General test procedure clarification which includes the following:

- Add new definitions for the following terms: thermostatically controlled valves, agitator, top-loader-vertical-axis clothes washer, and top-loader-horizontal-axis clothes washer.
- Delete the requirement to disconnect all lighting systems which consume more than 10 watts during the clothes washer test cycle.
- Introduce a new section, section 2.11 ''Agitation and Spin Speed Settings.''
- Delete reference to AHAM and AHAM procedures.
- Clarify the procedure for capacity testing.
- Clarify the requirements for ''maximum fill'' testing.

2. Incorporation of test procedure changes from approved Waivers to address the following issues:

- Add new definitions for the following terms: nonwater-heating clothes washers and water-heating clothes washers.
- Extend coverage for washers that operate at 120/208Y and 120/240 volts.
- Extend testing and performance coverage to water-heating clothes washers.
- Extend coverage for clothes washers that have infinite/variable temperature selection capability.

3. Addition of optional water consumption and extraction procedures which include the following:

- Add new definitions for the following terms: modified energy factor, moisture removal energy and water consumption factor.
- Add optional test procedures to determine the above values.

(4) Addition to subpart F, § 430.62, to add reporting requirements for energy factors for clothes washers, clothes dryers, and dishwashers.

In addition, metric units of measurements have been included in the three test procedures (English values are given followed by their appropriate International System of Units in parentheses).

II. Discussion

A. Water Heater Test Procedure

Today's proposed amendments to the water heater test procedure include: Revisions to make the water heater test procedure applicable to electric and oil-fired instantaneous water heaters; coverage for testing storage-type water heaters with rated storage capacities less than 20 gallons (76 liters); revision of the first hour rating for storage-type water heaters; amendment to the extant definition for heat pump water heater; and addition of new definitions for heat pump water heater storage tank, add-on heat pump water heater, integral heat pump water heater, and solar water heater.

The Department does not believe any of these changes would alter the energy conservation standards for water heaters currently in place, and requests comments on the impact of these changes, if any. In addition, DOE requests comments on the adequateness of the test procedure for heat pump water heaters regarding the use of backup electric resistance element(s). To the Department's knowledge, most heat pump water heaters are capable of meeting the current test draw requirements, and therefore, the backup electric resistance element(s) are often unnecessary, and are seldom activated. However, the current test setup and parameters may not represent operating conditions requiring backup electric resistance elements to activate. This is dependent on a number of factors, i.e., temperature settings, draw volume and rate, etc. Therefore, DOE is interested in receiving comments on the test procedure for heat pump water heaters regarding the use of backup electric resistance element(s).

Concurrently, the Department is conducting a rulemaking, independent of today's notice, to propose revised minimum energy conservation standards for eight consumer products, including water heaters. (59 FR 10464, March 4, 1994).

1. Electric and Oil-Fired Instantaneous Water Heaters

The current test procedure does not address testing of electric and oil-fired instantaneous water heaters in that they are not defined in the test procedure. The Department, therefore, proposes to include definitions for these two types of instantaneous water heaters, and to amend the existing language to include the testing of them. Definitions for storage-type water heaters are also modified to differentiate these types from the instantaneous-type water heaters. As a result, oil-fired and electric instantaneous water heaters will be subject to the applicable minimum energy conservation standards of 0.59-(0.0019 × rated storage volume in gallons) for oil-fired water heaters and 0.93-(0.00132 × rated storage volume in gallons) for electric water heaters, respectively. For electric and oil fired instantaneous water heaters, the rated storage volume may be zero. In today's proposed notice, the Department requests comments and data regarding the appropriateness of adding electric and oil-fired instantaneous water heaters to the test procedure and subjecting them to the respective energy conservation standards. See appendix E to subpart B of Title 10 CFR part 430, sections 1.8 and 5.2.

2. Storage-type Water Heaters Having Rated Storage Capacities Less Than 20 Gallons (76 liters)

In a letter to the Department, dated July 17, 1991, the Gas Appliance Manufacturer Association (GAMA) stated that storage-type water heaters having capacities less than 20 gallons (76 liters) are covered by the National Appliance Energy Conservation Act of 1987. The current test procedure does not cover storage-type water heaters having rated storage capacities less than 20 gallons (76 liters) and, therefore, those water heaters are not subject to the minimum efficiency standards. In order to correct this, GAMA requested that the test procedure be revised. DOE proposes to provide coverage for storage-type water heaters of less than 20 gallons (76 liters).

With regard to conducting the 24-hour simulated use test on water heaters having rated storage capacities less than 20 gallons (76 liters), the Department proposes to include the applicable draw schedule accepted by the water heater industry. (See American National Standards Institute/American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 118.2–1993: Method of Testing for Rated Residential Water Heaters.) The total volume withdrawn shall be 24 gallons (91 liters) for units having rated storage capacities greater than or equal to 10 gallons (38 liters), but less than 20 gallons (76 liters). The total volume withdrawn shall be 9 gallons (34 liters) for units having rated storage capacities less than 10 gallons (38 liters). The draw rate shall be 1.0±0.25 gallons per minute (3.8±0.95 liters per minute) for all units having rated storage capacities less than 20 gallons (76 liters). The Department requests comments and data regarding any impact on a manufacturer(s) as a result of extending coverage of the existing minimum energy efficiency standards to storage-type water heaters of less than 20 gallons (76 liters). See appendix E to subpart B of Title 10 CFR part 430, sections 1.11, 5.1.4.1, and 5.1.5.

3. First Hour Rating for Storage-type Water Heaters

Water heaters have historically been selected based on rated storage volume. The rate at which the water heater produces hot water, and whether the water heater uses a lone or multiple heat source, however, is also important when selecting a water heater. For example, a smaller electric water heater having two 4.5-kilowatt elements may provide more hot water over a given time interval than a larger electric water heater having a single 3.8-kilowatt element. The first hour rating seeks to account for the effect of storage capacity, heating rate, and the number of heat sources on the water heater's ability to provide hot water. Ideally, the consumer will use first hour rating to initially identify water heaters that will meet their hot water supply needs. Once the field has been narrowed based on this need, the consumer will then use energy factor, annual operating cost, first cost, warranty information, reputation of manufacturer, etc., in determining which water heater to select.

The first hour rating is not used in computing the efficiency (i.e., energy factor) of water heaters, but is used by the Federal Trade Commission for presenting size ranges in the labeling program for water heaters. It was hoped that this measure would gain recognition as a sizing criterion for consumers in selecting water heaters. As a result, the Department has been conducting a continuous effort to improve the first hour rating method in rulemakings for water heaters. However, the concept of what the first hour rating should represent (i.e., a balance between storage capacity, recovery rate, and mixing characteristics) and how to measure it accurately has proven to be a difficult task. Each attempt at establishing a first hour rating test has led to difficulties (repeatability problem with the 1989 proposal (54 FR 1890, January 17, 1989), and a low estimate of hot water availability for certain water heaters by the 1990 final rule. (55 FR 42162, October 17, 1990).) For example, in a October 15, 1991, letter from GAMA to DOE, GAMA stated that ''Gas Appliance Manufacturers Association members have results establishing first hour ratings in the range of 70 to 75 gallons for 120 gallon models. The calculated first hour rating is significantly less than the amount of water drawn during the first draw.'' This problem with the October 17, 1990, current test method is most evident for large tanks with one heating element because of the greater weighing given by the test procedure to recovery rate relative to storage volume.

To correct the problem of understating hot water production cited by GAMA, the Department requested NIST to evaluate a proposal recommended by GAMA in its October 15, 1991, letter to DOE. GAMA's recommendation would prorate the final draw of the 1990 first hour rating test with respect to a ratio of elapsed times. NIST summarized the advantages and disadvantages of GAMA's recommendation. The major advantages are: The first hour rating would always be greater than or equal to the first draw volume and retesting for FTC labeling may be unnecessary if the needed additional data was collected. The major disadvantages are: The rating would represent a volume of hot water that is greater than or equal to the maximum volume of hot water that can be delivered in an hour (overstating), and it may not differentiate single-element from two-element electric water heaters (recovery capabilities unrecognized). The Department, therefore, concludes that the disadvantages of GAMA's recommendation outweigh the advantages and rejects this proposal.

The Department requested NIST to conduct a second study to correct the problem of understating hot water production. NIST recommended that a revised version of the 1989 test method be proposed. NIST stated its recommendation will correct the understating problem cited by GAMA in the October 15, 1991, letter, and in addition, will minimize the aforementioned repeatability problem. The Department concurs and today proposes a revised first hour rating method for storage tank-type (including heat pump) water heaters. Section 5.1.4. Included in the proposed first hour rating are: Revisions to the test method for storage tank-type water heaters, hot and cold water mixing characteristics, and the criterion for initiating successive draws when conducting a first hour rating test on heat pump water heaters that use supplemental resistive heating.

In regard to storage tank-type water heaters, for draws initiated prior to one hour (as a result of a thermostat cut-out), the maximum outlet temperature shall be determined for each draw and used for determining when to terminate that draw, i.e., at $T^*_{max,i} - 25°F$, where i corresponds to the draw number. If a recovery is still in progress at one hour, the draw imposed to remove any stored ''hot'' water shall be terminated based on the cut-off temperature used for the previous draw ($T^*_{max,n-1} - 25°F$). In addition, for draws imposed at one hour, the first hour rating shall be the sum of: All the withdrawn volumes and the final withdrawn volume, where the final withdrawn volume is multiplied by the following temperature ratio: $(T^*_{del,n} - T^*_{min,n-1}) / (T^*_{del,n-1} - T^*_{min,n-1})$. The subscripts n and n–1 are used to indicate the final draw and the next-to-last draw, respectively, while $T^*_{min,n-1}$ designates the water temperature at which the next-to-last draw was terminated ($T^*_{min,n-1} = T^*_{max,n-1} - 25°F$). For all other draw volumes, no temperature ratio adjustment factor shall be used.

The Department notes that a temperature ratio can and has been used in the past to compensate for the amount of mixing that occurs between the stored hot water and the entering make-up water during a draw. The greater the volume of make-up water mixed into the outlet stream (while still maintaining an outlet temperature above the criterion of ''hot'' water), the greater the first hour rating. The amount of mixing is typically small and repeatable for designs that introduce make-up water near the bottom of the tank. However, if a water heater uses a thermally compensating dip tube (first discussed in the February 8, 1984, Proposed Rulemaking, 49 FR 4870), or an internal mixing valve, substantial mixing, and thus, a higher and unrealistic first hour rating could occur. At present, DOE is not aware of any currently manufactured water heaters which contain these features. Therefore, DOE is not employing a temperature ratio correction to handle mixing effects. The Department requests comments and data concerning the appropriateness of today's proposal relative to thermally compensating dip tubes, internal mixing valves, or any other mechanism used to increase the amount of mixing of stored hot water and make-up water during a draw.

The Department also notes that with a multiple draw first hour rating test, like the one proposed today, a temperature ratio can be used to compensate for the effect of the test tolerances allowed for the thermostat setting(s) [±5°F (±2.8°C)], and for the make-up water temperature [±2°F (±1.1°C)]. These test tolerances affect the time required for the water heater to recover from a hot water draw. For example, recovery time is quickest if the tank thermostat(s) is set to 130°F (54.4°C), and the make-up water is set at 60°F (15.6°C). Recovery time is slowest for settings at 140°F (60°C) and 56°F (13.3°C). To avoid the potential complication and confusion that would result from an additional temperature ratio correction, however, a test tolerance correction is not included in today's proposal. The Department recognizes that an incentive exists to conduct the first hour rating test with the tank thermostat set at or near 130°F (54.4°C), and with the make-up water at or near 60°F (15.6°C).

Preliminary studies conducted by NIST estimate today's proposed test method is successful in minimizing the repeatability problem to within ± 5 percent relative to the 1989 proposal. The Department today requests comments and data concerning this repeatability issue.

In addition, the Department proposes to modify the existing first hour rating definition so that it differentiates between storage and instantaneous water heaters. Section 1.5.

In regard to heat pump water heaters that use supplemental resistive heating, a draw is currently initiated only after all power to the water heater has been reduced, which corresponds to the case where the compressor has cycled off and any resistive heating has ceased. The Department today proposes a revision to the criterion used to initiate successive draws so that credit is given if this type of water heater provides a partial recovery. The proposed revision would require a draw to be initiated after the thermostat controlling the upper or lone resistive element, or the compressor is satisfied, whichever occurs first. However, this criterion shall be applicable only if the water located vertically above the resistive element thermostat or compressor thermostat is heated to 135 ± 5°F (57.2 ± 2.8°C) when cut-off occurs. The Department requests comments and data on the appropriateness and workability of the proposed changes to the test method for heat pump water heaters that use supplemental resistive heating. See appendix E to subpart B of Title 10 CFR part 430, section 5.1.4.2.

4. Definitions for Heat Pump Water Heaters, Add-on Heat Pump Water Heaters, Integral Heat Pump Water Heaters, Solar Water Heaters, and Heat Pump Water Heater Storage Tanks

The Department proposes to amend the extant definition for heat pump water heaters (section 1.11.3); add definitions of integral heat pump water heater (section 1.11.3.a), add-on heat pump water heaters (section 1.11.3.b), and solar water heaters (section 1.11.5) to differentiate these types of water heaters; and add definition of a heat pump water heater storage tank, i.e., the tank to be used with an add-on heat pump water heater (section 1.6).

B. Kitchen Ranges, Ovens and Microwave Ovens Test Procedures

The test procedures for kitchen ranges, ovens and microwave ovens have remained substantially unchanged since the final rule was published in the **Federal Register** on May 10, 1978 (43 FR 20120). It was amended on April 13, 1979, by prescribing that natural gas or propane would be the test gas used with gas ranges and ovens (44 FR 22418).

Today's proposed amendment will change the annual useful cooking energy output for kitchen ranges, ovens and microwave ovens to make it representative of current United States cooking product usage. In addition, the proposed test procedure will no longer contain annual energy consumption calculations for ranges (cooktop and oven combined), or other combined appliances (multiple conventional ovens, microwave and conventional range combined). The Department is proposing to calculate the annual energy consumption of combined appliances as the sum of the annual energy consumption of each individual component of the unit. Section 4.3. The Department is proposing to incorporate by reference the International Electrotechnical Commission (IEC), Publication 705, and Amendment 2–1993, ''Methods for Measuring the Performance of Microwave Ovens for Household and Similar Purposes,'' Section 4, Paragraph 12 ''Microwave Power Output Measurement,'' Paragraph 13 ''Electrical Power Output Measurement,'' and Paragraph 14

''Efficiency.'' DOE has not proposed test procedures for grill and griddle cook tops; the Department would consider adding test procedures for these products if such exist.

1. Ovens

Today's proposed revision to the oven test procedures lowers the constant for annual useful cooking energy [2] to make it representative of current United States cooking trends. This quantity is being changed for electric to 35.5 kWh (105.5 MJ) per year from 47.09 kWh (169.5 MJ) per year; for gas, to 124,200 BTU (131,038 kJ) per year from 160,700 BTU (169,547 kJ) per year. Sections 4.1.2.1.1, 4.1.2.1.2, and 4.1.4. Lawrence Berkeley Laboratory of Berkeley, California calculated this constant from several utility studies. These results are presented in the Technical Support Document: Energy Efficiency Standards for Consumer Products, Volume 2, November 1993, DOE/EE–0009, Vol. 2 of 3.

In addition, the Department proposes to eliminate the requirement to use a standard continuous flow calorimeter for gas cooking products because of the difficulty of locating this product. The instrument to be substituted for the standard continuous flow calorimeter is left to the discretion of the manufacturer; although, it is required that the heating value of natural or propane gas shall be measured with an instrument and associated indicator readout device of a maximum error no greater than ±.5 percent of the measured value and a resolution of ±.2 percent or less of the full scale reading of the indictor instrument. Section 2.9.4.

2. Cook Tops

The proposed revision to the cook top test procedures changes the constant for annual useful cooking energy [3] to make it representative of current United States cooking trends. This quantity is being lowered for electric to 209 kWh (752.4 MJ) per year from 277.7 kWh (1000 MJ) per year; for gas, to 732,500 BTU (772,800 kJ) per year from 947,500 BTU (999,600 kJ) per year. Lawrence Berkeley Laboratory of Berkeley, California calculated this constant from several utility studies. These results are presented in the Technical Support Document: Energy Efficiency Standards for Consumer Products, Volume 2, November 1993, DOE/EE–0009, Vol. 2 of 3.

3. Microwave Ovens

The proposed changes to the microwave oven test procedures are in response to a petition for rulemaking from the Association of Home Appliance Manufacturers (AHAM) to use the International Electrotechnical Commission standard as the DOE test procedure. The current DOE test procedure is based on a 1975 version of the International Electrotechnical Commission standard. The Association of Home Appliance Manufacturers cited the following deficiencies with the DOE test procedure:

(1) Errors caused by evaporative cooling of the water and heat absorption of the water containers during the heating period, and

(2) Errors caused by the constantly changing sodium chloride concentration due to sodium chloride precipitating out of solution.

The International Electrotechnical Commission issued Publication 705, and Amendment 2–1993 entitled ''Method for Measuring the Performance of Microwave Ovens for Household and Similar Purposes'' in 1993. The Department asked the National Institute of Standards and Technology to perform tests using the 1993 International Electrotechnical Commission test procedure. The National Institute of Standards and Technology found the test procedure to be acceptable for determining power output and efficiency, and recommended that the Department of Energy incorporate by reference the International Electrotechnical Commission 705 Amendment 2–1993 test procedure for these purposes. In computing energy consumption, the International Electrotechnical Commission 705 Amendment 2–1993 uses a watt meter and timer, ignoring transients, to obtain measurements from which energy consumption can be calculated. The Department believes that because of start-up transients, the use of a watt-hour meter is more accurate; therefore, today's notice includes the use of a watt-hour meter, which is not found in the IEC 1993 test procedure, to obtain energy consumption.

The annual useful cooking energy in the extant test procedure is 34.2 kWh (123 MJ) per year based on 1976 data. In the Eight Product rulemaking (59 FR 10464, March 4, 1994), DOE used an annual useful cooking energy of 145.8 kWh per year in its analysis. Technical Support Document: Energy Efficiency Standards for Consumer Products, Volume 2, November 1993, DOE/EE–0009, Vol. 2 of 3, pp. 1–49. After reviewing several utility studies and comments, DOE is proposing to change the annual useful cooking energy [4] from 34.2 kWh (123 MJ) per year to 77.3 kWh (278.3 MJ) per year. This revision to the annual useful cooking energy reflects current U.S. microwave cooking usage. This will change the value of O_m in the test procedure to 77.3 kWh/yr [143.2 kWh/yr $\times$ 0.54 = 77.3 kWh/yr] (278.3 MJ/yr). (See appendix I to subpart B of title 10 CFR part 430, ''Uniform Test Method for Measuring the Energy Consumption of Conventional Ranges, Conventional Cooking Tops, Conventional Ovens, and Microwave Ovens,'' sections 4.4.3 and 4.4.5). Lawrence Berkeley Laboratory of Berkeley, California calculated this constant from an average of six utility studies. These studies include: Lawrence Berkeley Laboratory, ''Baseline Data for the Residential and Development of a Residential Forecasting Database,'' LBL 33717, May 1994; American Electric Power, ''Utility Estimates of Household Appliance Electricity Consumption,'' 1992; Southern California Edison, ''Residential Appliance End-Use Survey,'' 1990 and 1991; Electric Power Research Institute, ''Residential End-Use Energy Consumption: A Survey of Conditional Demand Estimates,'' CU–6487, October 1989; and the Sierra Pacific Power Company, ''Integrating EIP and HES5 Information for Estimating End-Use Energies,'' March 1988. The microwave oven annual energy consumption proposed in today's notice also includes the energy used by the clock thus, eliminating the necessity to disable the clock during test setup.

C. Clothes Washer Test Procedure

The Department published the clothes washer test procedure on September 28, 1977, (42 FR 49802) and subsequently on June 29, 1979, (44 FR 37938) editorial changes were made. On December 22, 1993, (58 FR 67710) the Department published a proposed amendment to the clothes washer test procedure to address washers which offer a warm rinse lock-out feature. Today's proposed amendments to the clothes washer test procedure will

[2] The annual useful cooking energy is energy input to an oven which is transferred to the product being cooked and is a constant used to find the annual energy consumption and the energy factor. The annual energy consumption is calculated by multiplying the constant by the ratio of test energy consumption to the energy used to heat the test block. The energy factor is the ratio of the constant to the total annual energy consumption.

[3] See footnote 2, supra.

[4] The annual useful cooking energy is energy input to an oven which is transferred to the product being cooked and is a constant used to find the annual energy consumption and the energy factor. The annual energy consumption is calculated by multiplying the constant by the ratio of test energy consumption to the energy used to heat the test water load. The energy factor is the ratio of the constant to the total annual energy consumption.

address issues that are independent from the temperature selection lock-out feature.

Today's proposed amendments to the clothes washer test procedure do not alter the energy factor of any existing clothes washer that minimally complies with the existing efficiency standard.

In the Advance Notice of Proposed Rulemaking for energy conservation standards for clothes washers (59 FR 56423, November 14, 1994), the Department said it would consider an energy conservation standard that includes water extraction. The Department believes that mechanical water extraction in a clothes washer is much more cost effective and efficient than thermal extraction in a clothes dryer. The Department proposes today's procedures and calculations for water extraction in clothes washers that would be used in the standards rulemaking for consideration of water extraction. Any analysis for clothes dryer efficiency standards would account for the impact of moisture retention of clothes entering the clothes dryer.

The Department of Energy today proposes to modify the clothes washer test procedure as follows:

1. Title 10 CFR part 430, subpart B, section 430.22(j).

The number of representative average-use cycles per year is presently 416, based on Proctor and Gamble survey data from 1974–75. New Proctor and Gamble survey data has indicated the number of cycles consumers use on a yearly basis has decreased. Thus, the Department is proposing to revise the representative average-use cycles to 392 per year.[5] This change lowers annual energy use and annual energy cost.

2. Title 10 CFR part 430, subpart B, appendix J.

a. General test procedure clarification.

The Department is proposing to add a definition for ''agitator'' (section 1.1). The existing test procedure mentions ''agitator'' but, does not provide a definition.

The Department is proposing to add a definition for ''thermostatically controlled valves'' (section 1.19). The existing test procedure mentions ''thermostatically controlled valves'' but, does not provide a definition.

The Department is proposing to replace the definition for a ''top-loader'' clothes washer with ''top-loader-horizontal-axis clothes washer'' (section 1.21) and ''top-loader-vertical-axis clothes washer'' (section 1.22). The Department has become aware of top-loading-horizontal-axis clothes washers which are readily available in other countries. These clothes washers have not yet become available in the U.S. market; however, the Department wants to provide nomenclature for this type of clothes washer.

The Department is proposing to delete the following definitions: ''AHAM'' (section 1.1), ''HWL–1'' (section 1.7) and ''HLW–2EC'' (section 1.8). The revised test procedure proposed in today's notice does not use these terms.

The Department is proposing to delete the requirement specified in existing test procedure section 2.2: ''Disconnect all console lights or other lighting systems on the clothes washer, which do not consume more than 10 watts during the clothes washer test cycle.'' The Department believes that this requirement is burdensome.

The Department is proposing to add a new requirement for ''Agitation and spin speed settings'' (section 2.11). The existing test procedure does not specify agitation or spin speed settings. The Department is aware of clothes washers which allow selective agitation and spin speed settings independent of the normal cycle. Therefore, the proposed test procedure specifies requirements for clothes washers with these features.

The Department is proposing to change the symbol for density from ''d'' to ''ρ.'' The requirement to use the density of water at 140°F was deleted, so that the density of water at the measured temperature will be used.

The Department is proposing to clarify the requirement for ''maximum fill'' testing. The Department wants to ensure that testing of a clothes washer's energy consumption accounts for the clothes washer's maximum fill capability. The Department is proposing to revise the test procedure to add ''available on the clothes washer'' after the test procedure requirement for ''maximum fill'' (sections 3.2.1.2 and 3.2.2.1).

The Department is aware that some clothes washers may have similarly labeled wash/rinse temperature selections, i.e., ''automatic warm/cold'' and ''warm/cold,'' on the same machine, which actually provide different wash/rinse water temperatures. Under this scenario, the ''automatic warm/cold'' temperature selection has wash/rinse water temperature adjusted through the use of thermostatically controlled valves, whereas the ''warm/cold'' temperature selection is ''traditional,'' in that control of temperature is based on preset orifices. The Department believes that these machines are offering additional temperature selections. Therefore, instead of developing additional Temperature Utilization Factors, the Department is proposing to require the use of the temperature selection which results in the largest amount of hot water consumption for the energy consumption calculations (section 4.1.1.1). The Department believes the use of the temperature selection which results in the largest amount of hot water consumption is specified in the existing test procedure (''hottest setting available'' in section 3.2.2.2). The Department's proposal is intended to remove any ambiguity regarding the testing of clothes washers equipped with this type of temperature selection. The Department welcomes comments regarding this issue.

b. Test procedure revisions to include changes from approved Waivers.

The Department has granted two Petitions for Waivers to the clothes washer test procedure. Both Waivers were for water-heating clothes washers. New Harmony Systems Corporation (New Harmony) was issued a Waiver (Case No. CW–001) by Decision and Order, published on April 4, 1994. (59 FR 15710). Asko Incorporated (Asko) was issued a Waiver (Case No. CW–002) by Decision and Order, published on April 4, 1994. (59 FR 15719).

The Department is proposing definitions for ''nonwater-heating clothes washer'' (section 1.11) and ''water-heating clothes washer'' (section 1.24) to differentiate different types of clothes washers.

The Department is proposing to revise the requirements for ''electrical energy supply'' (section 2.2) to allow for higher voltage clothes washers. Furthermore, voltage tolerance has been increased from approximately 1.6 percent to 2 percent to reduce testing burden. This increase in tolerance will not reduce the accuracy of energy consumption testing/reporting.

The Department is proposing to add procedures for testing water-heating clothes washers which have variable temperature controls (sections 3.2.2 through 3.2.2.4). The Department is proposing to test water-heating clothes washers at the coldest and hottest setting available on the clothes washer in addition to the existing test procedure temperature settings for warm (nominally 100°F) and hot (nominally 140°F).

The proposed temperature use factors for water-heating clothes washers are based on revised temperature use factors for a three temperature selection nonwater-heating clothes washer. The Department believes that the existing TUFs for a three temperature selection nonwater-heating clothes washer are

[5] 392 represents the average number of cycles per year from 1986 through 1994, obtained by P & G survey data and provided to the Department via letter dated September 2, 1994.

appropriate for a water-heating clothes washer, except that some consumers will occasionally choose to use a temperature setting higher than the ''hot'' setting since it is available to them. The existing temperature use factors for ''cold/cold'' (15 percent), ''warm/warm or warm/cold'' (55 percent) and ''hot/warm or hot/cold'' (30 percent) have been split into four TUFs, one of 15 percent for the ''coldest'' setting, one of 55 percent for the ''warm'' setting, one of 25 percent for ''hot'' and one of 5 percent for the ''hottest'' setting. The Department does not have data regarding the 5 percent value, but is proposing to use it as originally proposed by New Harmony. The Department welcomes comments on this proposal.

The Department is proposing tighter tolerances for the supply water temperature, and the ''warm'' and ''hot'' settings for water-heating clothes washers as compared to nonwater-heating clothes washers. The Department is proposing that the supply water temperature be set at ''a minimum of 55°F (12.8°C) and a maximum of 60°F (15.6°C).'' The ''warm'' temperature shall be set at ''a minimum of 100°F (37.8°C) and a maximum of 105°F (40.6°C)'' and the ''hot'' temperature shall be set at ''a minimum of 140°F (60°C) and a maximum of 145°F (62.8°C).'' These tighter tolerances are required for water-heating clothes washers to reduce variability in energy consumption testing/reporting and to ensure that a minimum temperature rise is tested. The temperature tolerance and minimum temperature rise issues are unique to a water-heating clothes washer because the energy to raise the water temperature is measured from electrical consumption versus being calculated as it is for nonwater-heating clothes washers.

Since the issue of machine-controlled water fill capability has been raised by the Asko Waiver, the Department wants to provide a provision for the possibility of any type of clothes washer having this feature. Thus, the Department is proposing to add the definition of ''machine-controlled water fill capability'' (section 1.7) to the test procedure. In addition, the Department is proposing a revision to the ''top-loader-vertical-axis clothes washer'' section (section 2.8.1) to require the use of a test load for clothes washers with a machine-controlled water fill capability feature. Therefore, a clothes washer equipped with machined-controlled water fill capability will be tested for maximum fill energy consumption using a 7 pound (3.18 kg) test load and for minimum fill energy consumption using a 3 pound (1.36 kg) test load. The Department believes that consumers will occasionally wash loads which are larger than 7 pounds (3.18 kg) and will also wash loads which are smaller than 3 pounds (1.36 kg). This provision will allow for testing of clothes washers that may have this feature. The Department welcomes comments on this proposed provision.

c. Water consumption and extraction testing.

The Department is concerned about water conservation and wishes to provide for a procedure to determine the water consumption of clothes washers. The Department believes, consistent with the Energy Policy Act of 1992, Pub. L. 102–486, that water conservation is important, and a need may exist to determine actual water use.

Therefore, the Department is proposing to add definitions, testing procedures, and calculations regarding water use. Additionally, for those water or sewage utilities wishing to include particular clothes washers in rebate programs, the DOE test procedure would provide a standardized means of testing for water consumption.

The Department is proposing to add a definition for a ''Water consumption factor'' (section 1.23). Calculations for the water consumption factor are provided in section 4.3. The water consumption factor is the ratio of the clothes washer capacity divided by the weighted per-cycle water consumption. The weighted per-cycle water consumption is the actual weighted volume of water that a particular clothes washer consumes. This measurement could be used to estimate water consumption on an annual basis. The Department welcomes comments on this proposal.

The Department is concerned about water extraction in the clothes washers' final spin. The Department believes that mechanical extraction in a clothes washer is more efficient than thermal extraction in a clothes dryer. Therefore, the Department wishes to provide for a procedure measuring the water extraction in clothes washers. The Department is proposing to add a definition for ''moisture removal energy'' (section 1.10). Moisture removal energy equals the weight of the residual water in the test load at the completion of the clothes washer cycle multiplied by the nominal energy needed to remove moisture using a representative clothes dryer efficiency. The calculations for moisture removal energy are provided in the proposed test procedure section 4.2. In today's notice, the Department requests comments, data, and other relevant information regarding the definition and calculation of the moisture removal energy. The Department is proposing a value of 0.5 Kwh/lb as the energy efficiency of a representative clothes dryer to remove moisture. The Department also is interested in comments as to the validity and usage of this value.

The Department is interested in developing a new energy descriptor, called a modified energy factor, which will include moisture removal energy, for possible future standard use. This new descriptor will provide a means of determining and comparing the entire energy consumption of clothes washers. Therefore, the Department is proposing to add a definition for ''modified energy factor'' (section 1.9). The modified energy factor equals the ratio of the capacity of the clothes washer divided by the total energy, which consists of the mechanical, hot water and moisture removal energy. The calculations for the modified energy factor are provided in the proposed test procedure section 4.4. The Department requests comments, data, and other relevant information regarding the definition and calculation of this new energy descriptor.

D. Reporting Requirements

The Department is proposing to revise the reporting requirements for clothes washers, dishwashers and clothes dryers. The present regulations do not require the reporting of the energy factors for these products. Prior to the May 14, 1991 final rule for clothes washers, dishwashers and clothes dryers, there were no performance standards for these products. Now, since there are performance standards for these products, the Department is proposing to include certification reporting. Section 430.62(a)(2).

III. Environmental Review

Pursuant to section 7(a) of the Federal Energy Administration Act of 1974 (Pub. L. 93–275, 15 U.S.C. 766(a)), a copy of this notice was submitted to the Administrator of the Environmental Protection Agency for the Administrator's comments concerning the impacts of this proposal on the quality of the environment.

DOE has concluded that this proposed rule falls into a class of actions (categorical exclusion A5) that are categorically excluded from NEPA review because they would not individually or cumulatively have a significant impact on the human environment, as determined by DOE's regulations (10 CFR part 1021, Subpart D) implementing the National Environmental Policy Act of 1969 (42 U.S.C. 4321, 4331–35, 4341–47 (1976)).

Therefore, this proposed rule does not require an environmental impact statement or an environmental assessment pursuant to NEPA.

IV. Regulatory Review

Today's regulatory proposal has been determined not to be a ''significant regulatory action'' under Executive Order 12866, ''Regulatory Planning and Review,'' (58 FR 51735, October 4, 1993). Accordingly, today's action was not subject to review under the Executive Order by the Office of Information and Regulatory Affairs.

V. Regulatory Flexibility Review

The proposed rule has been reviewed under the Regulatory Flexibility Act, Pub. L. 96–354 (42 U.S.C. 601–612) which requires preparation of a regulatory flexibility analysis for any regulation that will have a significant economic impact on a substantial number of small entities, i.e., small businesses and small government jurisdictions. The proposed rule affects manufacturers of water heaters; kitchen ranges, ovens, and microwave ovens; and clothes washers. The test procedures would not have significant economic impact, but rather, would provide common testing methods. DOE accordingly certifies that the proposed rule would not, if promulgated, have a significant economic impact on a substantial number of small entities and that preparation of a regulatory flexibility analysis is not warranted.

VI. ''Takings'' Assessment Review

It has been determined pursuant to Executive Order 12630 (52 FR 8859, March 18, 1988) that this proposed regulation, if adopted, would not result in any takings which might require compensation under the Fifth Amendment to the United States Constitution.

The Department believes that test procedures implementing a long-established statutory mandate in a manner calculated to minimize adverse economic impacts does not constitute a ''taking'' of private property. Thus, testing under the appliance standards program does not invoke the provisions of E.O. 12630.

VII. Federalism Review

Executive Order 12612 (52 FR 41685, October 30, 1987) requires that regulations or rules be reviewed for any substantial direct effects on States, on the relationship between the Federal Government and the States, or on the distribution of power and responsibilities among various levels of Government. If there are sufficient substantial direct effects, the Executive Order 12612 requires the preparation of a Federalism assessment to be used in decisions by senior policymakers in promulgating or implementing the regulation.

DOE has identified a substantial direct effect that today's proposed rule would have on State governments. It would initially preempt inconsistent State regulations. However, DOE has concluded that such effect is not sufficient to warrant preparation of a federalism assessment for the following reason: the Act provided for subsequent State petitions for exemption. Thus, a determination as to whether a State law prevails must be made on a case-by-case basis using criteria set forth in the Act. When DOE receives such a petition, it will then be appropriate to consider preparing a federalism assessment consistent with the criteria in the Act.

VIII. Review Under Section 32 of the Federal Energy Administration Authorization Act

The test procedure amendments proposed today incorporate the International Electrotechnical Commission Publication 705, and Amendment 2–1993, ''Methods for Measuring the Performance of Microwave Ovens for Household and Similar Purposes,'' section 4, Paragraph 12 ''Microwave Power Output Measurement,'' Paragraph 13 ''Electrical Power Output Measurement,'' and Paragraph 14 ''Efficiency'' to determine the output power and efficiency for microwave ovens.

Pursuant to section 301 of the Department of Energy Organization Act (Pub. L. 95–91), DOE is required to comply with section 32 of the Federal Energy Authorization Act of 1974 (15 U.S.C. 788), which imposes certain requirements where a proposed rule contains commercial standards or authorizes or requires the use of such standards.

The findings required of DOE by section 32 of the Act serve to alert the public and DOE regarding the use and background of commercial standards in a proposal and through the rulemaking process. They allow interested persons to make known their views regarding the appropriateness of the use of any particular commercial standard in a proposed rulemaking.

DOE has evaluated the promulgation of International Electrotechnical Commission Publication 705, and Amendment 2–1993, in light of the public participation criteria of section 32(b). The Department is unable to conclude whether development of these standards fully complied with section 32(b) regarding the manner of public participation.

As required by section 32(c), DOE will consult with the Attorney General and the Chairman of the Federal Trade Commission concerning the impact of these standards on competition, prior to prescribing final test procedures.

IX. Paperwork Reduction Act Review

No new information or recordkeeping requirements are imposed by this rulemaking. Accordingly, no OMB clearance is required under the Paperwork Reduction Act (44 U.S.C. 3501 *et seq.*).

X. Review Under Executive Order 12778

Section 2 of Executive Order 12778 instructs each agency to adhere to certain requirements in promulgating new regulations and reviewing existing regulations. These requirements, set forth in sections 2(a) and (b)(2), include eliminating drafting errors and needless ambiguity, drafting the regulations to minimize litigation, providing clear and certain legal standards for affected conduct, and promoting simplification and burden reduction. Agencies are also instructed to make every reasonable effort to ensure that the regulation specifies clearly any preemptive effect, effect on existing Federal law or regulation, and retroactive effect; describes any administrative proceedings to be available prior to judicial review and any provisions for the exhaustion of such administrative proceedings; and defines key terms. The DOE certifies that today's proposed rule meets the requirements of sections 2(a) and (b)(2) of Executive Order 12778.

XI. Public Comment Procedures

A. Written Comment Procedures

Interested persons are invited to participate in the rulemaking by submitting data, comments, or information with respect to the proposed test procedures set forth in this notice to the address indicated at the beginning of the notice.

Comments should be identified both on the envelope and on the documents as ''Water Heaters; Kitchen Ranges, Ovens, and Microwave Ovens; and Clothes Washers Test Procedures, Docket No. EE–RM–94–230.'' Ten (10) copies are requested to be submitted. In addition, the Department requests that an electronic copy (3½″ diskette) of the comments on WordPerfectTM 5.1 be provided. All submittal received by the date specified at the beginning of this notice will be considered by the Department of Energy before final action is taken on the proposed amendments.

Pursuant to the provisions of 10 CFR 1004.11, any person submitting information which he or she believes to be confidential and exempt by law from public disclosure should submit one complete copy of the document and ten (10) copies, if possible, from which the information believed to be confidential has been deleted. The Department of Energy will make its own determination with regard to the confidential status of the information and treat it according to its determination.

Factors of interest to DOE when evaluating requests to treat as confidential information that has been submitted include: (1) A description of the items; (2) an indication as to whether and why such items are customarily treated as confidential within the industry; (3) whether the information is generally known by or available from other sources; (4) whether the information has previously been made available to others without obligation concerning its confidentiality; (5) an explanation of the competitive injury to the submitting person which would result from public disclosure; (6) an indication as to when such information might lose its confidential character due to the passage of time; and (7) why disclosure of the information would be contrary to the public interest.

B. Public Hearing

1. Procedures for Submitting Requests to Speak

The time and place of the public hearing are indicated at the beginning of this notice. The Department of Energy invites any person who has an interest in today's proposed rule, or who is a representative of a group or class of persons that has an interest in the proposed test procedures, to make a written request for an opportunity to make an oral presentation. Such requests should be directed to the address indicated at the beginning of this notice. Requests may be hand delivered to such address between the hours of 8 a.m. and 4 p.m., Monday through Friday, except Federal holidays. Requests should be labeled ''Test Procedure for Water Heaters; Kitchen Ranges, Ovens and Microwave Ovens; and Clothes Washers; and Reporting Requirements for Clothes Washers, Clothes Dryers, and Dishwashers, Docket No. EE–RM–94–230,'' both on the document and on the envelope.

The person making the request should briefly describe the interest concerned and state why he or she, either individually or as a representative of a group or class of persons that have such an interest, is an appropriate spokesperson, and give a telephone number where he or she may be contacted.

Each person selected to be heard is requested to submit an advance copy of their statement prior to the hearing as indicated at the beginning of this notice. In the event any persons wishing to testify cannot meet this requirement, that person may make alternative arrangements with the Office of Hearings and Dockets in advance by so indicating in the letter requesting to make an oral presentation.

2. Conduct of Hearing

The Department of Energy reserves the right to select the persons to be heard at the hearing, to schedule the respective presentations, and to establish the procedures governing the conduct of the hearing. The length of each presentation is limited to twenty (20) minutes.

A DOE official will be designated to preside at the hearing. The hearing will not be a judicial or an evidentiary-type hearing, but will be conducted in accordance with 5 U.S.C. 553 and section 336 of the Act. At the conclusion of all initial oral statements at each day of the hearing, each person who has made an oral statement will be given the opportunity to make a rebuttal statement, subject to time limitations. The rebuttal statement will be given in the order in which the initial statements were made. The official conducting the hearing will accept additional comments or questions from those attending, as time permits. Any interested person may submit, to the presiding official, written questions to be asked of any person making a statement at the hearing. The presiding official will determine whether the question is relevant, and whether time limitations permit it to be presented for answer.

Any further procedural rules regarding proper conduct of the hearing will be announced by the presiding official.

A transcript of the hearing will be made, and the entire record of this rulemaking, including the transcript, will be retained by DOE and made available for inspection at the DOE Freedom of Information Reading Room, U.S. Department of Energy, Forrestal Building, Room 1E–190, 1000 Independence Avenue, SW., Washington, DC 20585, (202) 586–6020, between the hours of 9 a.m. and 4 p.m., Monday through Friday, except Federal holidays. Any person may purchase a copy of the transcript from the transcribing reporter.

C. Issues for Public Comment

The Department of Energy is interested in receiving comments and data concerning the accuracy and workability of these test procedures. Also, the Department welcomes discussion on improvements or alternatives to these approaches. In particular, DOE is interested in gathering comments on the following:

- The appropriateness of including test procedures for electric and oil instantaneous water heaters.
- The impacts on manufacturer(s) as a result of extending coverage of the existing minimum energy efficiency standards for electric and oil-fired instantaneous water heaters.
- The appropriateness of including the draw schedule and draw rate of the American National Standards Institute/American Society of Heating, Refrigerating and Air Conditioning Engineers Standard 118.2–1993 for storage water heaters with rated storage capacities less than 20 gallons (76 liters).
- The impacts on manufacturer(s) as a result of extending coverage of the existing minimum energy efficiency standards for storage-type water heaters of less than 20 gallons (76 liters).
- The appropriateness of the proposed definition, first hour rating, for instantaneous and storage water heaters.
- The appropriateness of the proposed first hour rating test method for storage tank-type water heaters.
- The appropriateness of a first hour rating which might give unrealistic results for water heaters containing thermal compensating dip tubes or internal mixing valves.
- The appropriateness of the proposed definitions: heat pump water heater, add-on heat pump water heater, integral heat pump water heater, solar water heater, and heat pump water heater storage tank.
- The adequateness of the test provisions for heat pump water heaters regarding the usage of backup electric resistance element(s).
- The appropriateness of the proposed test energy method to determine the output energy for microwave ovens.
- The appropriateness to incorporate by reference the International Electrotechnical Commission Publication 705, and Amendment 2–1993, ''Methods for Measuring the Performance of Microwave Ovens for Household and Similar Purposes,'' section 4, Paragraph 12 ''Microwave Power Output Measurement,'' Paragraph 13 ''Electrical Power Output

Measurement,'' and Paragraph 14 ''Efficiency'' as a test method for microwave ovens.

- The appropriateness of the proposed definitions: Agitator, machine-controlled water fill capability, modified energy factor, moisture removal factor, nonwater-heating clothes washer, thermostatically controlled valves, top-loader-horizontal-axis clothes washer, top- loader-vertical-axis clothes washer, water consumption factor and water-heating clothes washer.
- The appropriateness of the proposed test and performance measurement methods for water-heating clothes washers.
- The appropriateness of using 5 percent and 25 percent to prorate the ''hottest'' available setting and the ''hot'' setting, respectively, for water-heating clothes washers.
- The appropriateness of a new descriptor (moisture removal energy) to determine the efficiency of moisture removal from the test load.
- The appropriateness of a new descriptor (water consumption factor) to determine the water consumption of clothes washers.
- The appropriateness of a new efficiency descriptor (modified energy factor) for possible future use in establishing energy conservation standards for clothes washers.

List of Subjects in 10 CFR Part 430

Administrative practice and procedure, Energy conservation, Household appliances, Incorporation by reference.

Issued in Washington, DC, February 8, 1995.

Christine Ervin,

Assistant Secretary, Energy Efficiency and Renewable Energy.

For the reasons set forth in the preamble, part 430 of chapter II of title 10, of the Code of Federal Regulations is proposed to be amended as set forth below:

PART 430—ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS

1. The authority citation for Part 430 continues to read as follows:

Authority: 42 U.S.C. 6291–6309.

2. Section 430.22 is amended by revising paragraph (a)(2)(ii) and adding paragraph (a)(3)(iv) and adding item number 13 to paragraph (a)(4) to read as follows:

§ 430.22 Reference sources.

(a) * * *

(2) * * *

(ii) U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Hearings and Dockets, Forrestal Building, 1000 Independence Avenue, SW., Washington, DC 20585.

(3) * * *

(iv) Copies of the International Electrotechnical Commission Publication can be obtained from the American National Standards Institute, 11 West 42nd Street, New York, New York 10036, (212) 642–4936.

(4) * * *

13. International Electrotechnical Commission Publication 705, and Amendment 2–1993, ''Methods for Measuring the Performance of Microwave Ovens for Household and Similar Purposes,'' Section 4, Paragraph 12 ''Microwave Power Output Measurement,'' Paragraph 13 ''Electrical Power Output Measurement,'' and Paragraph 14 ''Efficiency.''

§ 430.23 [Amended]

3. Section 430.23, Test procedures for measures of energy consumption, is amended to read as follows:

A. In § 430.23(i)(1)(iii) (second sentence) replace ''4.3.1, 4.2.2, 4.1.2.5, or 4.1.2.6, 4.4.3, and 4.5.1.3'' with ''4.3, 4.2.2, 4.1.2, and 4.4.3.''

B. In § 430.23(i)(2) (first sentence) replace ''4.2.1.3, 4.1.3 and 4.4.2'' with ''4.2.1, 4.1.3, and 4.4.4.''

C. In § 430.23(i)(3) (first sentence) replace ''4.3.2, and 4.5.2'' with ''4.3'' and replace the comma following ''subpart'' with a period and remove the remainder of the sentence.

D. In § 430.23(i)(4) (first sentence) replace ''4.3.3, 4.2.3, 4.1.4, 4.4.4 and 4.5.3'' with ''4.3, 4.2.3, 4.1.4, 4.4.5.''

E. In § 430.23(j)(1)(i)(A) replace ''416'' with ''392''.

F. In § 430.23(j)(1)(i)(B) replace ''determined according to 4.6'' with ''determined according to section 4.1.1.6 (nonwater-heating) or 4.1.2.2 (water-heating)''.

G. In § 430.23(j)(1)(ii) (introductory text) replace ''When gas-heated or oil-heated water is used, the product of: the representative average-use cycle of 416 cycles per year'' with ''When gas-heated or oil-heated water is used, the product of: the representative average-use cycle of 392 cycles per year (for nonwater-heating clothes washers)''.

H. In § 430.23(j)(1)(ii)(A) replace ''4.4'' with ''4.1.1.4''.

I. In § 430.23(j)(1)(ii)(B) replace ''in Btu per cycle, determined according to 4.5'' with ''in Btu per cycle (MJ per kwh), determined according to section 4.1.1.5''.

J. In § 430.23, paragraph (j)(2) is revised to read as follows:

§ 430.23 Test procedures for methods of energy consumption.

* * * * *

(j) * * *

(2)(i) The energy factor for automatic and semi-automatic clothes washers shall be the quotient of the cubic foot (liter) capacity of the clothes container as determined in 3.1 of appendix J to this subpart divided by the clothes washer energy consumption per cycle, expressed as: (for nonwater-heating clothes washers) the sum of the machine electrical energy consumption and the hot water energy consumption as determined in 4.1.1.4 and 4.1.1.3, respectively, of appendix J to this subpart; (or for water-heating clothes washers) the energy consumption as determined in 4.1.2.2, of appendix J to this subpart. The result shall be rounded off to the nearest 0.01 cubic foot per kilowatt-hour per cycle (0.01 liter per kilowatt-hour per cycle).

(ii) The modified energy factor for automatic and semi-automatic clothes washers is determined in accordance with section 4.4.1 (nonwater-heating clothes washers) or 4.4.2 (water-heating clothes washers), of appendix J to this subpart. The result shall be rounded off to the nearest 0.01 cubic foot per kilowatt-hour per cycle (0.01 liter per kilowatt-hour per cycle).

(iii) The water consumption factor for automatic and semi-automatic clothes washers is determined in accordance with section 4.3.3, of appendix J to this subpart. The result shall be rounded off to the nearest 0.001 cubic foot per gallon per cycle (0.001 liter per liter per cycle).

* * * * *

4. Appendix E to subpart B of part 430 is revised to read as follows:

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 burner.

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 (KJ) per hour as appropriate.

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

1.5 *First Hour Rating* is an estimate of the maximum volume of ''hot'' water that a storage-type water heater can supply within an hour that begins with the water heater fully heated (i.e., all thermostats satisfied). For instantaneous water heaters, first hour rating designates the maximum volume of hot water that can be supplied during any hour.

1.6 *Heat Pump Water Heater Storage Tank* is an insulated tank designed, wired and labeled for use exclusively with an add-on heat pump water heater or solar water heater and being unable to operate without an add-on heat pump water heater or solar water heater. The heat pump water heater storage tank may contain one or two thermostats and up to two electric resistance heating elements, and has a manufacturer's rated capacity of 120 gallons (450 liters) or less. When tested with the add-on heat pump water heater or solar water heater inoperative, the heat pump water heater storage tank shall have an energy factor that is determined in accordance with the test procedure for water heaters.

1.7 *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.

1.8 *Instantaneous-Type Water Heaters.*

1.8.1 *Electric Instantaneous Water Heater* means a water heater that uses electricity as the energy source, initiates heating based on sensing water flow, is designed to deliver water at a controlled temperature of less than 180°F (82°C), has a maximum input of 12 kilowatts or less, and has a manufacturer's specified storage capacity of less than 2 gallons (8 liters). The unit may use a fixed or variable power input.

1.8.2 *Gas Instantaneous Water Heater* means a water heater that uses gas as the energy source, initiates heating based on sensing water flow, is designed to deliver water at a controlled temperature of less than 180°F (82°C), has an input greater than 50,000 Btu per hour (53 MJ per hour) but less than 200,000 Btu per hour (210 MJ per hour), and has a manufacturer's specified storage capacity of less than 2 gallons (8 liters). The unit may use a fixed or variable burner input.

1.8.3 *Oil Instantaneous Water Heater* means a water heater that uses oil as the energy source, initiates heating based on sensing water flow, is designed to deliver water at a controlled temperature of less than 180°F (82°C), has an input greater than 50,000 Btu per hour (53 MJ per hour) but less than 200,000 Btu per hour (210 MJ per hour), and has a manufacturer's specified storage capacity of less than 2 gallons (8 liters). The unit may use a fixed or variable burner input.

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

1.10 *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: $\tau_{stby,1}$ represents the elapsed time between the time at which the maximum mean tank temperature is observed after the sixth draw and subsequent recovery and the end of the 24-hour test; $\tau_{stby,2}$ represents the total time during the 24-hour simulated use test when water was not being withdrawn from the water heater.

1.11 *Storage-Type Water Heaters.*

1.11.1 *Electric storage water heater* means a water heater that uses electricity as the energy source, is designed to heat and store water at a thermostatically controlled temperature of less than 180°F (82°C), has a nominal input of 12 kilowatts or less, and has a manufacturer's rated storage capacity of 120 gallons (450 liters) or less.

1.11.2 *Gas Storage Water Heater* means a water heater that uses gas as the energy source, is designed to heat and store water at a thermostatically controlled temperature of less than 180°F (82°C), has a nominal input of 75,000 Btu per hour (79 MJ per hour) or less, and has a manufacturer's rated storage capacity of 100 gallons (380 liters) or less.

1.11.3 *Heat Pump Water Heater* means a water heater that uses electricity as the energy source, is designed to heat and store water at a thermostatically controlled temperature of less than 180°F (82°C), has a maximum current rating of 24 amperes (includes the compressor and all auxiliary equipment such as fans, pumps, and controls, and if on the same circuit, any resistive elements) for an input voltage of 250 volts or less, and, if the tank is supplied, has a manufacturer's rated storage capacity of 120 gallons (450 liters) or less. Resistive elements used to provide supplemental heating may use the same circuit as the compressor if (1) An interlocking mechanism prevents concurrent compressor operation and resistive heating, or (2) concurrent operation does not result in the maximum current rating of 24 amperes being exceeded. Otherwise, separate circuits shall be used by the resistive elements and the heat pump components. A heat pump water heater may be an integral type or an add-on type.

a. Integral heat pump water heater—An air-to-water heat pump integral with an insulated storage tank.

b. Add-on heat pump water heater—An air-to-water heat pump designed for use with a heat pump water heater storage tank.

1.11.4 *Oil Storage Water Heater* means a water heater that uses oil as the energy source, is designed to heat and store water at a thermostatically controlled temperature of less than 180°F (82°C), has a nominal energy input of 105,000 Btu/hr (110 MJ/hr) or less, and has a manufacturer's rated storage capacity of 50 gallons (190 liters) or less.

1.11.5 *Solar Water Heater* means a water heater that is designed to obtain at least half of the annual energy for heating water from the sun.

1.12 *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.

1.13 *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.

1.14 *Rated Storage Volume* means the water storage capacity of a water heater, in gallons (liters), 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 of this appendix.

2.2 *Ambient Air Temperature.* The ambient air temperature shall be controlled to a value between 65.0°F and 70.0°F (18.3°C and 21.1°C) on a continuous basis. For heat pump water heaters, the dry bulb temperature shall be maintained at 67.5°F ± 1°F (19.7°C ± 0.6°C) and, in addition, 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°F± 2°F (14.4°C±1.1°C) throughout the test.

2.4 *Storage Tank Temperature.* The average temperature of the water within the storage tank shall be set to 135°F±5°F (57.2°C±2.8°C).

2.5 *Supply Water Pressure.* During the test when water is not being withdrawn, the supply pressure shall be maintained between 40 psig (275 kPa) 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 ±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 (1.7 Kpa to 2.5 Kpa). If the water heater is equipped with a gas appliance pressure regulator, the regulator outlet pressure shall be within ±10% of the manufacturer's specified manifold pressure. Use natural gas having a higher heating value of approximately 1,025 Btu per standard cubic foot (38190 KJ per standard cubic meter).

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 (2.7 kPa to 3.2 kPa). If the water heater is equipped with a gas appliance pressure regulator, the regulator outlet pressure shall be within ±10% of the manufacturer's specified manifold pressure. Use propane gas with a higher heating value of approximately 2,500 Btu per standard cubic foot (93 kJ per standard cubic meter).

2.6.4 *Fuel Oil Supply.* Maintain an uninterrupted supply of fuel oil. Use fuel oil having a heating value of approximately 138,700 Btu per gallon (38,660 kJ per liter).

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	± 0.1 inch of water column (± 0.025 kPa)	± 0.05 inch of water column (± 0.012 kPa).
Atmospheric pressure	± 0.1 inch of mercury column (± 0.34 kPa)	± 0.05 inch of mercury column (± 0.17 kPa).
Water pressure	± 1.0 pounds per square inch (± 6.9 kPa)	± 0.50 pounds per square inch (± 3.45 kPa).

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	± 0.2 °F (± 0.1 °C)	± 0.1 °F (± 0.06 °C).
Air wet bulb temperature	± 0.2 °F (± 0.1 °C)	± 0.1 °F (± 0.06 °C).
Inlet and outlet water temperatures	± 0.2 °F (± 0.1 °C)	± 0.1 °F (± 0.06 °C).
Storage tank temperatures	± 0.5 °F (± 0.3 °C)	± 0.25 °F (± 0.14 °C).

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. A thermopile
b. Calibrated resistance thermometers
c. Precision thermometers
d. Calibrated thermistors
e. Calibrated thermocouple
f. 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.

3.2.6 *Time Constant.* The time constant of the instruments used to measure the inlet and outlet water temperatures shall be no greater than 5 seconds.

3.3 *Liquid Flow Measurements.* The accuracy of the liquid flow rate measurement, using the calibration if furnished, shall be equal to or less than ± 1% of the measured value in mass units per unit time.

3.4 *Electric Energy.* The electrical energy used shall be measured with an instrument and associated readout device that are accurate within ±1% of the reading.

3.5 *Fossil Fuels.* The quantity of fuel used by the water heater shall be measured with an instrument and associated readout device that is accurate within ±1% of the reading.

3.6 *Mass Measurements.* For mass measurements greater than or equal to 10 pounds (4.5 kg), a scale that is accurate within ±1.0% of the reading shall be used to make the measurement. For mass measurements less than 10 pounds (4.5 kg), the scale shall provide a measurement that is accurate within ±0.1 pound (±0.045 kg).

3.7 *Heating Value.* The higher heating value of the natural gas, propane, or fuel oil shall be measured with an instrument and associated readout device that is accurate within ±1% of the reading. The heating value of natural gas and propane must be corrected for local temperature and pressure conditions.

3.8 *Time.* The elapsed time measurements shall be measured with an instrument that is accurate within ±0.5 seconds per hour.

4. Installation

4.1 *Water Heater Mounting.* A water heater designed to be free standing shall be installed according to the manufacturer's directions on a ¾ inch (2 cm) thick plywood platform supported by three 2×4 inch (5 cm×10 cm) runners. If the water heater is not approved for installation on combustible flooring, suitable non-combustible material shall be placed between it and the platform. For heat pump water heaters without a storage tank supplied by the manufacturer, connections shall be made with a storage tank as described in section 4.10 and in accordance with manufacturer-published installation instructions. The storage tank and heat pump section shall be placed on platform(s) constructed as previously described. If installation materials are not provided by the heat pump manufacturer, use uninsulated 8 foot (2.4 m) long connecting hoses, having an inside diameter of ⅝ inch (1.6 cm). Wall mounted water heaters shall be installed in accordance with manufacturer-published installation instructions on a simulated wall section made from ¾ inch (2 centimeter) plywood and 2×4 inch (5×10 centimeter) studs. Placement in the test room shall be in an area protected from drafts.

4.2 *Water Supply.* The water supply shall be capable of delivering water at conditions as specified in sections 2.3 and 2.5.

4.3 *Water Inlet and Outlet Configuration.* Inlet and outlet piping connections shall be configured as illustrated in Figures 1, 2, or 3. For water heaters that are 36 inches (91 centimeters) or less in height and intended for installation either beneath, adjacent to, or in conjunction with a counter (commonly referred to as an under-the-counter or table-top model), the inlet and outlet connections shall be configured as illustrated in Figures 4a and 4b. Type ''L'' hard copper tubing, the same size as the connections on the water heater, shall be connected to the tank and extend 24 inches (61 centimeters) in length. If an under-the-counter type water heater is not factory equipped with pipe to extend the field connection point of the water heater lines to outside of the jacket or cabinet, type ''L'' hard copper tubing shall be used to extend the water line horizontally to the exterior of the jacket or cabinet. Unions may be used to facilitate installation and removal of the piping arrangements. A pressure gauge and diaphragm expansion tank shall be installed in the supply water piping at a location upstream of the 24-inch (61 centimeters) cold water inlet pipe. An appropriately rated pressure and temperature relief valve shall be installed on all water heaters at the port specified by the manufacturer. Discharge piping for the relief valve shall be non-metallic. If heat traps and/or piping insulation and/or pressure relief valve insulation are supplied with the water heater, they shall be installed for testing. Clearance shall be provided such that none of the piping contacts other surfaces in the test room.

4.4 *Fuel and/or Electrical Power and Energy Consumption.* Install one or more instruments which measure, as appropriate, the quantity and rate of electrical energy and/or fossil fuel consumption in accordance with Section 3. For heat pump water heaters that use supplemental resistive heating, the electrical energy supplied to the resistive element(s) shall be metered separately from the electrical energy supplied to the entire appliance or to the remaining components (i.e., compressor, fans, pumps, controls, etc.).

4.5 *Internal Storage Tank Temperature Measurements.* Install six temperature measurement sensors inside the water heater tank with a vertical distance of at least 4 inches (10 centimeters) between successive sensors. A temperature sensor shall be positioned at the vertical midpoint of each of the six equal volume nodes within the tank. Nodes designate the equal volumes used to evenly partition the total volume of the tank. As much as is possible, the temperature sensor should be positioned away from any heating elements, anodic protective devices, tank walls, and flue pipe walls. If the tank cannot accommodate six temperature sensors and meet the installation requirements specified above, install the maximum number of sensors which comply with the installation requirements. The temperature sensors shall be installed either through (1) the anodic device opening; (2) the relief valve opening; or (3) the hot water outlet. If installed through the relief valve opening or the hot water outlet, a tee fitting or outlet piping, as applicable, shall be installed as close as possible to its original location. If the relief valve temperature sensor is relocated, and it no longer extends into the top of the tank, a substitute relief valve that has a sensing element that can reach into the tank shall be installed. If the hot water outlet includes a heat trap, the heat trap shall be installed on top of the tee fitting. Added fittings shall be covered with thermal insulation having an R value between 4 and 8 hr·ft^{2}·°F/Btu (0.7 and 1.4 m^{2}·°C/W).

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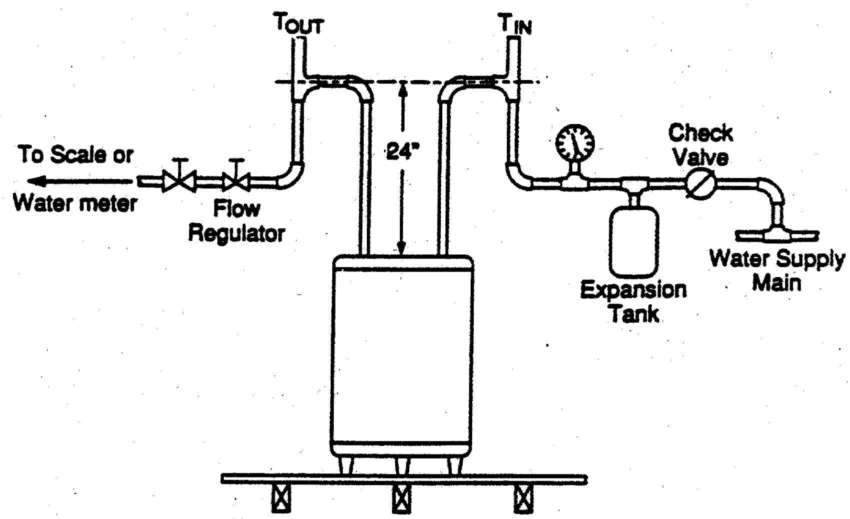

Figure 1

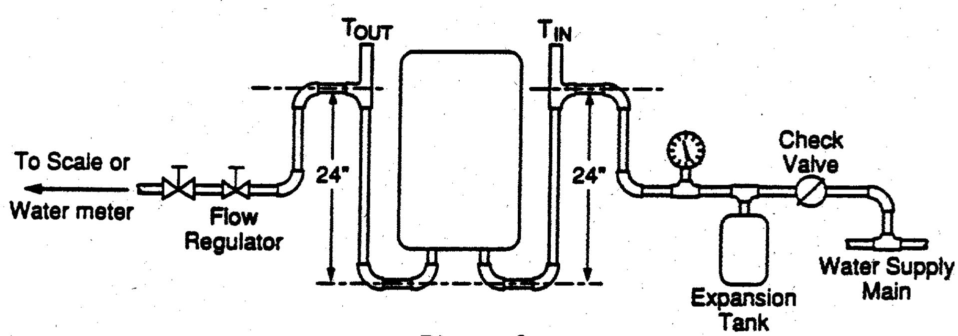

Figure 2

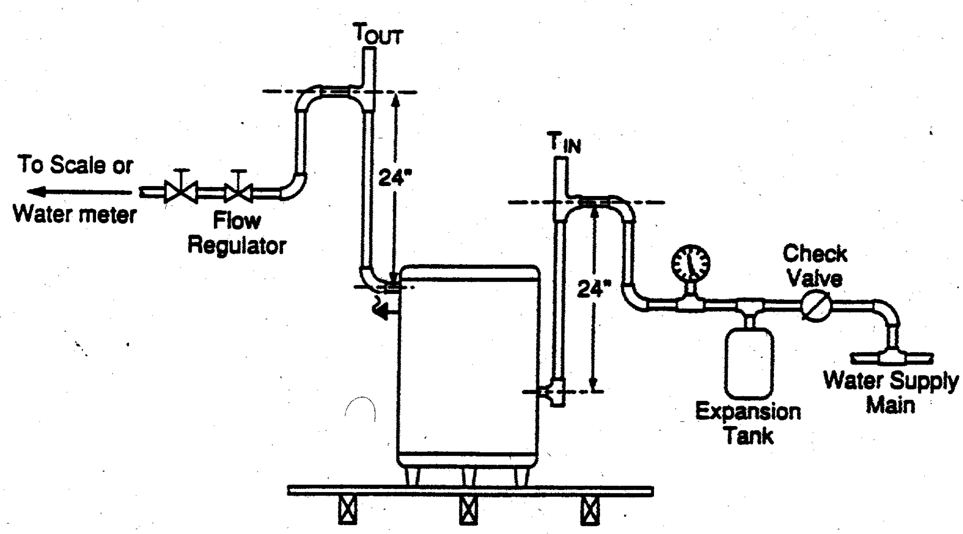

Figure 3

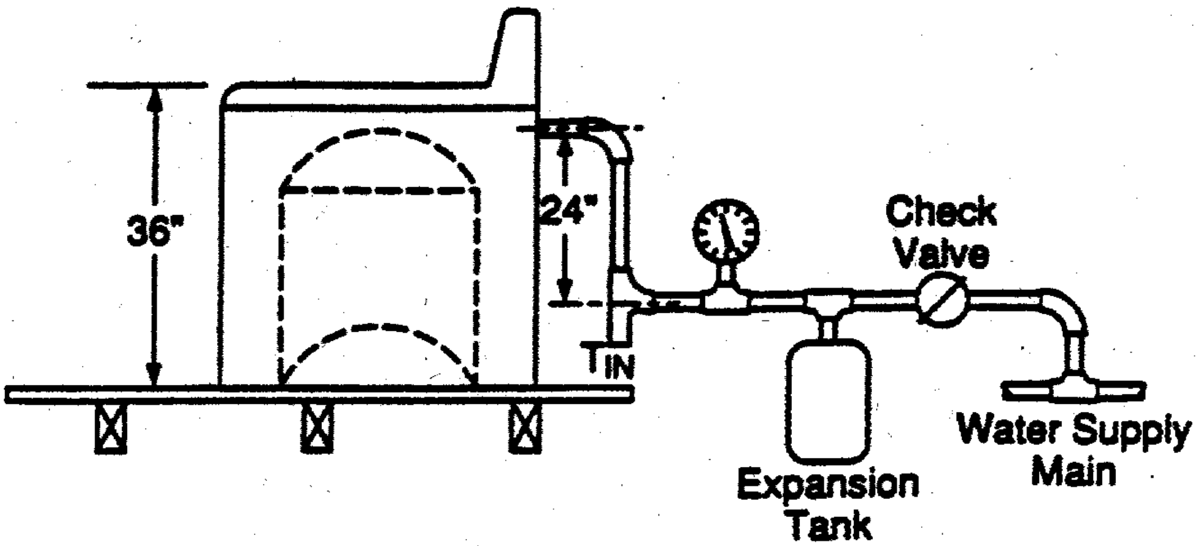

Figure 4a.

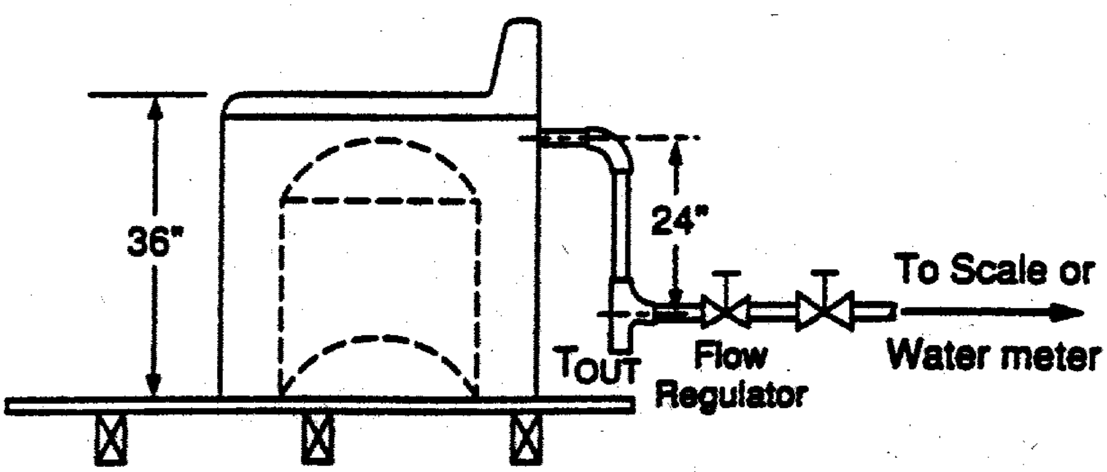

Figure 4b.

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4.6 *Ambient Temperature.* The ambient air temperature shall be measured approximately at the vertical mid-point of the water heater and approximately 2 feet (60 centimeters) from the surface of the water heater. The sensor shall be shielded against radiation.

4.7 *Inlet and Outlet Water Temperature Measurements.* Install temperature sensors in the cold-water inlet pipe and hot-water outlet pipe as shown in Figures 1, 2, 3, or 4a and 4b, as applicable.

4.8 *Flow Control.* A flow control valve shall be installed to provide flow as specified in Section 5.

4.9 *Flue Requirements.*

4.9.1 *Gas-Fired Water Heaters.* Establish a natural draft in the following manner. For gas-fired water heaters having a vertically discharging draft hood outlet, a 5-foot (1.5 meter) vertical vent pipe extension having a diameter equal to the largest flue collar size of the draft hood shall be connected to the draft hood outlet. For gas-fired water heaters having a horizontally discharging draft hood outlet, a 90-degree elbow having a diameter equal to the largest flue collar size of the draft hood shall be connected to the draft hood outlet. A 5-foot (1.5 meter) length of vent pipe shall be connected to the elbow and oriented to discharge vertically upward. Direct vent gas-fired water heaters shall be installed with venting equipment specified in the manufacturer's instructions using the minimum vertical and horizontal lengths of vent pipe recommended by the manufacturer.

4.9.2 *Oil-Fired Water Heaters.* Establish a draft at the flue collar as specified in the manufacturer's literature. Establish the draft by using a sufficient length of vent pipe connected to the water heater flue outlet and directed vertically upward. For an oil-fired water heater having a horizontally discharging draft hood outlet, a 90-degree elbow having a diameter equal to the largest flue collar size of the draft hood shall be connected to the draft hood outlet. A length of vent pipe sufficient to establish the draft shall be connected to the elbow fitting and oriented to discharge vertically upward. Direct vent oil-fired water heaters should be installed with venting equipment as specified in the manufacturer's instructions, using the minimum vertical and horizontal lengths of vent pipe recommended by the manufacturer.

4.10 *Heat Pump Water Heater Storage Tank.* The heat pump water heater storage tank to be used for testing a heat pump water heater without a tank supplied by the manufacturer shall have a volume of 47.0 gallons ±1.0 gallon C 180±4 liters with an Energy Factor of 0.87±.01 as determined in accordance with Section 6.1.7 with two 4.5 kW heating elements controlled in such a manner as to prevent both elements from operating simultaneously.

5. Test Procedures

5.1 *Storage-Type Water Heaters, Including Heat Pump Water Heaters.*

5.1.1 *Determination of Storage Tank Volume.* Determine the storage capacity, Vst, of the water heater under test, in gallons (liters), by subtracting the tare weight—measured while the tank is empty—from the gross weight of the storage tank when completely filled with water (with all air eliminated and line pressure applied as described in section 2.5) and dividing the resulting net weight by the density of water. Density shall be evaluated based on the temperature of the stored water.

5.1.2 *Setting the Thermostat for a Thermostatically Operated Water Heater.* Starting with a tank of supply water, initiate normal operation of the water heater. After cutout, determine the mean tank temperature (based on all of the in-tank sensors) every minute until the maximum value is observed. Determine whether this maximum value for the mean tank temperature is within the range of 135°F±5°F (57.2°C±2.8°C). If not, turn off the water heater, adjust the thermostat, and refill the tank with supply water. Then, initiate normal operation of the water heater, and once again determine the maximum mean tank temperature after cut-out. Repeat this sequence until the maximum mean tank temperature after cut-out is within the range of 135°F±5°F (57.2°C±2.8°C).

If an electric water heater has two or more thermostats, the thermostat that controls the upper-most heating element shall be set first to yield a maximum water temperature of 135°F±5°F (57.2°C±2.8°C), as measured by the in-tank sensors that are positioned above the upper-most heating element. The thermostat that controls the heating element positioned next highest in the tank shall then be set to yield a maximum water temperature of 135°F±5°F (57.2°C±2.8°C). This process shall be repeated until the thermostat controlling the lowest element is correctly adjusted. When adjusting the thermostat that controls the lowest element, the maximum mean tank temperature after cut-out, as determined using all the in-tank sensors, shall be within 135°F±5°F (57.2°C±2.8°C). When adjusting all other thermostats, use only the in-tank temperature sensors positioned above the heating element in question to evaluate the maximum water temperature after cut-out.

For heat pump water heaters, which control an auxiliary resistance element, the thermostat shall be set in accordance with the manufacturer's installation instructions.

5.1.3 *Power Input Determination.* For all water heaters except electric types having immersed heating elements, initiate normal operation and determine the power input, P, to the main burners (including pilot light power, if any) after 15 minutes of operation. If the water heater is equipped with a gas appliance pressure regulator, the regulator outlet pressure shall be set within ±10% of that recommended by the manufacturer. For oil-fired water heaters the fuel pump pressure shall be within ±10% of the manufacturer's specified pump pressure. All burners shall be adjusted to achieve an hourly Btu (kJ) rating that is within ±2% of the value specified by the manufacturer. For an oil-fired water heater, adjust the burner to give a CO2 reading recommended by the manufacturer and an hourly Btu (kJ) rating that is within ±2% of that specified by the manufacturer. Smoke in the flue may not exceed No. 1 smoke as measured by the procedure in ASTM–D–2156–80.

5.1.4 *First Hour Rating Test.*

5.1.4.1 *General.* During hot water draws, remove water at a rate of 3.00±0.25 gallons per minute (11.4±0.95 liters per minute) for units with rated storage capacities of 20 gallons (76 liters) or more and 1.0±0.25 gallons per minute (3.8±0.95 liters per minute) for units with rated storage capacities less than 20 gallons (76 liters). Collect the water in a container that is large enough to hold the volume removed during an individual draw and suitable for weighing at the termination of each draw. Alternatively, a water meter may be used to directly measure the water volume(s) withdrawn.

5.1.4.2 *Draw Initiation Criterion.* Begin the first hour rating test by imposing a draw on the storage-type water heater. After completion of this first draw, initiate successive draws based on the following criteria. For gas- and oil-fired water heaters, initiate successive draws when the thermostat acts to reduce the supply of fuel to the main burner. For electric water heaters having a single element or multiple elements that all operate simultaneously, initiate successive draws when the thermostat acts to reduce the electrical input supplied to the element(s). For electric water heaters having two or more elements that do not operate simultaneously, initiate successive draws when the applicable thermostat acts to reduce the electrical input to the element located vertically highest in the storage tank. For heat pump water heaters that do not use supplemental resistive heating, initiate successive draws immediately after the electrical input to the compressor is reduced by the action of the water heater's thermostat. For heat pump water heaters that do use supplemental resistive heating, initiate successive draws immediately after the electrical input to the compressor or the uppermost resistive element is reduced by the action of the applicable water heater thermostat. This draw initiation criterion for heat pump water heaters that use supplemental resistive heating, however, shall only apply when the water located above the thermostat at cut-out is heated to 135°F ±5°F (57.2°C±2.8°C).

5.1.4.3 *Test Sequence.* Establish normal water heater operation. If the water heater is not presently operating, initiate a draw. The draw may be terminated anytime after cut-in occurs. Once cut-out occurs (e.g., all thermostats satisfied), monitor the internal storage tank temperature sensors described in section 4.5 every minute. For each set of measurements, calculate the mean tank temperature. If any of these mean values are outside the range specified in section 2.4, adjust the thermostat(s) as specified in section 5.1.2 and reevaluate the mean tank temperature after all thermostats are again satisfied.

Initiate a draw after a maximum mean tank temperature has been observed following cut-out. Record the time when the draw is initiated and designate it as an elapsed time of zero, ($\tau^* = 0$). The superscript * is used to denote variables pertaining to the first hour rating test. Record the outlet water temperature beginning 15 seconds after the draw is initiated and at 5 second intervals thereafter, until the draw is terminated. Determine the maximum outlet temperature that occurs during this first draw and record it as $T^*_{max,1}$. For the duration of this first draw and all successive draws, in addition, monitor the inlet temperature to the water heater to assure that the required 58°F±2°F (14.4°C ± 1.1°C) test condition is met. Terminate the hot water draw when the outlet temperature decreases to $T^*_{max,1} - 25$°F ($T^*_{max,1} - 13.9$°C). Record this temperature as $T^*_{min,1}$. Following draw termination, determine the average outlet water temperature and the mass or volume removed during this first draw and record them as $\bar{T}^*_{del,1}$ and M^*_1 or V^*_1, respectively.

Initiate a second and, if applicable, successive draws each time the applicable draw initiation criterion described in section 5.1.4.2 is satisfied. As required for the first draw, record the outlet water temperature beginning 15 seconds after initiating each draw and at 5 second intervals thereafter until the draw is terminated. Determine the maximum outlet temperature that occurs during each draw and record it as $T^*_{max,i}$, where $_i$ refers to the draw number. Terminate each hot water draw when the outlet temperature decreases to $T^*_{max,i} - 25$°F ($T^*_{max,i} - 13.9$°C). Record this temperature as $T^*_{min,i}$. Calculate and record the average outlet temperature and the mass or volume removed during each draw ($\bar{T}^*_{del,i}$ and M^*_i or V^*_i). Continue this sequence of draw and recovery until one hour has elapsed, at which time the electrical power and/or the fuel supplied to the water heater shall be disconnected and/or terminated.

If a draw is occurring at an elapsed time of one hour, continue this draw until the outlet temperature decreases to $T^*_{max,n} - 25$°F ($T^*_{max,n} - 13.9$°C), at which time the draw shall be immediately terminated. The subscript $_n$ shall be used to denote quantities associated with the final draw. If a draw is not occurring at an elapsed time of one hour, a final draw shall be imposed at one hour. This draw shall be immediately terminated when the outlet temperature first indicates a value less than or equal to the cut-off temperature used for the previous draw ($T^*_{min,n-1}$). For cases where the outlet temperature is close to $T^*_{min,n-1}$, the final draw shall proceed for a minimum of 30 seconds. If an outlet temperature greater than $T^*_{min,n-1}$ is not measured within 30 seconds, the draw shall be immediately terminated and zero additional credit shall be given towards first hour rating (i.e., $M^*_n = 0$ or $V^*_n = 0$). Once the final draw is terminated, calculate and record the average outlet temperature and the mass or volume removed during the draw ($\bar{T}^*_{del,n}$ and M^*_n or V^*_n).

5.1.5 *24-Hour Simulated Use Test.* During the simulated use test, a total of 64.3 ±1 gallon (243±4 liters) shall be removed if the rated storage tank volume is 20 gallons (76 liters) or greater. If the rated storage tank volume is less than 20 gallons (76 liters) but greater than or equal to 10 gallons (38 liters), a total of 24±0.5 gallon (91±1.9 liters) shall be removed; and if the rated storage tank volume is less than 10 gallons (38 liters), a total of 9±0.5 gallon (34±1.9 liters) shall be removed. These values are referred to as the daily hot water usage in the following text.

With the water heater turned off, fill the water heater with supply water and apply pressure as described in section 2.5. Turn on the water heater and associated heat pump unit, if present. After the cutout occurs, measure the mean tank temperature using the temperature sensors described in section 4.5 every minute until the maximum mean storage tank temperature is achieved. If this maximum mean temperature is outside the range specified in section 2.4, adjust the thermostat(s) as specified in section 5.1.2 and reevaluate the mean tank temperature after all thermostats are again satisfied. After thermostat adjustments are completed, the water heater may be operated for up to three cycles of drawing until cut-in and then operating until cut-out, prior to the start of the test.

At this time, record the mean tank temperature ($\bar{T}_o$), and the electrical and/or fuel measurement readings, as appropriate. Begin the 24-hour simulated use test by withdrawing a volume from the water heater that equals one-sixth of the daily hot water usage. Record the time when this first draw is initiated and assign it as the test elapsed time (τ) of zero. Record the average storage tank and ambient temperature every 15 minutes throughout the 24-hour simulated use test unless a recovery or a draw is occurring. At elapsed time intervals of one, two, three, four, and five hours from τ = 0, initiate additional draws removing an amount of water equivalent to one-sixth of the daily hot water usage with the maximum allowable deviation for any single draw being ±0.5 gallons (±1.9 liters) for units having rated storage capacities of 20 gallons (76 liters) or greater, and ±0.1 gallons (0.4 liters) for units having rated storage capacities less than 20 gallons (76 liters). The quantity of water withdrawn during the sixth draw shall be increased or decreased as necessary such that the total volume of water withdrawn equals: 64.3±1.0 gallons (243.4±3.8 liters) for water heaters having rated storage capacities of 20 gallons (76 liters) or more, 24±0.5 gallons (90.8±1.9 liters) for water heaters having rated storage capacities less than 20 gallons (76 liters) but greater than or equal to 10 gallons (38 liters), and 9.0±0.5 gallons (34.1±1.9 liters) for water heaters having rated storage capacities less than 10 gallons (38 liters).

All draws during the simulated use test shall be made at flow rates of 3.0±0.25 gallons per minute (11.4±0.95 liters per minute) when testing water heaters having rated storage capacities of 20 gallons (76 liters) or more. For water heaters having rated storage capacities less than 20 gallons (76 liters), flow rates of 1.0±0.25 gallons per minute (3.8±0.95 liters per minutes) shall be achieved. Measurements of the inlet and outlet temperatures shall be made beginning 15 seconds after the draw is initiated and at every subsequent 5 second interval throughout the duration of each draw. The arithmetic mean of the hot water discharge temperature and the cold water inlet temperature shall be determined for each draw ($\bar{T}_{del,i}$ and $\bar{T}_{in,i}$). Determine and record the net mass or volume removed (M_i or V_i), as appropriate, after each draw.

At the end of the recovery period following the first draw, record the maximum mean tank temperature observed after cut-out, $\bar{T}_{max,1}$, and the energy consumed by a gas or oil water heater, Q_r. For heat pump water heaters, the total electrical energy consumed by the heat pump (including compressor, fan, controls, pump, etc.) and, if applicable, by the resistive element(s) during the first recovery shall be recorded as Q_r. In addition, the total operating time of the compressor during the first recovery shall be determined and recorded as $\tau_{cmp,1}$. Finally, for heat pump water heaters that use resistive heating during the first recovery, the electrical energy consumed by the resistive element(s) shall be separately metered and recorded, $Q_{res,1}$.

At the end of the recovery period that follows the sixth draw, determine and record the total electrical energy and/or fossil-fuel consumed since the beginning of the test, Q_{su}. In preparation for determining the energy consumed during stand-by, record the reading given on the electrical energy (watt-hour) meter, the gas meter, and/or the scale used to determine oil consumption, as appropriate. Record the maximum value of the mean tank temperature after cutout as $\bar{T}_{su}$. Except as noted below, allow the water heater to remain in the standby mode until 24-hours have elapsed from the start of the test, i.e., since τ = 0. Prevent the water heater from beginning a recovery cycle during the last hour of the test by turning off the electric power to the electrical heating elements and heat pump, if present, or by turning down the fuel supply to the main burner at an elapsed time of 23 hours. If a recovery is taking place at an elapsed time of 23 hours, wait until the recovery is complete before reducing the electrical and/or fuel supply to the water heater. At 24 hours, record the mean tank temperature, $\bar{T}_{24}$, and the electric and/or fuel instrument readings. Determine the total fossil fuel or electrical energy consumption, as appropriate, for the entire 24-hour simulated use test, Q. Record the time interval between the time at which the maximum mean tank temperature is observed after the sixth draw and the end of the 24-hour test as $\tau_{stby,1}$. Record the time during which water was not being withdrawn from the water heater during the entire 24-hour period as $\tau_{stby,2}$.

5.2 *Instantaneous Water Heaters.*

5.2.1 *Setting the Outlet Discharge Temperature.* Initiate normal operation of the water heater at the full input rating. Monitor the discharge water temperature and set to a value of 135°F±5°F (57.2°C±2.8°C) in accordance with the manufacturer's instructions. If the water heater is not capable of providing this discharge temperature when the flow rate is 3.00±0.25 gallons per minute (11.4±0.95 liters per minute), then adjust the flow rate as necessary to achieve the specified discharge water temperature. Record the corresponding flow rate as V_{max}.

If the instantaneous water heater incorporates a controller that permits continuous burner or electric heating element operation at a reduced input rate, adjust the flow rate as necessary to achieve a discharge water temperature of 135°F±5°F (57.2°C±2.8°C) while maintaining the minimum input rate. Record the corresponding flow rate as V_{min}. If an outlet temperature of 135°±5°F (57.2°C±2.8°C) cannot be achieved at the minimum flow rate permitted by the instantaneous water heater, record the flow rate as V_{min} and the corresponding outlet temperature as T_{min}.

25.2.2 *Power Input Determination.* Gas-fired and oil-fired instantaneous water heaters shall have the burners adjusted to the maximum firing rate specified by the manufacturer.

5.2.3 *First Hour Rating Test for Instantaneous Water Heaters.* Establish normal water heater operation at the maximum input rate with the discharge water temperature set in accordance with section 5.2.1. During the test, do not interrupt the electrical energy or fossil fuel supplied to the water heater. During the one hour test, either collect the withdrawn water for later measuring the total mass removed, or alternatively, use a water meter to directly measure the water volume removed.

Begin with the water flow rate temporarily discontinued. Record the scale or water meter reading as appropriate. Initiate a draw and record the corresponding time. Record the inlet and outlet water temperatures beginning 15 seconds after the draw is initiated and at every subsequent 5 second interval throughout the duration of the draw. At the end of one hour terminate the draw. Determine the mass of water withdrawn, M_{FHR}, in pounds (kilograms), or the volume of water withdrawn, V_{FHR}, in gallons (liters) with an error no greater than 2 percent.

5.2.4 *24-Hour Simulated Use Test*

5.2.4.1 *Fixed Input Instantaneous Water Heaters.* Establish normal operation with the discharge water temperature and flow rate set to values of 135°F±5°F (57.2°C±2.8°C) and V_{max}, respectively. With no draw occurring, record the reading given by the gas meter, the scale used for determining oil consumption, and/or the electrical energy meter as appropriate. Begin the 24-hour simulated use test by drawing an amount of water out of the water heater equivalent to one-sixth of the daily hot water usage, 64.3 gallons (243 liters). Record the time when this first draw is initiated and designated it as an elapsed time, τ, of 0. At elapsed time intervals of one, two, three, four, and five hours from $\tau = 0$, initiate additional draws removing an amount of water equivalent to one-sixth of 64.3 gallons (243 liters), with the maximum allowable deviation for any single draw being ±0.5 gallons (±2 liters). The quantity of water drawn during the sixth draw shall be increased or decreased as necessary such that the total volume of water withdrawn equals 64.3±1.0 gallons (243±4 liters).

Measurements of the inlet and outlet water temperatures shall be made beginning 15 seconds after the draw is initiated and at every 5 second interval throughout the duration of the draw. The arithmetic mean of the hot water discharge temperature and the cold water inlet temperature shall be determined for each draw. Record the scale used to measure the mass of the withdrawn water or the water meter reading, as appropriate, after each draw. At the end of the recovery period following the first draw, determine and record the fossil fuel or electrical energy consumed, Q_r. Following the sixth draw and subsequent recovery, allow the water heater to remain in the standby mode until exactly 24 hours have elapsed since the start of the test, i.e., since $\tau = 0$. At 24 hours, record the reading given by the gas meter, the scale used for determining oil consumption, and/or the electrical energy meter as appropriate. Determine the fossil fuel or electrical energy consumed during the entire 24-hour simulated use test and designate the quantity as Q.

5.2.4.2 *Variable Input Instantaneous Water Heaters.* If the instantaneous water heater incorporates a controller that permits continuous operation at a reduced input rate, the first three draws shall be conducted using the maximum flow rate, V_{max}, while removing an amount of water equivalent to one-sixth of 64.3 gallons (243 liters), with the maximum allowable deviation for any one of the three draws being ±0.5 gallons (2 liters). The second three draws shall be conducted at V_{min}. If an outlet temperature of 135°F±5°F (57.2°C±2.8°C) could not be achieved at the minimum flow rate permitted by the instantaneous water heater, the last three draws should be lengthened such that the volume removed is:

$$V_{4,5,6} = \frac{64.3\ \text{gal}}{6} \times \left[\frac{77°\text{F}}{\left(T_{min} - 58°\text{F}\right)}\right]$$

or

$$V_{4,5,6} = \frac{243\text{L}}{6} \times \left[\frac{42.8°\text{C}}{\left(T_{min} - 14.4°\text{C}\right)}\right]$$

where the maximum allowable variation for any one of the three draws is ± 0.5 gallons (2 liters). The quantity of water withdrawn during the sixth draw shall be increased or decreased as necessary such that the total volume of water withdrawn equals $(32.15+3\times V_{4,5,6})\pm 1.0$ gallons $((121.7+3\times V_{4,5,6})\pm 3.8$ liters).

Measurements of the inlet and outlet water temperatures shall be made beginning 15 seconds after a draw is initiated and at every 5 second interval throughout the duration of the draw. Determine the arithmetic mean of the hot water discharge temperature and the cold water inlet temperature for each draw. Record the scale used to measure the mass of the withdrawn water or the water meter reading, as appropriate, after each draw. At the end of the recovery period following the first draw, determine and record the fossil fuel or electrical energy consumed, $Q_{r,max}$. Likewise, record the reading of the meter or scale used to measure fossil fuel or electrical energy consumption prior to the fourth draw and at the end of the recovery period following the fourth draw, and designate the difference as $Q_{r,min}$. Following the sixth draw and subsequent recovery, allow the water heater to remain in the standby mode until exactly 24 hours have elapsed since the start of the test, i.e., since $\tau = 0$. At 24 hours, record the reading given by the gas meter, the scale used for determining oil consumption, and/or the electrical energy meter, as appropriate. Determine the fossil fuel or electrical energy consumed during the entire 24-hour simulated use test and designate the quantity as Q.

6. Computations

6.1 *Storage Tank and Heat Pump Water Heaters.*

6.1.1 *Storage Tank Capacity.* The storage tank capacity is computed using the following:

$$V_{st} = \frac{\left(W_f - W_t\right)}{\rho}$$

Where:

V_{st}=the storage capacity of the water heater, gal (L).

W_f=the weight of the storage tank when completely filled with water, lb_m (kg).

W_t=the (tare) weight of the storage tank when completely empty, lb_m (kg)

ρ=the density of water use to fill the tank; evaluated based on the temperature of the water, lb_m/gal (kg/L).

6.1.2 *First Hour Rating Computation.* For water heaters where the final draw was initiated at or prior to an elapsed time of one hour, the first hour rating shall be computed using,

$$F_{hr} = \sum_{i=1}^{n} V_i^*$$

Where:

n=the number of draws that are completed during the first hour rating test.

V^*_i=the volume of water removed during the ith draw of the first hour rating test, gal (L).

$$V_i^* = \frac{M_i^*}{\rho}$$

Where:

M^*_i=the mass of water removed during the ith draw of the first hour rating test, lb_m (kg).

ρ=the water density corresponding to the average outlet temperature measured during the ith draw ($\bar{T}^*_{del,i}$), lb_m/gal (kg/L).

For water heaters where a draw was not in progress at the elapsed time of one hour and a final draw was imposed at the elapsed time of one hour, the first hour rating shall be calculated using,

$$F_{hr} = \sum_{i=1}^{n-1} V_i^* + V_n^* \left(\frac{\bar{T}^*_{del,n} - T^*_{min,n-1}}{\bar{T}^*_{del,n-1} - T^*_{min,n-1}} \right)$$

where n and V^*_i are the same quantities as defined above and,

$\bar{T}^*_{del,n-1}$=the average water outlet temperature measured during the (n − 1)th draw of the first hour rating test, °F (°C).

$\bar{T}^*_{del,n}$=the average water outlet temperature measured during the nth (final) draw of the first hour rating test, °F (°C).

$\bar{T}^*_{min,n-1}$=the minimum water outlet temperature measured during the (n − 1)th draw of the first hour rating test, °F (°C).

6.1.3 *Recovery Efficiency.* The recovery efficiency for gas, oil, and heat pump storage type water heaters is computed as:

$$\eta_r = \frac{M_1 C_{\rho 1}\left(\overline{T}_{del,1} - \overline{T}_{in,1}\right)}{Q_r} + \frac{V_{st}\rho_2 C_{\rho 2}\left(\overline{T}_{max,1} - \overline{T}_o\right)}{Q_r}$$

Where:

M_1=total mass removed during the first draw of the 24-hour simulated use test, lb_m (kg).
$=V_1 \times \rho_i$

V_1=total volume removed during the first draw of the 24-hour simulated use test, gal (L).

ρ_1=density of the water as evaluated at the water temperature at the point where the flow volume is measured, lb_m/gal (kg/L).

$C\rho_1$=specific heat of the withdrawn water as evaluated at $(\overline{T}_{del,1} + \overline{T}_{in,1})/2$ Btu/lb_m·°F (kJ/kg·K).

$\overline{T}_{del,1}$=average water outlet temperature measured during the first draw of the 24-hour simulated use test,°F (°C).

$\overline{T}_{in,1}$=average water inlet temperature measured during the first draw of the 24-hour simulated use test,°F (°C).

V_{st}=measured volume of the storage tank, as determined in section 6.1.1, gal (L).

ρ_2=density of stored hot water evaluated at $(\overline{T}_{max,1}+\overline{T}_o)/2$, lb_m/gal (kg/L).

$C\rho_2$=specific heat of stored hot water evaluated at $(\overline{T}_{max,1}+\overline{T}_o)/2$, Btu/$lb_m$·°F (kJ/kg·K).

$\overline{T}_{max,1}$=maximum mean tank temperature recorded after cut-out following the first draw of the 24-hour simulated use test, °F (°C).

$\overline{T}_o$=maximum mean tank temperature recorded prior to the first draw of the 24-hour simulated use test, °F (°C).

$Q_{res,1}$=electrical energy used by the supplemental resistive elements of a heat pump water heater during the first recovery of the 24-hour simulated use test, Wh.

$\tau_{cmp,1}$=the total operating time of the compressor of a heat pump water heater during the first recovery of the 24-hour simulated use test, hr.

Q_r=the total energy used by the water heater between cut-out prior to the first draw and cutout following the first draw, including auxiliary energy such as pilot lights, pumps, fans, etc., Btu (MJ). (electrical auxiliary energy shall be converted to thermal energy using the following conversion: 1 Kwh=3412 Btu).

The recovery efficiency for electric water heaters with immersed heating elements is assumed to be 98 percent.

6.1.4 *Hourly Standby Losses.* The hourly standby losses are computed as
Where:

$$Q_{hr} = \frac{Q_{stby} - \dfrac{V_{st}\rho C_\rho\left(\overline{T}_{24} - \overline{T}_{su}\right)}{\eta_r}}{\tau_{stby,1}}$$

Q_{hr}=the hourly standby energy losses of the water heater, Btu/hr (kJ/hr).

Q_{stby}=the total energy consumed by the water heater between the time at which the maximum mean tank temperature is observed after the sixth draw and the end of the 24-hour test period, Btu (kJ).

V_{st}=measured volume of the storage tank, as determined in section 6.1.1, gal (L).

ρ=density of stored hot water as evaluated at, $(\overline{T}_{24}+\overline{T}_{su})/2$, lb_m/gal (kg/L).

C_ρ=specific heat of the stored water as evaluated at $(\overline{T}_{24}+\overline{T}_{su})/2$, Btu/$lb_m$·°F (kJ/kg·°C).

$\overline{T}_{24}$=the mean tank temperature at the end of the 24-hour simulated use test, °F (°C).

$\overline{T}_{su}$=maximum mean tank temperature observed after the sixth draw, °F (°C).

$\tau_{stby,1}$=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 simulated use test, hr.

The standby heat loss coefficient for the tank is computed as:

$$UA = \frac{Q_{hr}}{\overline{T}_{t,stby} - \overline{T}_{a,stby}}$$

Where:

Q_{hr}=defined in section 6.1.4.

$T_{t,stby}$=overall average storage tank temperature between the time when the maximum mean tank temperature is observed after the sixth draw and the end of the 24-hour simulated use test, °F (°C).

$\overline{T}_{a,stby}$=overall average ambient temperature between the time when the maximum mean tank temperature is observed after the sixth draw and the end of the 24-hour simulated use test, °F (°C).

UA=standby heat loss coefficient of the storage tank, Btu/hr·°F (kJ/hr·°C).

6.1.5 *Daily Water Heating Energy Consumption.* The daily water heating energy consumption, Q_d is computed as:

$$Q_d = Q - \frac{V_{st}\rho C_\rho\left(\overline{T}_{24} - \overline{T}_o\right)}{\eta_r}$$

Where:

Q=total energy used by the water heater during the 24-hour simulated use test including auxiliary energy such as pilot lights, pumps, fans, etc., Btu (kJ) (Electrical auxiliary energy shall be converted to thermal energy using the following conversion: 1 kWh = 3412 Btu).

V_{st}=measured volume of the storage tank, as determined in section 6.1.1, gal (L).

ρ=density of the stored hot water as evaluated at $(\overline{T}_{24}+\overline{T}_o)/2$, lb_m/gal (kg/L).

$C\rho$=specific heat of the stored water as evaluated at $(\overline{T}_{24}+\overline{T}_o)/2$, Btu/$lb_m$·°F (kJ/kg·°C).

$\overline{T}_{24}$=mean tank temperature at the end of the 24-hour simulated use test, °F (°C).

$\overline{T}_o$=mean tank temperature at the beginning of the 24-hour simulated use test, recorded one minute before the first draw is initiated, °F (°C).

η_r=recovery efficiency of the hot water heater, dimensionless.

6.1.6 *Adjusted Daily Water Heating Energy Consumption.* The adjusted daily water heating energy consumption, Q_{da} takes into account that the temperature difference between the storage tank and surrounding ambient temperature may not be the nominal value of 67.5°F (135°F–67.5°F) or 37.5°C (57.2°C–19.7°C) due to the 10°F (5.6°C) allowable variation in storage tank temperature, 135±5°F (57.2±2.8°C), and the 5°F (2.8°C) allowable variation in surrounding ambient temperature 65°F (18.3°C) to 70°F (21.1°C). The adjusted daily water heating energy consumption is computed as:

$$Q_{da} = Q_d - [(\overline{T}_{stby} - \overline{T}_{a,stby}) - (135\ ^\circ F - 67.5\ ^\circ F)]UA\tau_{stby,2}$$

or $$Q_{da} = Q_d - [(\overline{T}_{stby} - \overline{T}_{a,stby}) - (57.2\ ^\circ C - 19.7\ ^\circ C)]UA\tau_{stby,2}$$

Where:

Q_{da}=the adjusted daily water heating energy consumption, in Btu (kJ).

$\overline{T}_{stby}$=the mean tank temperature during the total standby portion, $T_{stby,2}$, of the 24-hour test, in °F (°C).

$\overline{T}_{a,stby}$=the average ambient temperature during the total standby portion, $T_{stby,2}$, of the 24-hour test, in °F (°C).

UA=the standby heat loss coefficient for the storage tank, in Btu/hr·°F (kJ/hr·°C).

$\tau_{stby,2}$=the number of hours during the 24-hour simulated test when water was not being withdrawn from the water heater.

A modification is also needed to take into account that the temperature difference between the outlet water temperature and supply water temperature may not be equivalent to the nominal value of 77°F (135°F − 58°F) or 42.8°C (57.2°C − 14.4°C). The following equations adjust the experimental data to a nominal 77°F (42.8°C) temperature rise.

The energy used to heat water, Btu/day (kJ/day) may be computed as:

$$Q_{HW} = \sum_{i=1}^{6} \frac{M_i C_{\rho i}\left(\overline{T}_{del,i} - \overline{T}_{in,i}\right)}{\eta_r}$$

Where:

M_i=the mass withdrawn for the ith draw (i=1 to 6), in lb_m (kg).

$C\rho_i$=the specific heat of water, in Btu/lb_m°F (kJ/kg·°C).

$\bar{T}_{del,i}$=the average water outlet temperature measured during the *i*th draw (i=1 to 6), °F(°C).
$\bar{T}_{in,i}$=the average water inlet temperature measured during the *i*th draw (i=1 to 6), °F(°C).
η_r=as defined in section 6.1.3.

The energy required to heat the same quantity of water over a 77°F (42.8°C) temperature rise, Btu/day (kJ/day), is:

$$Q_{HW,\ 77°F} = \sum_{i=1}^{6} \frac{M_i C_{\rho i}(135°F - 58°F)}{\eta_r}$$

or

$$Q_{HW,\ 42.8°C} = \sum_{i=1}^{6} \frac{M_i C_{\rho i}(57.2°C - 14.4°C)}{\eta_r}$$

The difference between these two values is:

$$Q_{HWD} = Q_{HW,77°F} - Q_{HW}$$

or

$$Q_{HWD} = Q_{HW,42.8°C} - Q_{HW}$$

which must be added to the adjusted daily water heating energy consumption value. Thus, the daily energy consumption value which takes into account that the temperature difference between the storage tank and ambient temperature may not be 67.5°F (37.5°C) and the temperature rise across the storage tank may not be 77°F (42.8°C) is:

$$Q_{dm} = Q_{da} + Q_{HWD}$$

6.1.7 *Energy Factor.* The energy factor, E_f, is computed as:

$$E_f = \sum_{i=1}^{6} \frac{M_i C_{\rho i}(135°F - 58°F)}{Q_{dm}}$$

or

$$E_f = \sum_{i=1}^{6} \frac{M_i C_{\rho i}(57.2°C - 14.4°C)}{Q_{dm}}$$

Where:

Q_{dm}=the modified daily water heating energy consumption as computed in accordance with section 6.1.6, in Btu (kJ).
M_i=as defined in section 6.1.6.
$C\rho_i$=as defined in section 6.1.6.

6.1.8 *Annual Energy Consumption.* The annual energy consumption for storage type and heat pump water heaters is computed as:

$$E_{annual} = 365 \times Q_{dm}$$

Where:

Q_{dm}=the modified daily energy consumption value, Btu/day (kJ/day), and 365 is the number of days in a year.

6.2 *Instantaneous Hot Water Heaters.*

6.2.1 *First Hour Rating Computation.* Compute the first hour rating as:

$$F_{hr} = \frac{M_{FHR}\left(\bar{T}_{del} - \bar{T}_{in}\right)}{\rho(135°F - 58°F)}$$

$$\text{or}\quad F_{hr} = \frac{M_{FHR}\left(\bar{T}_{del} - \bar{T}_{in}\right)}{\rho(57.2°C - 14.4°C)}$$

which may be expressed as:

$$F_{hr} = \frac{M_{FHR}\left(\bar{T}_{del} - \bar{T}_{in}\right)}{\rho(77°F)}$$

$$\text{or}\ F_{hr} = \frac{M_{FHR}\left(\bar{T}_{del} - \bar{T}_{in}\right)}{\rho(42.8°C)}$$

Where:

M_{FHR}=the mass removed during the one hour continuous draw, in lb_m (kg).
$\bar{T}_{del}$=the average delivery temperature, in °F (°C).
$\bar{T}_{in}$=the average inlet temperature, in °F (°C).
ρ=the density of water at the average delivery temperature, in lb_m/gal (kg/L).

If a water meter is used in lieu of a scale the first hour rating is computed as:

$$F_{hr} = \frac{V\left(\bar{T}_{del} - \bar{T}_{in}\right)}{77°F}$$

$$\text{or}\ F_{hr} = \frac{V\left(\bar{T}_{del} - \bar{T}_{in}\right)}{42.8°C}$$

Where:

V=the volume of water removed during the one hour continuous draw, in gallons (liters).
$\bar{T}_{del}$=defined in section 6.2.1.
$\bar{T}_{in}$=defined in section 6.2.1.

6.2.2 *Recovery Efficiency*

6.2.2.1 *Fixed Input Instantaneous Water Heaters.* The recovery efficiency is computed as:

$$\eta_r = \frac{M_1 C_{\rho 1}\left(\bar{T}_{del,1} - \bar{T}_{in,1}\right)}{Q_r}$$

Where:

M_1=the mass withdrawn during the first draw of the 24-hour simulated use test, lb_m (kg).

$C\rho_1$=the specific heat of water at the average temperature $(\bar{T}_{del,1}+\bar{T}_{in,1})/2$, Btu/$lb_m$·°F (kJ/kg·°C).

$\bar{T}_{del,1}$=the average temperature for the first draw, °F (°C).

$\bar{T}_{in,1}$=the average inlet temperature for the first draw, °F (°C).

Q_r=the total energy used by the water heater between cutout prior to the first draw and cut-out following the first draw, including auxiliary energy such as pilot lights, pumps, fans, etc., Btu (kJ).

6.2.2.2. *Variable Input Instantaneous Water Heaters.* For instantaneous water heaters which have a variable firing rate, two recovery efficiency values are computed, one at the maximum input rate and one at the minimum input rate. The recovery efficiency used in subsequent computations is taken as the average of these two values. The maximum recovery efficiency is computed as:

$$\eta_{r,max} = \frac{M_1 C_{\rho 1}\left(\bar{T}_{del,1} - \bar{T}_{in,1}\right)}{Q_{r,max}}$$

Where:

M_1=defined in section 6.2.2.1.
$C\rho_1$=defined in section 6.2.2.1.
$\bar{T}_{del,1}$=defined in section 6.2.2.1.
$\bar{T}_{in,1}$=defined in section 6.2.2.1.
$Q_{r,max}$=the total energy used by the water heater between cut-out prior to the first draw and cut-out following the first draw, including auxiliary energy such as pilot lights, Btu (kJ).

The minimum recovery efficiency is computed as:

$$\eta_{r,min} = \frac{M_4 C_{\rho 4}\left(\bar{T}_{del,4} - \bar{T}_{in,4}\right)}{Q_{r,min}}$$

Where:

M_4=the mass withdrawn during the fourth draw, in lb_m (kg).
$C\rho_4$=the specific heat of water, in Btu/lb_m·°F (kJ/kg·°C).
$\bar{T}_{del,4}$=the average delivery temperature for the fourth draw, in °F (°C).
$\bar{T}_{in,4}$=the average inlet temperature for the fourth draw, in °F (°C).
$Q_{r,min}$=the total energy consumed immediately prior to the fourth draw and cut-out following the fourth draw, including auxiliary energy such as pilot lights, in Btu (kJ).

The recovery efficiency is computed as:

$$\eta_r = \frac{\eta_{r,max} + \eta_{r,min}}{2}$$

Where:

$\eta_{r,max}$=defined in section 6.2.2.2.
$\eta_{r,min}$=defined in section 6.2.2.2.

6.2.3 *Daily Water Heating Energy Consumption.* The daily water heating energy consumption, Q_d is computed as:

Q_d=Q

Where:

Q=the energy used by the flow actuated water heater during the 24-hour simulated use test.

A modification is needed to take into account that the temperature difference between the outlet water temperature and supply water temperature may not be equivalent to the nominal value of 77°F (135°F − 58°F) or 42.8°C (57.2°C − 14.4°C). The following equations adjust the experimental data to a nominal 77°F (42.8°C) temperature rise.

The energy used to heat water may be computed as:

$$Q_{HW} = \sum_{i=1}^{6} \frac{M_i C_{\rho i}\left(\bar{T}_{del,i} - \bar{T}_{in,i}\right)}{\eta_r}$$

Where:

M_i=the mass withdrawn during the ith draw, in lb_m (kg).
$C\rho_i$=the specific heat of water of the ith draw, in Btu/lb_m°F(kJ/kg·°C).
$\bar{T}_{del,i}$=the average delivery temperature of the ith draw, in °F(°C).
$\bar{T}_{in,i}$=the average inlet temperature of the ith draw, in °F(°C).
η_r=defined in section 6.2.2.2.

The energy required to heat the same quantity of water over a 77°F (42.8°C) temperature rise is:

$$Q_{HW,77°F} = \sum_{i=1}^{6} \frac{M_i C_{\rho i}(135°F - 58°F)}{\eta_r}$$

$$\text{or } Q_{HW,42.8°C} = \sum_{i=1}^{6} \frac{M_i C_{\rho i}(57.2°C - 14.4°C)}{\eta_r}$$

Where:
M_i=defined above.
$C\rho_i$=defined above.
η_r=defined in above.

The difference between these two values is:

$$Q_{HWD} = Q_{HW,77°F} - Q_{HW}$$

$$\text{or } Q_{HWD} = Q_{HW,42.8°C} - Q_{HW}$$

which must be added to the daily water heating energy consumption value. Thus, the daily energy consumption value which takes into account that the temperature rise across the storage tank may not be 77°F (42.8°C) is:

$$Q_{dm} = Q_d + Q_{HWD}$$

6.2.4 *Energy Factor.* The energy factor, E_f, is computed as:

$$E_f = \sum_{i=1}^{6} \frac{M_i C_{\rho i}(135°F - 58°F)}{Q_{dm}}$$

$$\text{or } E_f = \sum_{i=1}^{6} \frac{M_i C_{\rho i}(57.2°C - 14.4°C)}{Q_{dm}}$$

Where:
Q_{dm}=the daily water heating energy consumption as computed in accordance with Section 6.2.3, in Btu (kJ).
M_i=the mass associated with the ith draw, in lb_m (kg).
$C\rho_i$=the specific heat of water computed at a temperature of (58°F+135°F)/2, Btu/lb_m·°F [(14.4°C+57.2°C)/2, kJ/kg·°C].
$\bar{T}_{del,i}$=the average delivery temperature of the ith draw, in °F(°C).
$\bar{T}_{in,i}$=the average inlet temperature of the ith draw, in °F(°C).

6.2.5 *Annual Energy Consumption.* The annual energy consumption for instantaneous type water heaters is computed as:

$$E_{annual} = 365 \times Q_{dm}$$

Where:
Q_{dm}=the modified daily energy consumption, in Btu/day (kJ/day) and 365 is the number of days within a year.

7. Ratings for Untested Models

In order to relieve the test burden to manufacturers who offer water heaters which differ only in fuel type or power input, ratings for untested models may be established in accordance with the following procedures. In lieu of the following procedures a manufacturer may elect to test the unit for which a rating is sought.

7.1 *Gas Water Heaters.* Ratings obtained for gas water heaters using natural gas can be used for an identical water heater which utilizes propane gas if the input ratings are within 10 percent.

7.2 *Electric Water Heaters*

7.2.1 *First Hour Rating.* If an electric storage type water heater is available with more than one input rating, the manufacturer shall designate the standard input rating and the water heater need only be tested with heating elements at the designated standard input ratings. The first hour ratings for units having power input rating less than the designated standard input rating shall be assigned a first hour rating equivalent to the first draw of the first hour rating for the electric water heater with the standard input rating. For units having power inputs greater than the designated standard input rating, the first hour rating shall be equivalent to that measured for the water heater with the standard input rating.

7.2.2 *Energy Factor.* The energy factor for identical electric storage type water heaters, with the exception of heating element wattage, may use the energy factor obtained during testing of the water heater with the designated standard input rating.

5. Appendix I to subpart B of part 430 is revised to read as follows:

Appendix I to Subpart B of Part 430—Uniform Test Method for Measuring the Energy Consumption of Conventional Ranges, Conventional Cooking Tops, Conventional Ovens, and Microwave Ovens

1. Definitions

1.1 *Built-in* means the product is supported by surrounding cabinetry, walls, or other similar structures.

1.2 *Drop-in* means the product is supported by horizontal surface cabinetry.

1.3 *Forced convection* means a mode of conventional oven operation in which a fan is used to circulate the heated air within the oven compartment during cooking.

1.4 *Freestanding* means the product is not supported by surrounding cabinetry, walls, or other similar structures.

1.5 *IEC 705* refers to the test standard published by the International Electrotechnical Commission, entitled ''Method for Measuring the Performance of Microwaves Ovens for Household and Similar Purposes,'' Publication 705, Amendment 2–1993.

1.6 *Normal nonoperating temperature* means the temperature of all areas of an appliance to be tested that is within 5 degrees (2.8°C) of the temperature that the identical areas of the same basic model of the appliance would attain if it remained in the test room for 24 hours while not operating with all oven doors closed and with any gas pilot lights on and adjusted in accordance with manufacturer's instructions.

1.7 *Primary energy consumption* means either the electrical energy consumption of a conventional electric oven or the gas energy consumption of a conventional gas oven.

1.8 *Secondary energy consumption* means any electrical energy consumption, other than clock energy consumption, of a conventional gas oven.

1.9 *Standard cubic foot (L) of gas* means that quantity of gas that occupies 1 cubic foot (L) when saturated with water vapor at a temperature of 60°F (15.6°C) and a pressure of 30 inches of mercury (101.6 kPa) (density of mercury equals 13.595 grams per cubic centimeter).

1.10 *Thermocouple* means a device consisting of two dissimilar metals which are joined together and, with their associated wires, are used to measure temperature by means of electromotive force.

2. Test Conditions

2.1 *Installation.* A free standing appliance shall be installed with the back directly against, or as near as possible to, a vertical wall which extends at least 1 foot above and on either side of the appliance. There shall be no side walls. A drop-in, built-in or wall-mounted appliance shall be installed in an enclosure in accordance with the manufacturer's instructions. These appliances are to be completely assembled with all handles, knobs, guards and the like mounted in place. Any electric resistance heaters, gas burners, baking racks, and baffles shall be in place in accordance with the manufacturer's instructions; however, broiler pans are to be removed from the oven's baking compartment.

Disconnect any electrical clock which uses energy continuously, except for the microwave oven. Do not disconnect or modify the circuit to any other electrical devices or features, except as indicated in section 2.1.3.

2.1.1 *Conventional electric ranges, ovens, and cooking tops.* These products shall be connected to an electrical supply circuit with voltage as specified in section 2.2.1 with a watt-hour meter installed in the circuit. The watt-hour meter shall be as described in section 2.9.1.1.

2.1.2 *Conventional gas ranges, ovens, and cooking tops.* These products shall be connected to a gas supply line with a gas meter installed between the supply line and the appliance being tested, according to manufacturer's specifications. The gas meter shall be as described in section 2.9.2. Conventional gas ranges, ovens and cooking tops with electrical ignition devices or other electrical components shall be connected to an electrical supply circuit of nameplate voltage with a watt-hour meter installed in the circuit. The watt-hour meter shall be as described in section 2.9.1.1.

2.1.3 *Microwave ovens.* Install the microwave oven in accordance with the manufacturer's instructions and connect to an electrical supply circuit with voltage as specified in section 2.2.1. A watt meter and watt-hour meter shall be installed in the circuit and shall be as described in section 2.9.1.1. and 2.9.1.2. If trial runs are needed to set the ''on'' time for the test, the test measurements are to be separated according to section 4, Paragraph 12.6 of IEC 705.

2.2 *Energy supply.*

2.2.1 *Electrical supply.* Maintain the electrical supply to the conventional range, conventional cooking top, and conventional oven being tested at 240/120 volts except that basic models rated only at 208/120 volts shall be tested at that rating. Maintain the voltage within 2 percent of the above specified voltages, except for the microwave oven testing. Maintain the electrical supply to a microwave oven at 120 volts ± 1 volt and at 60 hertz.

2.2.2 *Gas supply.*

2.2.2.1 *Gas burner adjustments.* Conventional gas ranges, ovens, and cooking tops shall be tested with all of the gas burners adjusted in accordance with the installation or operation instructions provided by the manufacturer. In every case, the burner must be adjusted with sufficient air flow to prevent a yellow flame or a flame with yellow tips.

2.2.2.2 *Natural gas.* For testing convertible cooking appliances or appliances which are designed to operate using only natural gas, maintain the natural gas pressure immediately ahead of all controls of the unit under test at 7 to 10 inches of water column (1743.6 to 2490.8 Pa). The regulator outlet pressure shall equal the manufacturer's recommendation. The natural gas supplied should have a heating value of approximately 1,025 Btu's per standard cubic foot (38.2 kJ/L). The actual gross heating value, Hn, in Btu's per standard cubic foot (kJ/L), for the natural gas to be used in the test shall be obtained either from measurements made by the manufacturer conducting the test using equipment that meet the requirements described in section 2.9.4 or by the use of bottled natural gas whose gross heating value is certified to be at least as accurate a value that meet the requirements in section 2.9.4.

2.2.2.3 *Propane.* For testing convertible cooking appliances with propane or for testing appliances which are designed to operate using only LP-gas, maintain the propane pressure immediately ahead of all controls of the unit under test at 11 to 13 inches of water column (2740 to 3238 Pa). The regulator outlet pressure shall equal the manufacturer's recommendation. The propane supplied should have a heating value of approximately 2,500 Btu's per standard cubic foot (93.15 kJ/L). The actual gross heating value, H_p, in Btu's per standard cubic foot (kJ/L), for the propane to be used in the test shall be obtained either from measurements made by the manufacturer conducting the test using equipment that meet the requirements described in section 2.9.4 or by the use of bottled propane whose gross heating value is certified to be at least as accurate a value that meet the requirements described in section 2.9.4.

2.2.2.4 *Test gas.* A basic model of a convertible cooking appliance shall be tested with natural gas, but may also be tested with propane. Any basic model of a conventional range, conventional cooking top, or conventional oven which is designed to operate using only natural gas as the energy source must be tested with natural gas. Any basic model of a conventional range, conventional cooking top, or conventional oven which is designed to operate using only LP gas as the gas energy source must be tested with propane gas.

2.3 *Air circulation.* Maintain air circulation in the room sufficient to secure a reasonably uniform temperature distribution, but do not cause a direct draft on the unit under test.

2.4 *Setting the conventional oven thermostat.*

2.4.1 *Conventional electric oven.* Install a thermocouple approximately in the center of the usable baking space. Provide a temperature indicator system for measuring the oven's temperature with an accuracy as indicated in section 2.9.3.2. If the oven thermostat does not cycle on and off, adjust or determine the conventional electric oven thermostat setting to provide an average internal temperature which is 325°±5°F (162.8°±2.8°C) higher than the room ambient air temperature. If the oven thermostat operates by cycling on and off, adjust or determine the conventional electric oven thermostat setting to provide an average internal temperature which is 325°±5°F (162.8°±2.8°C) higher than the room ambient air temperature. This shall be done by measuring the maximum and minimum temperatures in any three consecutive cut-off/cut-on actions of the electric resistance heaters, excluding the initial cut-off/cut-on action, by the thermostat after the temperature rise of 325°±5°F (162.8°±2.8°C) has been attained by the conventional electric oven. Remove the thermocouple after the thermostat has been set.

2.4.2 *Conventional gas oven.* Install five parallel-connected weighted thermocouples, one located at the center of the conventional gas oven's usable baking space and the other four equally spaced between the center and the corners of the conventional gas oven on the diagonals of a horizontal plane through the center of the conventional gas oven. Each weighted thermocouple shall be constructed of a copper disc that is 1-inch (25.4 mm) in diameter and ⅛-inch (3.2 mm) thick. The two thermocouple wires shall be located in two holes in the disc spaced ½-inch (12.7 mm) apart, with each hole being located ¼-inch (6.4 mm) from the center of the disc. Both thermocouple wires shall be silver-soldered to the copper disc. Provide a temperature indicator system for measuring the oven's temperature with an accuracy as indicated in section 2.9.3.2. If the oven thermostat does not cycle on or off, adjust or determine the conventional gas oven thermostat setting to provide an average internal temperature which is 325°±5°F (162.8°±2.8°C) higher than the room ambient air temperature. If the oven thermostat operates by cycling on and off, adjust or determine the conventional gas oven thermostat setting to provide an average internal temperature which is 325°±5°F (162.8±2.8°C) higher than the room ambient air temperature. This shall be done by measuring the maximum and minimum temperatures in any three consecutive cut-off/cut-on actions of the gas burners, excluding the initial cut-off/cut-on action, by the thermostat after the temperature rise of 325°±5°F (162.8°±2.8°C) has been attained by the conventional gas oven. Remove the thermocouple after the thermostat has been set.

2.5 *Ambient room air temperature.* During the test, maintain an ambient room air temperature, T_R, of 77°±9°F (25°±5°C) for conventional ovens and cooking tops, or as indicated in section 4, Paragraph 12.4 of IEC 705 for microwave ovens as measured at least 5 feet (1.5 m) and not more than 8 feet (2.4 m) from the nearest surface of the unit under test and approximately 3 feet (.9 m) above the floor. The temperature shall be measured with a thermometer or temperature indicating system with an accuracy as indicated in section 2.9.3.1.

2.6 *Normal nonoperating temperature.* All areas of the appliance to be tested shall attain the normal nonoperating temperature, as defined in section 1.6, before any testing begins. The equipment for measuring the applicable normal nonoperating temperature shall be as described in sections 2.9.3.1, 2.9.3.2, 2.9.3.4, and 2.9.3.5, as applicable.

2.7 *Test blocks for conventional oven and cooking top.* The test blocks shall be made of aluminum alloy No. 6061, with a specific heat of 0.23 Btu/lb-°F (0.96 kJ/[kg°C]) and with any temper that will give a coefficient of thermal conductivity of 2.6 to 2.8 BTU-in/in-ft^2-°F (154.8 to 171.5 W/[m°C]). Each block shall have a hole at its top. The hole shall be 0.08 inch (2.03 mm) in diameter and 0.80 inch (20.3 mm) deep. The manufacturer conducting the test may provide other means which will ensure that the thermocouple junction is installed at this same position and depth.

The bottom of each block shall be flat to within 0.002 inch (0.051 mm) TIR (total indicator reading). Determine the actual weight of each test block with a scale with an accuracy as indicated in section 2.9.5.

2.7.1 *Conventional oven test block.* The test block for the conventional oven, W_1, shall be 6.25±0.05 inch (158.8±1.3 mm) in diameter, approximately 2.8 inches (71 mm) high and shall weigh 8.5±0.1 lbs (3.86±0.05 kg). The block shall be finished with an anodic black coating which has a minimum thickness of 0.001 inch (0.025 mm) or with a finish having the equivalent absorptivity.

2.7.2 *Small test block for conventional cooking top.* The small test block, W_2, shall be 6.25±0.05 inches (158.8±1.3 mm) in diameter, approximately 2.8 inches (71 mm) high and shall weigh 8.5±0.1lbs (3.86±0.05 kg).

2.7.3 *Large test block for conventional cooking top.* The large test block for the conventional cooking top, W_3, shall be 9±0.05 inches (228.6±1.3 mm) in diameter, approximately 3.0 inches (76 mm) high and shall weigh 19±0.1 lbs (8.62±0.05 kg).

2.7.4 *Thermocouple installation.* Install the thermocouple such that the thermocouple junction (where the thermocouple contacts the test block) is at the bottom of the hole provided in the test block and that the thermocouple junction makes good thermal contact with the aluminum block. If the test blocks are to be water cooled between tests the thermocouple hole should be sealed, or other steps taken, to insure that the thermocouple hole is completely dry at the start of the next test. Provide a temperature indicator system for measuring the test block temperature with an accuracy as indicated in section 2.9.3.3.

2.7.5 *Initial test block temperature.* Maintain the initial temperature of the test blocks, T_I, within ±4°F (±2.2°C) of the ambient room air temperature as specified in section 2.5. If the test block has been cooled (or heated) to bring it to room temperature, allow the block to stabilize for at least 2 minutes after removal from the cooling (or heating) source, before measuring its initial temperature.

2.8 *Microwave oven test load.*

2.8.1 *Test container.* The test container shall be as specified in section 4, Paragraph 12.2 of IEC 705.

2.8.2 *Test water load.* The test water load shall be as specified in section 4, Paragraph 12.1 of IEC 705.

2.8.2.1 *Test water load and test container temperature.* Before the start of the test, the oven and the test container shall be at ambient temperature as specified in section 4, Paragraph 12.4 of IEC 705. The test water load shall be contained in a chiller (not the test container) and maintained at 18°±1.8°F (10°±1°C) below the ambient room temperature.

2.9 *Instrumentation.* Perform all test measurements using the following instruments, as appropriate:

2.9.1 *Electrical Measurements.*

2.9.1.1 *Watt-hour meter.* The watt-hour meter for measuring the electrical energy consumption of conventional ovens and cooking tops shall have a resolution of at least 1 watt-hour (3.6 kJ) and a maximum error no greater than 1.5 percent of the measured value. The watt-hour meter for measuring the energy consumption of microwave ovens shall have a resolution of at least 0.1 watt-hour (.36 kJ) and a maximum error no greater than 1.5 percent of the measured value.

2.9.1.2 *Wattmeter.* The wattmeter used to measure the conventional oven, conventional range, microwave/conventional range clock power or the power input of the microwave shall have a resolution of at least 0.2 watt (0.2 J/s) and a maximum error no greater than 5 percent of the measured value.

2.9.2 *Gas Measurements.*

2.9.2.1 *Positive displacement meters.* The gas meter to be used for measuring the gas consumed by the gas burners of the oven or cooking top shall have a resolution of at least 0.01 cubic foot (0.28 L) and a maximum error no greater than 1 percent of the measured value. If a positive displacement gas meter is used for measuring the gas consumed by the pilot lights, it shall have a resolution of at least 0.01 cubic foot (0.28 L) and have a maximum error no greater than 2 percent of the measured value.

2.9.2.2 *Flow meter.* If a gas flow meter is used for measuring the gas consumed by the pilot lights, it shall be calibrated to have a maximum error no greater than 1.5 percent of the measured value and a resolution of at least 1 percent of the measured value.

2.9.3 *Temperature measurement equipment.*

2.9.3.1 *Room temperature indicating system.* The room temperature indicating system shall be as specified in section 4, Paragraph 12.3 of IEC 705.

2.9.3.2 *Temperature indicator system for measuring conventional oven temperature.* The equipment for measuring the conventional oven temperature shall have an error no greater than ±4°F (±2.2°C) over the range of 65° to 500°F (18°C to 260°C).

2.9.3.3 *Temperature indicator system for measuring test block temperature.* The system shall have an error no greater than ±2°F (±1.1°C) when measuring specific temperatures over the range of 65° to 330°F (18.3°C to 165.6°C). It shall also have an error no greater than ±2°F (±1.1°C) when measuring any temperature difference up to 240°F (115.6°C) within the above range.

2.9.3.4 *Test load temperatures.* The thermometer or other temperature measuring instrument used to measure the test water load temperature shall be as specified in section 4, Paragraph 12.3 of IEC 705. Use only one thermometer or other temperature measuring device throughout the entire test procedure.

2.9.3.5 *Temperature indicator system for measuring surface temperatures.* The temperatures of an external surface of an appliance shall be measured by means of a thermocouple in firm contact with the surface. The temperature indicating system shall have an error no greater than ±.45°F (±0.25°C) over the range 65° to 90°F (18°C to 32°C).

2.9.4 *Heating Value.* The heating value of the natural gas or propane shall be measured with an instrument and associated readout device that has a maximum error no greater than .5% of the measured value and a resolution of .2% or less of the full scale reading of the indicator instrument. The heating value of natural gas or propane must be corrected for local temperature and pressure conditions.

2.9.5 *Scale.* The scale used for weighing the test blocks shall have a maximum error no greater than 1 ounce (28.4 g). The scale used for weighing the microwave oven test water load shall be as specified in section four, paragraph 12.3 of IEC 705.

3. Test Methods and Measurements

3.1 *Test methods.*

3.1.1 *Conventional oven.* Perform a test by establishing the testing conditions set forth in section 2, ''TEST CONDITIONS,'' of this appendix, and adjust any pilot lights of a conventional gas oven in accordance with the manufacturer's instructions and turn off the gas flow to the conventional cooking top, if so equipped.

Before beginning the test, the conventional oven shall be at its normal nonoperating temperature as defined in section 1.6 and described in section 2.6. Set the conventional oven test block W1 approximately in the center of the usable baking space. If there is a selector switch for selecting the mode of operation of the oven, set it for normal baking. If an oven permits baking by either forced convection by using a fan, or without forced convection, the oven is to be tested in each of those two modes. If the oven thermostat does not cycle on and off, adjust or determine the conventional electric oven thermostat setting to provide an average internal temperature which is 325°±5°F (162.8°±2.8°C) air temperature. If the oven thermostat operates by cycling on and off, adjust or determine the conventional electric oven thermostat setting to provide an average internal temperature which is 325°±5°F (162.8°±2.8°C) higher than the room ambient air temperature. The oven shall remain on for at least one complete thermostat ''cut-off/cut-on'' of the electrical resistance heaters or gas burners after the test block temperature has increased 234°F (112.2°C) above its initial temperature.

3.1.1.1 *Self-cleaning operation of a conventional oven.* Establish the test conditions set forth in section 2, ''TEST CONDITIONS,'' of this Appendix. Adjust any pilot lights of a conventional gas oven in accordance with the manufacturer's instructions and turn off the gas flow to the conventional cooking top. The temperature of the conventional oven shall be its normal nonoperating temperature as defined in section 1.6 and described in section 2.6. Then set the conventional oven's self-cleaning process in accordance with the manufacturer's instructions. If the self-cleaning process is adjustable, use the average time recommended by the manufacturer for a moderately soiled oven.

3.1.1.2 *Continuously burning pilot lights of a conventional gas oven.* Establish the test conditions set forth in section 2, ''TEST CONDITIONS,'' of this appendix. Adjust any pilot lights of a conventional gas oven in accordance with the manufacturer's instructions and turn off the gas flow to the conventional cooking top. If a positive displacement gas meter is used the, test duration shall be sufficient to measure a gas consumption which is at least 200 times the resolution of the gas meter.

3.1.2 *Conventional cooking top.* Establish the test conditions set forth in section 2, ''TEST CONDITIONS,'' of this appendix. Adjust any pilot lights of a conventional gas cooking top in accordance with the manufacturer's instructions and turn off the gas flow to the conventional oven(s), if so equipped. The temperature of the conventional cooking top shall be its normal nonoperating temperature as defined in section 1.6 and described in section 2.6. Set the test block in the center of the surface unit under test. The small test block, W_2, shall be used on electric surface units of 7 inches (178 mm) or less in diameter. The large test block, W_3, shall be used on electric surface units over 7 inches (177.8 mm) in diameter and on all gas surface units. Turn on the surface unit under test and set its energy input rate to the maximum setting (100 percent). When the test block reaches 144°F (62.2°C) above its initial test block temperature, immediately reduce the energy input rate to 25±5 percent of the maximum energy input rate. After 15±0.1 minutes at the reduced energy setting, turn off the surface unit under test.

3.1.2.1 *Continuously burning pilot lights of a conventional gas cooking top.* Establish the test conditions set forth in section 2, ''TEST CONDITIONS,'' of this appendix.

Adjust any pilot lights of a conventional gas cooking top in accordance with the manufacturer's instructions and turn off the gas flow to the conventional oven(s). If a positive displacement gas meter is used, the test duration shall be sufficient to measure a gas consumption which is at least 200 times the resolution of the gas meter.

3.1.3 *Microwave oven.*

3.1.3.1 *Microwave oven test energy or power output.* Establish the testing conditions set forth in section 2, ''TEST CONDITIONS,'' of this appendix. Follow the test procedure as specified in section 4, Paragraph 12.4 of IEC 705.

3.2 *Test measurements.*

3.2.1 *Conventional oven test energy consumption.* If the oven thermostat controls the oven temperature without cycling on and off, measure the energy consumed, E_O, when the temperature of the block reaches T_O (T_O is 234°F (112.2°C) above the initial block temperature, T_I). If the oven thermostat operates by cycling on and off, make the following series of measurements: Measure the block temperature, T_A, and the energy consumed, E_A, at the end of the last ''ON'' period of the conventional oven before the block reaches T_O. Measure the block temperature, T_B, and the energy consumed, E_B, at the beginning of the next ''ON'' period. Measure the block temperature, T_C, and the energy consumed, E_C, at the end of that ''ON'' period. Measure the block temperature, T_D, and the energy consumed, E_D, at the beginning of the following ''ON'' period. Energy measurements for E_O, E_A, E_B, E_C and E_D should be expressed in watt-hours for conventional electric ovens or standard cubic feet (L) of gas for conventional gas ovens. For a gas oven, measure in watt-hours any electrical energy, E_{IO}, consumed by an ignition device or other electrical components required for the operation of a conventional gas oven while heating the test block to T_O.

3.2.1.1 *Conventional oven average test energy consumption.* If the conventional oven permits baking by either forced convection or without forced convection and the oven thermostat does not cycle on and off, measure the energy consumed with the forced convection mode, $(E_O)_1$, and without the forced convection mode, $(E_O)_2$, when the temperature of the block reaches T_O (T_O is 234°F (112.2°C) above the initial block temperature, T_I). If the conventional oven permits baking by either forced convection or without forced convection and the oven thermostat operates by cycling on and off, make the following series of measurements with and without the forced convection mode: Measure the block temperature, T_A, and the energy consumed, E_A, at the end of the last ''ON'' period of the conventional oven before the block reaches T_O. Measure the block temperature, T_B, and the energy consumed, E_B, at the beginning of the next ''ON'' period. Measure the block temperature, T_C, and the energy consumed, E_C, at the end of that ''ON'' period. Measure the block temperature, T_D, and the energy consumed, E_D, at the beginning of the following ''ON'' period. Energy measurements for E_O, E_A, E_B, E_C and E_D should be expressed in watt-hours for conventional electric ovens or standard cubic feet (L) of gas for conventional gas ovens. For a gas oven that can be operated with or without forced convection, measure in watt-hours any electrical energy consumed by an ignition device or other electrical components required for the operation of a conventional gas oven while heating the test block to T_O using the forced convection mode, $(E_{IO})_1$, and without using the forced convection mode, $(E_{IO})_2$.

3.2.1.2 *Energy consumption of self-cleaning operation.* Measure the energy consumption, E_S, in watt-hours of electricity or in standard cubic feet (L) of gas consumed during the self-cleaning test set forth in section 3.1.1.1. For a gas oven, also measure in watt-hours (kJ) any electrical energy, E_{IS}, consumed by ignition devices or other electrical components required during the self-cleaning test.

3.2.1.3 *Gas consumption of continuously burning pilot lights.* Measure the gas consumption of the pilot lights, P_O, in standard cubic feet (L) of gas and the test duration, L_O, in hours for the test set forth in Section 3.1.1.2. If a gas flow rate meter is used, measure the flow rate, P_R, in standard cubic feet per hour (L/s).

3.2.1.4 *Clock power.* If the conventional oven, conventional range, or microwave/conventional range includes an electric clock which is on continuously, and the power rating in watts (J/s) of this feature is not known, measure the clock power, P_{CL}, in watts (J/s.)

3.2.2 *Conventional surface unit test energy consumption.* For the surface unit under test, measure the energy consumption, E_{CT}, in standard cubic feet (L) of gas or watt-hours of electricity, and the test block temperature, T_{CT}, at the end of the 15 minute (reduced input setting) test interval for the test specified in section 3.1.2 and the total time, T_T, in hours, that the unit is under test. Measure any electrical energy, E_{IC}, consumed by an ignition device of a gas heating element in watt-hours.

3.2.2.1 *Gas consumption of continuously burning pilot lights.* If the conventional gas cooking top under test has one or more continuously burning pilot lights, measure the gas consumed during the test by the pilot lights, P_C, in standard cubic feet (L) of gas, and the test duration, L_C, in hours as specified in section 3.1.2.1. If a gas flow rate meter is used, measure the flow rate, P, in standard cubic feet per hour (L/s).

3.2.3 *Microwave oven test energy consumption and power input.* Measurements are to be made as specified in section 4, Paragraphs 12.4 and 13 of IEC 705. Measure the electrical input energy, E_M, in watt-hours consumed by the microwave oven during the test. Repeat all tests three times.

3.3 *Recorded values.*

3.3.1 Record the test room temperature, T_R, at the start and end of each test, as determined in section 2.5.

3.3.2 Record measured test block weights W_1, W_2, and W_3 in pounds (kg).

3.3.3 Record the initial temperature, T_I, of the test block under test.

3.3.4 For a conventional oven with a thermostat which operates by cycling on and off, record the conventional oven test measurements T_A, E_A, T_B, E_B, T_C, E_C, T_D, and E_D. If the thermostat controls the oven temperature without cycling on and off, record E_O. For a gas oven which also uses electrical energy for the ignition or operation of the oven, also record E_{IO}.

3.3.5 For a conventional oven that can be operated with or without forced convection and the oven thermostat controls the oven temperature without cycling on and off, measure the energy consumed with the forced convection mode, $(E_O)_1$, and without the forced convection mode, $(E_O)_2$. If the conventional oven operates with or without forced convection and the thermostat controls the oven temperature by cycling on and off, record the conventional oven test measurements T_A, E_A, T_B, E_B, T_C, E_C, T_D, and E_D. For a gas oven that can be operated with or without forced convection, measure any electrical energy consumed by an ignition device or other electrical components used during the forced convection mode, $(E_{IO})_1$, and without using the forced convection mode, $(E_{IO})_2$.

3.3.6 Record the measured energy consumption, E_S, and for a gas oven, any electrical energy, E_{IS}, for the test of the self-cleaning operation of a conventional oven.

3.3.7 Record the gas flow rate, P_R; or the gas consumption, P_O, and the elapsed time, L_O, that any continuously burning pilot lights of a conventional oven are under test.

3.3.8 Record the clock power measurement or rating, P_{CL}, in watts.

3.3.9 For the surface unit under test, record the energy consumption, E_{CT}, the final test block temperature, T_{CT}, the total test time, T_T. For a gas cooking top which uses electrical energy for ignition of the burners, also record E_{IC}.

3.3.10 Record the gas flow rate, P; or the gas consumption, P_C, and the elapsed time, L_C, that any continuously burning pilot lights of a conventional gas cooking top are under test.

3.3.11 Record the heating value, H_n, as determined in section 2.2.2.2 for the natural gas supply.

3.3.12 Record the heating value, H_p, as determined in section 2.2.2.3 for the propane supply.

3.3.13 Record the electrical input energy and power input E_M and P_M for the microwave oven test; the initial and final temperature, T_1 and T_2, of the test water load; the mass of the test container before filling with the test water load and the mass of the test water load, M_C and M_W respectively; and the measured room temperature, T_O; as determined in section 3.2.3.

4. Calculation of Derived Results From Test Measurements

4.1 *Conventional oven.*

4.1.1 *Test energy consumption.* For a conventional oven with a thermostat which operates by cycling on and off, calculate the test energy consumption, E_O, corresponding to T_O with the aid of the figure in section 5 of this appendix, expressed in watt-hours (kJ) for electric ovens and in Btu's (kJ) for gas ovens, and defined as:

$$E_0 = E_{AB} + \left[\left(\frac{T_0 - T_{AB}}{T_{CD} - T_{AB}}\right) \times \left(E_{CD} - E_{AB}\right)\right] \text{ for electric ovens,}$$

$$\text{and, } E_0 = \left(E_{AB} \times H\right) + \left[\left(\frac{T_0 - T_{AB}}{T_{CD} - T_{AB}}\right) \times \left(E_{CD} - E_{AB}\right) \times H\right] \text{ for gas ovens}$$

Where:

H=either H_n or H_p, the heating value of the gas used in the test as specified in section 2.2.2.2 and section 2.2.2.3, expressed in Btu's per standard cubic foot (kJ/L).

T_O=234°F (112.2°C) plus the initial test block temperature.

and,

$$T_{AB} = \frac{\left(T_A + T_B\right)}{2}$$

$$T_{CD} = \frac{\left(T_C + T_D\right)}{2}$$

$$E_{AB} = \frac{\left(E_A + E_B\right)}{2}$$

$$E_{CD} = \frac{\left(E_C + E_D\right)}{2}$$

Where:

T_A=block temperature in °F (°C) at the end of the last ''ON'' period of the conventional oven before the test block reaches T_O.

T_B=block temperature in °F (°C) at the beginning of the ''ON'' period following the measurement of T_A.

T_C=block temperature in °F (°C) at the end of the ''ON'' period which starts with T_B.

T_D=block temperature in °F (°C) at the beginning of the ''ON'' period which follows the measurement of T_C.

E_A=volume of gas consumed in standard cubic feet (L) at the end of the last ''ON'' period before the test block reaches T_O.

E_B=volume of gas consumed in standard cubic feet (L) of gas at the beginning of the ''ON'' period following the measurement T_A.

E_C=volume of gas consumed in standard cubic feet (L) of gas at the end of the ''ON'' period which starts with T_B.

E_D=volume of gas consumed in standard cubic feet (L) of gas at the beginning of the ''ON'' period which follows the measurement of T_C.

4.1.1.1 *Average test energy consumption.* If the conventional oven can be operated with or without forced convection, determine the average test energy consumption, E_O and E_{IO}, in watt-hours (kJ) for electric ovens and Btu's (kJ) for gas ovens using the following equations:

$$E_0 = \frac{\left(E_0\right)_1 + \left(E_0\right)_2}{2}$$

$$E_{10} = \frac{\left(E_{10}\right)_1 + \left(E_{10}\right)_2}{2}$$

Where:

$(E_O)_1$=test energy consumption using the forced convection mode in watt-hours (kJ) for electric ovens and in Btu's (kJ) for gas ovens as measured in section 3.2.1.1.

$(E_O)_2$=test energy consumption without using the forced convection mode in watt-hours (kJ) for electric ovens and in Btu's (kJ) for gas ovens as measured in section 3.2.1.1.

$(E_{IO})_1$=electrical energy consumption in watt-hours (kJ) of a gas oven in forced convection mode as measured in section 3.2.1.1.

$(E_{IO})_2$=electrical energy consumption in watt-hours (kJ) of a gas oven without using the forced convection mode as measured in section 3.2.1.1.

4.1.2 *Conventional oven annual energy consumption.*

4.1.2.1 *Annual cooking energy consumption.*

4.1.2.1.1 *Annual primary energy consumption.* Calculate the annual primary energy consumption for cooking, E_{CO}, expressed in kilowatt-hours (kJ) for electric ovens and in Btu's (kJ) for gas ovens, and defined as:

$$E_{C0} = \frac{E_0 \times H_e \times O_0}{W_1 \times C_\rho \times T} \quad \text{for electric ovens,}$$

Where:

E_O=test energy consumption as measured in section 3.2.1 or as calculated in section 4.1.1 or section 4.1.1.1.

H_e=3.412 Btu/Wh (3.6 kJ/Wh,) conversion factor of watt-hours to Btu's.

O_O=35.5 kWh per year, annual useful cooking energy output of conventional electric oven.

W_1=measured weight of test block in pounds (kg).

C_p=0.23 Btu/lb-°F (0.96 kJ/kg·°C), specific heat of test block.

T=234°F (112.2°C), temperature rise of test block.

or,

$$E_{C0} = \frac{E_0 \times O_0}{W_1 \times C_\rho \times T} \quad \text{for gas ovens,}$$

Where:

E_O=test energy consumption as measured in section 3.2.1. or as calculated in section 4.1.1 or section 4.1.1.1.

O_O=124,200 Btu (131,038 kJ) per year, annual useful cooking energy output of conventional gas oven.

W_1, C_p and T are the same as defined above.

4.1.2.1.2 *Annual secondary energy consumption for cooking of gas ovens.* Calculate the annual secondary energy consumption for cooking, E_{SO}, expressed in kilowatt-hours and defined as:

$$E_{S0} = \frac{E_{I0} \times H_e \times O_0}{W_1 \times C_\rho \times T},$$

Where:

E_{IO}=electrical test energy consumption as measured in section 3.2.1 or as calculated in section 4.1.1.1.

O_O=35.5 kWh per year, annual useful cooking energy output.

H_e, W_1, C_p, and T are as defined in section 4.1.2.1.1.

4.1.2.2 *Annual energy consumption of any continuously burning pilot lights.* Calculate the annual energy consumption of any continuously burning pilot lights, E_{PO}, expressed in Btu's (kJ) and defined as:

$$E_{P0} = P_R \times H \times (A - B),$$

or,

$$E_{P0} = \frac{P_0}{L_0} \times H \times (A - B)$$

Where:

P_R=pilot gas flow rate in standard cubic feet per hour (L/s), as measured in section 3.2.1.2.

P_O=standard cubic feet (L) of gas consumed by any continuously burning pilot lights, as measured in section 3.2.1.2.

L_O=elapsed test time in hours for any continuously burning pilot lights tested, as measured in section 3.2.1.2.

H=H_n or H_p,the heating value of the gas used in the test as specified in section 2.2.2.2 and section 2.2.2.3 in Btu's per standard cubic foot (kJ/L).

A=8,760, number of hours in a year.

B=300, number of hours any continuously burning pilot lights contribute to the heating of an oven for cooking food.

4.1.2.3 *Annual conventional oven self-cleaning energy.*

4.1.2.3.1 *Annual primary energy consumption.* Calculate the annual primary energy consumption for conventional oven self-cleaning operations, E_{SC}, expressed in kilowatt-hours (kJ) for electric ovens and in Btu's (kJ) for gas ovens, and defined as:

$$E_{SC} = E_S \times S_e \times C, \quad \text{for electric ovens,}$$

Where:

E_S=energy consumption in watt-hours, as measured in section 3.2.1.2.

S_e=11, average number of times a self-cleaning operation of a conventional electric oven is used per year.

C=.001 kW/W conversion factor for watts to kilowatts.

or,

$$E_{SC} = E_S \times H \times S_g, \quad \text{for gas ovens,}$$

Where:

E_S=gas consumption in standard cubic feet (L), as measured in section 3.2.1.2.

$H = H_n$ or H_p, the heating value of the gas used in the test as specified in section 2.2.2.2 and section 2.2.2.3 in Btu's per standard cubic foot (kJ/L).
$S_g = 7$, average number of times a self-cleaning operation of a conventional gas oven is used per year.

4.1.2.3.2 *Annual secondary energy consumption for self-cleaning operation of gas ovens.* Calculate the annual secondary energy consumption for self-cleaning operations of a gas oven, E_{SS}, expressed in kilowatt-hours and defined as:

$$E_{SS} = E_{IS} \times S_g \times C,$$

Where:
E_{IS} = electrical energy consumed during the self-cleaning operation of a conventional gas oven, as measured in section 3.2.1.2.
S_g = 7, average number of times a self-cleaning operation of a conventional gas oven is used per year.
C = .001 kW/W conversion factor for watts to kilowatts.

4.1.2.4 *Annual clock energy consumption.* Calculate the annual energy consumption of any constantly operating electric clock, E_{CL}, expressed in kilowatt-hours and defined as:

$$E_{CL} = P_{CL} \times H_K \times C,$$

Where:
P_{CL} = power rating of clock which is on continuously, in watts, as measured in section 3.2.1.3.
H_K = 8,760, number of hours in a year.
C = .001 kW/W conversion factor for watts to kilowatts.

4.1.2.5 *Total annual energy consumption of a single conventional oven.*

4.1.2.5.1 *Conventional electric oven energy consumption.* Calculate the total annual energy consumption of a conventional electric oven, E_{AO}, expressed in kilowatt-hours and defined as:

$$E_{AO} = E_{CO} + E_{SC} + E_{CL},$$

Where:
E_{CO} = annual primary cooking energy consumption as determined in section 4.1.2.1.1.
E_{SC} = annual primary self-cleaning energy consumption as determined in section 4.1.2.3.1.
E_{CL} = annual clock energy consumption as determined in section 4.1.2.4.

4.1.2.5.2 *Conventional gas oven energy consumption.* Calculate the total annual gas energy consumption of a conventional gas oven, E_{AOG}, expressed in Btu's (kJ) and defined as:

$$E_{AOG} = E_{CO} + E_{PO} + E_{SC},$$

Where:
E_{CO} = annual primary cooking energy consumption as determined in section 4.1.2.1.1.
E_{PO} = annual pilot light energy consumption as determined in section 4.1.2.2.
E_{SC} = annual primary self-cleaning energy consumption as determined in section 4.1.2.3.1.

If the conventional gas oven uses electrical energy, calculate the total annual electrical energy consumption, E_{AOE}, expressed in kilowatt-hours and defined as:

$$E_{AOE} = E_{SO} + E_{SS} + E_{CL},$$

Where:
E_{SO} = annual secondary cooking energy consumption as determined in section 4.1.2.1.2.
E_{SS} = annual secondary self-cleaning energy consumption as determined in section 4.1.2.3.2.
E_{CL} = annual clock energy consumption as determined in section 4.1.2.4.

4.1.2.6 *Total annual energy consumption of multiple conventional ovens.* If the cooking appliance includes more than one conventional oven calculate the total annual energy consumption of the conventional ovens using the following equations:

4.1.2.6.1 *Conventional electric oven energy consumption.* Calculate the total annual energy consumption, E_{TO}, in kilowatt-hours and define as:

$$E_{TO} = E_{ACO} + E_{ASC} + E_{CL},$$

Where:

$$E_{ACO} = \frac{1}{n}\sum_{i=1}^{n}(E_{CO})_i,$$

average annual primary energy consumption for cooking,
Where:
n = number of conventional ovens in the basic model.
E_{CO} = annual primary energy consumption for cooking as determined in section 4.1.2.1.1.

$$E_{ASC} = \frac{1}{n}\sum_{i=1}^{n}\left(E_{SC}\right)_i,$$

average annual self-cleaning energy consumption,
Where:
n = number of self-cleaning conventional ovens in the basic model.
E_{SC} = annual primary self-cleaning energy consumption as determined according to section 4.1.2.3.1.
E_{CL} = clock energy consumption as determined according to section 4.1.2.4.

4.1.2.6.2 *Conventional gas oven energy consumption.* Calculate the total annual gas energy consumption, E_{TOG}, in Btu's (kJ) and define as:

$$E_{TOG} = E_{ACO} + E_{ASC} + E_{TPO},$$

Where:
E_{ACO} = average annual primary energy consumption for cooking in Btu's (kJ) as defined in section 4.1.2.6.1.
E_{ASC} = average annual self-cleaning energy consumption in Btu's (kJ) as defined in section 4.1.2.6.1.

$$E_{TPO} = \sum_{i=1}^{n}\left(E_{PO}\right)_i,$$

total annual energy consumption of any pilot lights,
Where:
E_{PO} = annual energy consumption of any continuously burning pilot lights determined according to section 4.1.2.2.
n = number of pilot lights in the basic model.

If the oven also uses electrical energy, calculate the total annual electrical energy consumption, E_{TOE}, in kilowatt-hours and define as:

$$E_{TOE} = E_{ASO} + E_{AAS} + E_{CL},$$

Where:

$$E_{ASO} = \frac{1}{n}\sum_{i=1}^{n}\left(E_{SO}\right)_i,$$

average annual secondary energy consumption for cooking,
Where:
n = number of conventional ovens in the basic model.
E_{SO} = annual secondary energy consumption for cooking of gas ovens as determined in section 4.1.2.1.2.

$$E_{AAS} = \frac{1}{n}\sum_{i=1}^{n}\left(E_{SS}\right)_i,$$

average annual secondary self-cleaning energy consumption,
Where:
n = number of self-cleaning ovens in the basic model.
E_{SS} = annual secondary self-cleaning energy consumption of gas ovens as determined in section 4.1.2.3.2.
E_{CL} = annual clock energy consumption as determined in section 4.1.2.4.

4.1.3 *Conventional oven cooking efficiency.*

4.1.3.1 *Single conventional oven.* Calculate the conventional oven cooking efficiency, Eff_{AO}, using the following equations:

For electric ovens:

$$Eff_{AO} = \frac{W_1 \times C_p \times T}{E_O \times H_e},$$

and,

For gas ovens:

$$Eff_{AO} = \frac{W_1 \times C_p \times T}{E_O + \left(E_{10} \times H_e\right)},$$

Where:
W_1 = measured weight of test block in pounds (kg).
C_p = 0.23 Btu/lb-°F (0.96 kJ/kg·°C), specific heat of test block.
T = 234°F (112.2°C), temperature rise of test block.

E_O = test energy consumption as measured in section 3.2.1 or calculated in section 4.1.1 or section 4.1.1.1.
H_e = 3.412 Btu/Wh (3.6 kJ/Wh), conversion factor for watt-hours to Btu's.
E_{IO} = electrical test energy consumption according to section 3.2.1 or as calculated in section 4.1.1.1.

4.1.3.2 *Multiple conventional ovens.* If the cooking appliance includes more than one conventional oven, calculate the cooking efficiency for all of the conventional ovens in the appliance, Eff_{TO}, using the following equation:

$$Eff_{T0} = \frac{n}{\sum_{i=1}^{n}\left(\frac{1}{Eff_{A0}}\right)_i},$$

Where:
n = number of conventional ovens in the cooking appliance.
Eff_{AO} = cooking efficiency of each oven determined according to section 4.1.3.1.

4.1.4 *Conventional oven energy factor.* Calculate the energy factor, or the ratio of useful cooking energy output to the total energy input, R_O, using the following equations:

For electric ovens,

$$R_O = \frac{O_O}{E_{AO}},$$

Where:
O_O = 35.5 kWh per year, annual useful cooking energy output.
E_{AO} = total annual energy consumption for electric ovens as determined in section 4.1.2.5.1.

For gas ovens:

$$R_O = \frac{O_O}{E_{AOG} + \left(E_{AOE} \times H_e\right)},$$

Where:
O_O = 124,200 Btu (131,038 kJ) per year, annual useful cooking energy output.
E_{AOG} = total annual gas energy consumption for conventional gas ovens as determined in section 4.1.2.5.2.
E_{AOE} = total annual electrical energy consumption for conventional gas ovens as determined in section 4.1.2.5.2.
H_e = 3,412 Btu/kWh (3.6 kJ/Wh), conversion factor for kilowatt-hours to Btu's.

4.2 *Conventional cooking top.*

4.2.1 *Conventional cooking top cooking efficiency.*

4.2.1.1 *Electric surface unit cooking efficiency.* Calculate the cooking efficiency, Eff_{SU}, of the electric surface unit under test, defined as:

$$Eff_{SU} = W \times C_p \times \left(\frac{T_{SU}}{H_e \times E_{CT}}\right),$$

Where:
W = measured weight of test block, W_2 or W_3, expressed in pounds (kg).
C_p = 0.23 Btu/lb-°F (0.96 kJ/kg-°C), specific heat of test block.
T_{SU} = temperature rise of the test block: Final test block temperature, T_{CT}, as determined in section 3.2.2, minus the initial test block temperature, T_I, expressed in °F (°C).
H_e = 3.412 Btu/Wh (3.6 kJ/Wh,) conversion factor of watt-hours to Btu's.
E_{CT} = measured energy consumption, as determined according to section 3.2.2, expressed in watt-hours.

4.2.1.2 *Gas surface unit cooking efficiency.* Calculate the cooking efficiency, Eff_{SU}, of the gas surface unit under test, defined as:

$$Eff_{SU} = \frac{W_3 \times C_p \times T_{SU}}{E},$$

Where:
W_3 = measured weight of test block as measured in section 3.3.2, expressed in pounds (kg).
C_p and T_{SU} are the same as defined in section 4.2.1.1.

and,

$$E = \left[\left(E_{CT} - E_{CP}\right) \times H\right] + \left(E_{IC} \times H_e\right),$$

Where:
E_{CT} = total gas consumption for the gas surface unit test as measured in section 3.2.2.
E_{IC} = electrical energy consumed by an ignition device of a gas surface unit as measured in section 3.2.2.
H_e = 3.412 Btu/Wh, conversion factor of watt-hours to Btu's.
H = either H_n or H_p, the heating value of the gas used in the test as specified in section 2.2.2.2 and section 2.2.2.3, expressed in Btu's per standard cubic foot (kJ/L) of gas.
E_{CP} = P x T_T, (pilot consumption, in standard cubic feet (L), during unit test), where:

$$P = \frac{P_c}{L_c}, \quad \text{(pilot flow in standard cubic feet per hour)}$$

Where:
P_C = any pilot lights gas consumption defined in section 3.2.2.1.
L_C = elapsed time of the cooking top pilot lights test as defined in section 3.1.2.1.
T_T = the elapsed test time as defined in section 3.2.2.

4.2.1.3 *Conventional cooking top cooking efficiency.* Calculate the conventional cooking top cooking efficiency, Eff_{CT}, using the following equation:

$$Eff_{CT} = \frac{1}{n}\sum_{i=1}^{n}\left(Eff_{SU}\right)_i,$$

Where:
n = number of surface units in the cooking top.
Eff_{SU} = the efficiency of each of the surface units, as determined according to section 4.2.1.1 or section 4.2.1.2.

4.2.2 *Conventional cooking top annual energy consumption.*

4.2.2.1 *Conventional electric cooking top energy consumption.* Calculate the annual energy consumption of an electric cooking top, E_{CA}, in kilowatt-hours per year, defined as:

$$E_{CA} = \frac{O_{CT}}{Eff_{CT}},$$

Where:
O_{CT} = 209.4 kWh per year, annual useful cooking energy output.
Eff_{CT} = conventional cooking top cooking efficiency as defined in section 4.2.1.3.

4.2.2.2 *Conventional gas cooking top.*

4.2.2.2.1 *Annual cooking energy consumption.* Calculate the annual energy consumption for cooking, E_{CC}, in Btu's (kJ) per year for a gas cooking top, defined as:

$$E_{CC} = \frac{O_{CT}}{Eff_{CT}},$$

Where:
O_{CT} = 732,500 Btu (772,828 kJ) per year, annual useful cooking energy output.
Eff_{CT} = the gas cooking top efficiency as defined in section 4.2.1.3.

4.2.2.2.2 *Annual energy consumption of any continuously burning gas pilots.* Calculate the annual energy consumption of any continuously burning gas pilot lights of the cooking top, E_{PC}, in Btu's (kJ) per year, defined as:

$$E_{PC} = P \times A \times H,$$

Where:
P = pilot light gas flow rate as defined in section 4.2.1.2, or as measured in section 3.2.2.1.
A = 8,760 hours, the total number of hours in a year.
H = either H_n or H_p, the heating value of the gas used in the test as specified in section 2.2.2.2. and section 2.2.2.3, expressed in Btu's per standard cubic foot (kJ/L) of gas.

4.2.2.2.3 *Total annual energy consumption of a conventional gas cooking top.* Calculate the total annual energy consumption of a conventional gas cooking top, E_{CA}, in Btu's (kJ) per year, defined as:

$$E_{CA} = E_{CC} + E_{PC},$$

Where:
E_{CC} = energy consumption for cooking as determined in section 4.2.2.2.1.
E_{PC} = annual energy consumption of the pilot lights as determined in section 4.2.2.2.2.

4.2.3 *Conventional cooking top energy factor.* Calculate the energy factor or ratio of useful cooking energy output for cooking to the total energy input, R_{CT}, as follows:

For an electric cooking top, the energy factor is the same as the cooking efficiency as determined according to section 4.2.1.3.

For gas cooking tops,

$$R_{CT} = \frac{O_{CT}}{E_{CA}},$$

Where:

O_{CT} = 732,500 Btu (772,828 kJ) per year, annual useful cooking energy output of cooking top.

E_{CA} = total annual energy consumption of cooking top determined according to section 4.2.2.2.3.

4.3 *Combined Components.*

The annual energy consumption and cooking efficiency of a kitchen range, e.g. a cooktop and oven combined, shall be the sum of the annual energy consumption and cooking efficiency of each of its components. The annual energy consumption and cooking efficiency for other combinations of ovens, cooktops and microwaves will also be treated as the sum of the annual energy consumption and cooking efficiency of each of its components. The energy factor of a combined component is the sum of the ratio of the annual useful cooking energy output to the total annual energy consumption of each component.

4.4 *Microwave oven.*

4.4.1 *Microwave oven test energy.* Calculate the microwave oven test energy output, E_T, in watt-hour's (kJ). The calculation is repeated three times as required in section 3.2.3. The average of the three E_T's is used for calculations in 4.4.3 and 4.4.5. For calculations specified in units of energy (watt-hours), use the equation below:

$$E_T = \frac{4.187 M_W (T_2 - T_1) + 0.88 M_C (T_2 - T_0)}{H_E}$$

Where:

M_W = the measured mass of the test water load, in grams.

M_C = the measured mass of the test container before filling with test water load, in grams.

T_1 = the initial test water load temperature, in °C (°F).

T_2 = the final test water load temperature, in °C (°F).

T_O = the measured ambient room temperature, in °F (°C).

C = 0.88 kJ/kg-°C, (0.210 Btu/lb-°F) specific heat of test container.

C_p = 4.187 kJ/kg-°C, (1.0 Btu/lb-°F) specific heat of water.

H_e = 3.6 kJ/Wh (3.412 Btu/Wh,) conversion factor for Btu's to Watt-hours.

4.4.2 *Microwave oven test power output.* Calculate the microwave oven test power output, P_T, in watts as specified in Section four, paragraph 12.5 of IEC 705. The calculation is repeated for each of the three tests as required in section 3.2.3. The average of the three P_T's is used for calculations in section 4.4.4.

4.4.3 *Microwave oven annual energy consumption.* Calculate the microwave oven annual energy consumption, E_{MO}, in kWh's per year, defined as:

$$E_{MO} = \frac{E_M \times O_M}{E_T}$$

Where:

E_M = the energy consumption as defined in section 3.2.3.

O_M = 77.3 kWh's per year, the microwave oven annual useful cooking energy output.

E_T = the test energy as calculated in section 4.4.1.

4.4.4 *Microwave oven cooking efficiency.* Calculate the microwave oven cooking efficiency, Eff_{MO}, as specified in section four, paragraph 14 of IEC 705.

4.4.5 *Microwave oven energy factor.* Calculate the energy factor or the ratio of the useful cooking energy output to total energy input on a yearly basis, R_{MO}, defined as:

$$R_{MO} = \frac{O_M}{E_{MO}},$$

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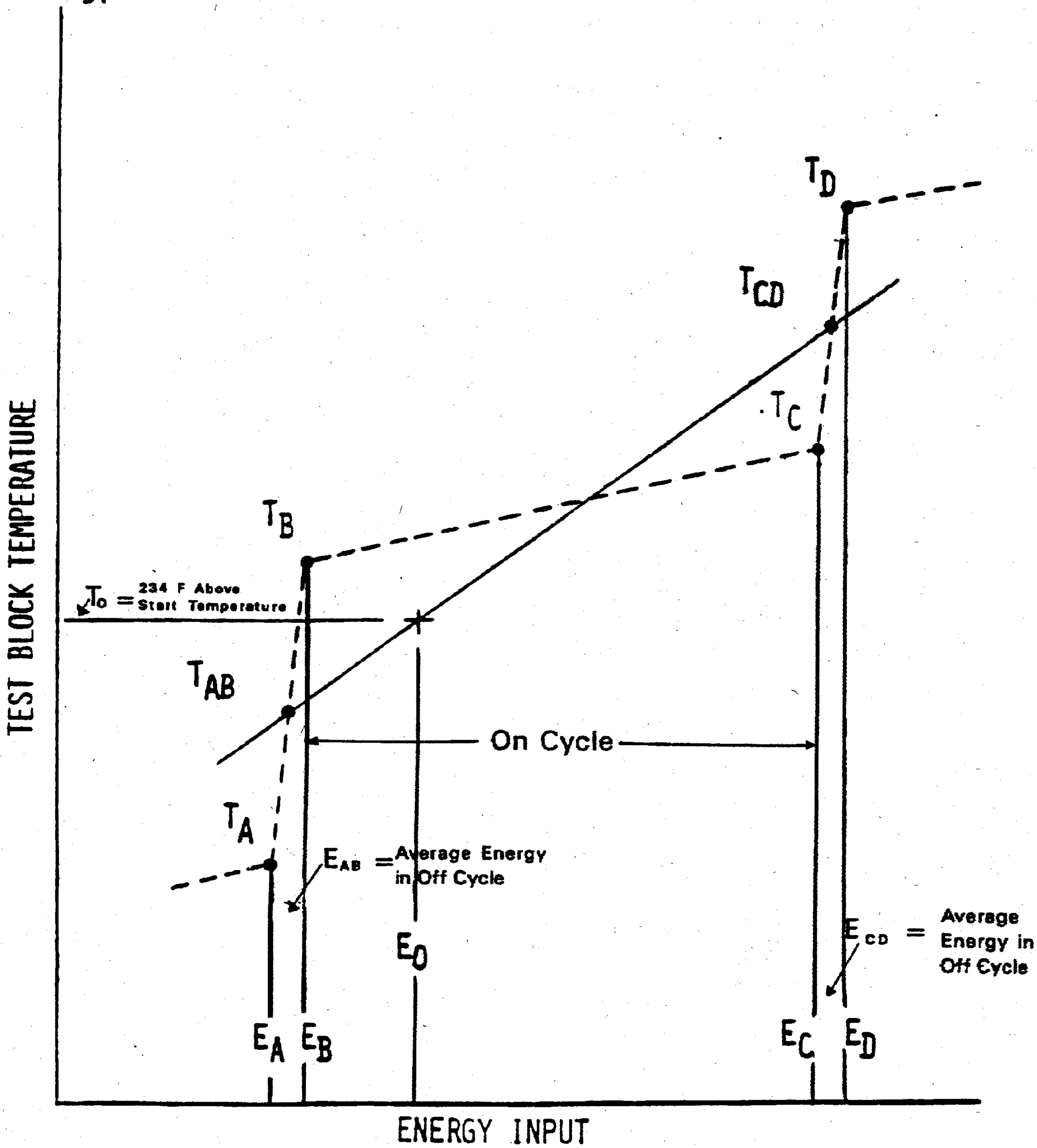
5. ILLUSTRATION OF CONVENTIONAL OVEN TEST DATA



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Where:

O_M = 77.3 kWh, annual useful cooking energy output.

E_{MO} = annual total energy consumption as determined in section 4.4.3.

6. Appendix J to subpart B of part 430 is revised to read as follows:

Appendix J to Subpart B of Part 430—Uniform Test Method for Measuring the Energy Consumption of Automatic and Semi-Automatic Clothes Washers

1. Definitions

1.1 *Agitator* means the device that provides the shaking or stirring motion to the clothes for washing. The device shall include all fixtures and other essential assemblies needed for clothes washing in the normal cycle.

1.2 *Bone-dry* means a condition or a load of test cloth which has been dried in a dryer at maximum temperature for a minimum of 10 minutes, removed and weighed before cool down, and then dried again for 10-minute periods until the final weight change of the load is 1 percent or less.

1.3 *Clothes container* means the compartment within the clothes washer that holds the clothes during operation of the machine.

1.4 *Compact* refers to a clothes washer which has a clothes container capacity of less than 1.6 ft^3 (45 L).

1.5 *Deep rinse cycle* refers to a rinse cycle in which the clothes container is filled with water to a selected level and the clothes load is rinsed by agitating it or tumbling it through the water.

1.6 *Front-loader* means a clothes washer which sequentially rotates or tumbles portions of the clothes load above the water level allowing the clothes load to fall freely back into the water. The principal axis of the clothes container is in a horizontal plane and the access to the clothes container is through the front of the machine.

1.7 *Machine-controlled water fill capability* means a clothes washer which has the capability of automatically controlling the level of the water in the tub dependent upon the size of the test load, without operator intervention.

1.8 *Make-up water* means the amount of fresh water needed to supplement the amount of stored water pumped from the external laundry tub back into the clothes washer when the suds-return feature is activated in order to achieve the required water fill level in the clothes washer.

1.9 *Modified energy factor* means the quotient of the cubic foot (liter) capacity of the clothes container divided by the total clothes washer energy consumption per cycle, expressed as the sum of the machine electrical energy consumption, the hot water energy consumption, and the energy required for removal of remaining moisture of the test load for nonwater-heating clothes washers and expressed as the sum of the machine electrical energy consumption and the energy required for removal of moisture of the test load for water-heating clothes washers.

1.10 *Moisture removal energy* means the nominal energy required for a clothes dryer to remove moisture from clothes multiplied by the difference between weighted test load after the normal cycles and the weighted reference (bone-dry) weight of the test load.

1.11 *Nonwater-heating clothes washer* refers to a clothes washer that has both hot and cold water supply pipe connections. This type of clothes washer does not have an internal hot water heater device to generate the energy needed to heat inlet water.

1.12 *Normal cycle* means the cycle recommended by the manufacturer for washing cotton and/or linen clothes.

1.13 *Sensor filled* refers to a type of water fill control which automatically terminates the fill when the water reaches an appropriate level in the tub.

1.14 *Spray rinse cycle* refers to a rinse cycle in which water is sprayed onto the clothes load for a definite period of time without maintaining any specific water level in the clothes container.

1. *Standard* refers to a clothes washer which has a clothes container capacity of 1.6 ft^3 (45 L) or greater.

1.16 *Suds-return* means a feature or option on a clothes washer which causes the stored wash water obtained by utilizing the suds-saver feature to be pumped from the external laundry tub back into the clothes washer.

1.17 *Suds-saver* means a feature or option on a clothes washer which allows the user to store used wash water in an external laundry tub for use with subsequent wash loads.

1.18 *Temperature use factor* means the percentage of the total number of washes a user would wash with a particular wash/rinse temperature setting.

1.19 *Thermostatically controlled valves* refer to clothes washer valves which sense water temperature and adjust valve orifices appropriately to maintain a desired mixed water temperature.

1.20 *Time filled* refers to a type of water fill control which uses a combination of water flow controls in conjunction with time to terminate the water fill cycle.

1.21 *Top-loader-horizontal-axis clothes washer* means a clothes washer which sequentially rotates or tumbles portions of the clothes load above the water level allowing the clothes load to fall freely back into the water. The principal axis of the clothes container is in a horizontal plane and the access to the clothes container is through the top of the clothes washer.

1.22 *Top-loader-vertical-axis clothes washer* means a clothes washer that flexes and oscillates the submerged clothes load through the water by means of mechanical agitation or other movement. The principal axis of the clothes container is in a vertical plane and the access to the clothes container is through the top of the clothes washer.

1.23 *Water consumption factor* means the quotient of the cubic foot (liter) capacity of the clothes washer divided by the total weighted per-cycle water consumption.

1.24 *Water-heating clothes washer* refers to a clothes washer which does not have a supply pipe connection for hot water. This type of clothes washer does have an internal electrical water heating device to generate the energy needed to heat inlet water.

2. Testing Conditions

2.1 *Installation.* Install the clothes washer in accordance with manufacturer's instructions.

2.2 *Electrical energy supply.* Maintain the electrical supply at the clothes washer terminal block within 2 percent of 120/240 or 120/208Y as applicable to the particular terminal block wiring system as specified by the manufacturer. If the clothes washer has a dual voltage conversion capability, conduct the test at the highest voltage specified by the manufacturer.

2.3 *Water temperature.* For nonwater-heating clothes washers not equipped with thermostatically controlled inlet water valves, the temperature of the hot and cold water supply shall be maintained at 100°F ±10°F (37.8°C±5.5°C). For nonwater-heating clothes washers equipped with thermostatic controlled inlet valves, the temperature of the hot water supply shall be maintained at 140°F±5°F (60.0°C±2.8°C) and the cold water supply shall be maintained at 60°F±5°F (15.6°C±2.8°C). For water-heating clothes washers that have infinite or various temperature selection feature, the temperature of the water supply shall be maintained at a minimum of 55°F (12.8°C) and a maximum of 60°F (15.6°C). Water meters shall be installed in both the hot and cold water lines to measure water consumption.

2.4 *Water pressure.* The static water pressure at the hot and cold water inlet connections of the machine shall be maintained during the test at 35 pounds per square inch gauge (psig)±2.5 psig (241.3 kPa±17.2 Kpa). The static water pressure for a single water inlet connection shall be maintained during the test at 35 psig±2.5 psig (241.3 Kpa±17.2 kPa). Water pressure gauges shall be installed in both the hot and cold water lines to measure water pressure.

2.5 *Instrumentation.* Perform all test measurements using the following instruments, as appropriate:

2.5. *Weighing scales.*

2.5.1.1 *Weighing scale for test cloth.* The scale shall have a range of 0 lbs (0 kg) to a maximum of 30 lbs (13.6 kg) with a resolution of at least 0.2 oz (5.7 g) and a maximum error no greater than 0.3 percent of any measured value within the range of 3 lbs (1.4 kg) to 15 lbs (6.8 kg).

2.5.1.2 *Weighing scale for clothes container capacity measurements.* The scale should have a range of 0 lbs (0 kg) to a maximum of 500 lbs (226.8 kg) with a resolution of 0.50 lbs (0.23 kg) and a maximum error no greater than 0.5 percent of the measured value.

2.5.2 *Watt-hour meter.* The watt-hour meter shall have a resolution of at least 1 Wh (3.6 kJ) and a maximum error no greater than 2 percent of the measured value for any demand greater than 50 Wh (180.0 kJ).

2.5.3 *Temperature sensing device.* The temperature sensing device shall have an error no greater than ±1°F (±0.6°C) over the range of 32°F (0°C) to 200°F (93.3°C).

2.5.4 *Water meter.* The water meter shall have a resolution no larger than 0.1 gallons (0.4 liters) and a maximum error no greater than 2 percent for all water flow rates from 1 gal/min (3.8 L/min) to 5 gal/min (18.9 L/min).

2.5.5 *Water pressure gauge.* The water pressure gauge shall have a resolution of 1 psig (6.9 kPa) and shall have an error no greater than 5 percent of any measured value over the range of 32.5 psig (224.1 kPa) to 37.5 psig (258.6 kPa).

2.6 *Test cloths.*

2.6.1 *Energy test cloth.* The energy test cloth shall be clean and consist of the following:

2.6.1.2 *Pure finished bleached cloth.* Pure finished bleached cloth, made with a momie or granite weave, which is 50 percent cotton and 50 percent polyester and weighs 5.75 oz/yd^2 (195.0 g/m^2) and has 65 ends on the warp and 57 picks on the fill.

2.6.1.3 *Cloth material.* Cloth material that is 24 in by 36 in (61.0 cm by 91.4 cm) and has been hemmed to 22 in by 34 in (55.9 cm by 86.4 cm) before washing. The maximum shrinkage after five washes shall not be more than four percent on the length and width.

2.6.1.4 *Number of tests.* The number of test runs on the same energy test cloth shall not exceed 25 runs.

2.6.2 *Energy stuffier cloths.* The energy stuffier cloths shall be made from energy test cloth material and shall consist of pieces of material that are 12 in by 12 in (30.5 cm by 30.5 cm) and have been hemmed to 10 in by 10 in (25.4 cm by 25.4 cm) before washing. The maximum shrinkage after five washes shall not be more than four percent on the length and width. The number of test runs on the same energy stuffier cloth shall not exceed 25 runs.

2.7 *Composition of test loads.*

2.7.1 *Seven pound test load.* The seven pound test load shall consist of bone-dry energy test cloths which weigh 7±0.07 lbs (3.18±0.03 kg). Adjustments to the test load to achieve the proper weight can be made by the use of energy stuffier cloths.

2.7.2 *Three pound test load.* The three pound test load shall consist of bone-dry energy test cloths which weigh 3±0.03 lbs (1.36±0.014 kg). Adjustments to the test load to achieve the proper weight can be made by the use of energy stuffier cloths.

2.8 *Use of test loads.*

2.8.1 *Top-loader-vertical-axis clothes washers for calculating energy factor.* The top-loader clothes washer shall be tested without a test load, except for clothes washers equipped with machine controlled water fill capability. Machine controlled water fill capable clothes washers shall use a test load per section 2.8.2.

2.8.2 *Front-loader, top-loader-horizontal-axis, top-loader-vertical-axis with machine-controlled water fill capable and top-loader-vertical-axis for calculating modified energy factor, clothes washers.*

2.8.2.1 *Standard size clothes washer.* When the maximum water fill level is being tested, the test load shall be seven pounds as described in section 2.7.1. When the minimum water fill level is being tested, the test load shall be three pounds as described in section 2.7.2.

2.8.2.2 *Compact size clothes washer.* When either the maximum or minimum water fill levels are being tested, the test load shall be as described in section 2.7.2.

2.8.3 *Method of loading.* Load the energy test clothes by grasping them in the center, shaking them to hang loosely and then dropping them into the clothes container prior to activating the clothes washer.

2.9 *Preconditioning.* If the clothes washer has not previously been tested nor filled with water in the preceding 96 hours, precondition it by running it through a cold rinse cycle and then draining it to insure that the hose, pump, and sump are filled with water.

2.10 *Wash time setting.* The actual wash time (period of agitation) shall be not less than 9.75 minutes.

2.11 *Agitator and spin speed settings.* Where controls are provided for agitation and spin speed selections, set them at the normal cycle settings. If settings at the normal cycle are not offered, set the control settings to the maximum levels permitted on the clothes washer.

3. Test Measurements

3.1 *Clothes container capacity.* Measure the entire volume which a dry clothes load could occupy within the clothes container, according to sections 3.1.1 and 3.1.2.

3.1.1 *Top-loader-vertical-axis clothes washer.* Line the clothes container and agitator with 2 mil (0.051 mm) plastic sheet or use some other method to prevent the water from entering the outer tub container and into the agitator. The agitator shall be in place. Fill the clothes container with water to its uppermost edge. (This filling procedure may require overriding of the fill level control, or manually completing the fill to the top of the container after the fill sensor terminates the fill at maximum level.) Record the weight of the machine before filling it with water and then after filling it with water. The clothes container capacity is calculated as follows:

$$C = \frac{W}{\rho}$$

Where:

C = capacity in cubic feet (liters).
W = mass of water in pounds (kilograms).
ρ = density of water at the measured temperature in pounds per cubic foot (kilograms per liter).

3.1.2 *Front-loader and top-loader-horizontal-axis clothes washer.* For front-loader-horizontal-axis clothes washers, position the tub and shaft axis vertically with the tub facing up. For top-loader-horizontal-axis clothes washers, position the washer in its upright position and the centerline of the inner door at the top position. Line the clothes container with 2 mil (0.051 mm) plastic sheet or use some other method to prevent the water from entering the outer tub container. Fill the clothes container with water to its uppermost edge. (This filling procedure may require overriding of the fill level control, or manually completing the fill to the top of the container after the fill sensor terminates the fill at maximum level.) Record the weight of the machine before filling it with water and then after filling it with water. The clothes container capacity is calculated as follows:

$$C = \frac{W}{\rho}$$

Where:

C = capacity in cubic feet (liters).
W = mass of water in pounds (kilograms).
ρ = density of water at the measured temperature in pounds per cubic foot (kilograms per liter).

3.2 *Test cycle.* Establish the test conditions set forth in section 2 of this appendix. Automatic and semi-automatic clothes washers that have infinite or various temperature selection features that do not conform to the wash/rinse temperature combination settings of sections 5 or 6 shall be tested at the following temperature settings: Hottest setting available on the machine, hot (a minimum of 140°F (60.0°C) and a maximum of 145°F (62.8°C)), warm (a minimum of 100°F (37.8°C) and a maximum of 105°F (40.6°C)), and coldest setting available on the machine.

3.2.1 *Nonwater-heating clothes washers.*

3.2.1.1 *Per-cycle electrical energy consumption.* Set the water level selector at maximum fill available on the clothes washer and insert the appropriate test load, if applicable. Activate the normal cycle of the clothes washer and also any suds-saver switch.

3.2.1.1.1 Measure the electrical energy consumption of the clothes washer for the complete normal cycle.

3.2.1.2 *Hot and cold water consumption with the water level selector at maximum fill available on the clothes washer, if manually controlled.*

3.2.1.2.1 Set the water level selector at maximum fill available on the clothes washer and insert the appropriate test load. Activate the normal cycle of the clothes washer and also any suds-saver switch.

3.2.1.2.2 For automatic clothes washers, set the wash/rinse temperature selector to the hottest TUF combination setting. For semi-automatic clothes washers, open the hot water faucet valve completely and close the cold water faucet valve completely to achieve the hottest TUF combination setting.

3.2.1.2.3 Measure the respective number of gallons (liters) of hot and cold water used to fill the tub for the wash cycle.

3.2.1.2.4 Measure the respective number of gallons (liters) of hot and cold water used for all deep rinse cycles.

3.2.1.2.5 Measure the respective gallons (liters) of hot and cold water used for all spray rinse cycles.

3.2.1.2.6 For automatic clothes washers repeat sections 3.2.1.2.3, 3.2.1.2.4, and 3.2.1.2.5 for each of the other wash/rinse temperature selections available that use hot water. For semi-automatic clothes washers repeat sections 3.2.1.2.3, 3.2.1.2.4, and 3.2.1.2.5 for the TUFs in section 6 with the following water faucet valve adjustments:

	Faucet position	
	Hot valve	Cold valve
Hot	Completely open.	Closed.

	Faucet position	
	Hot valve	Cold valve
Warm	Completely open.	Completely open.
Cold	Closed	Completely open.

3.2.1.2.7 Set the suds-saver switch to activate the suds-return. Repeat sections 3.2.1.2.3 to 3.2.1.2.5 for a Warm/Cold temperature setting.

3.2.1.3 *Hot and cold water consumption with the water level selector at minimum fill.* Set the water level selector at minimum fill and insert the appropriate test load. Activate the normal cycle of the clothes washer and also any suds-saver switch. Repeat sections 3.2.1.2.2 through 3.2.1.2.7.

3.2.1.4 *Hot and cold water consumption for clothes washers that incorporate a partial fill during the rinse cycle.* When sections 3.2.1.2 and 3.2.1.3 cannot be used for clothes washers that incorporate a partial fill during the rinse cycle, activate any suds-saver switch and operate the clothes washer for the complete normal cycle at both the maximum water fill level and the minimum water fill level for each of the wash/rinse temperature selections available. Measure the respective hot and cold water consumed during the complete normal cycle.

3.2.2 *Water-heating clothes washers.* For water-heating clothes washers the following temperature settings will be tested: hottest setting available on the machine, hot (a minimum of 140°F (60.0°C) and a maximum of 145°F (62.8°C)), warm (a minimum of 100°F (37.8°C) and a maximum of 105°F (40.6°C)), and coldest setting available on the machine. These temperature must be confirmed by measurement using a temperature sensing device.

3.2.2.1 *Per-cycle electrical energy consumption at maximum fill.* Set the water level selector at maximum fill available on the clothes washer, if manually controlled.

3.2.2.1.1 *Hottest wash at maximum fill.* Activate the machine and insert the appropriate test load, if applicable. Select the normal or its equivalent wash cycle. Where spin speed selection is available, set the control to its maximum setting. Set the water temperature selector to the hottest setting and activate the wash cycle. Measure and record the kilowatt-hours of electrical energy consumed for the complete cycle as $E_{ht,max}$.

3.2.2.1.2 *Hot wash at maximum fill.* Insert a water temperature sensing device inside the inner drum prior to testing. Activate the machine and insert the appropriate test load, if applicable. Select the normal or its equivalent wash cycle. Where spin speed selection is available, set the control to its maximum setting. Set the water temperature selector to the hot setting (a minimum of 140°F (60.0°C) and a maximum of 145°F (62.8°C)) and activate the wash cycle. Verify the wash water temperature, which must be at a minimum of 140°F (60.0°C) and a maximum of 145°F (62.8°C). If the measured water temperature is not within the specified range, stop testing, adjust the temperature selector accordingly and repeat the procedure. Otherwise, proceed and complete testing. Measure and record the kilowatt-hours of electrical energy consumed for the complete cycle as $E_{h,max}$.

3.2.2.1.3 *Warm wash at maximum fill.* Repeat section 3.2.2.1.2 for a warm wash setting at a minimum of 100°F (37.8°C) and a maximum of 105°F (40.6°C). Measure and record the kilowatt-hours of electrical energy consumed for the complete cycle as $E_{w,max}$.

3.2.2.1.4 *Cold wash at maximum fill.* Repeat section 3.2.2.1.1 for the coldest water setting. Measure and record the kilowatt-hours of electrical energy consumed for the complete cycle as $E_{c,max}$. Ensure that the inlet water temperature is maintained per section 2.3.

3.2.2.2 *Per-cycle water consumption at maximum fill.* Measure the total number of gallons (liters) of water used in sections 3.2.2.1.1, 3.2.2.1.2, 3.2.2.1.3, and 3.2.2.1.4, including all wash, deep rinse, and spray rinse cycles as V_{htmax}, $V_{h,max}$, $V_{w,max}$, and $V_{c,max}$.

3.2.2.3 *Per-cycle electrical energy consumption at minimum fill.* Set the water level selector to the minimum fill position, if manually controlled.

3.2.2.3.1 *Hottest wash at minimum fill.* Repeat section 3.2.2.1.1. Measure and record the kilowatt-hours of electrical energy consumed for the complete cycle as $E_{ht,min}$.

3.2.2.3.2 *Hot wash at minimum fill.* Repeat section 3.2.2.1.2. The hot wash setting shall be at a minimum of 140°F (60.0°C) and a maximum of 145°F (62.8°C). Measure and record the kilowatt-hours of electrical energy consumed for the complete cycle as $E_{h,min}$.

3.2.2.3.3 *Warm wash at minimum fill.* Repeat section 3.2.2.1.2 for warm wash setting at a minimum of 100°F (37.8°C) and a maximum of 105°F (40.6°C). Measure and record the kilowatt-hours of electrical energy consumed for the complete cycle as $E_{w,min}$.

3.2.2.3.4 *Cold wash at minimum fill.* Repeat section 3.2.2.1.1 for the coldest wash setting. Measure and record the kilowatt-hours of electrical energy consumed for the complete cycle as $E_{c,min}$. Ensure that the inlet water temperature is maintained per section 2.3.

3.2.2.4 *Per-cycle water consumption at minimum fill.* Measure the total number of gallons (liters) of water used in sections 3.2.2.3.1, 3.2.2.3.2, 3.2.2.3.3, and 3.2.2.3.4, including all wash, deep rinse, and spray rinse cycles.

3.3 *Moisture content of test load.* Weigh the test loads after completion of test cycles in warm wash/cold rinse or cold wash/cold rinse temperature setting for both maximum and minimum water fills.

3.4 *Data recording.* Record for each test cycle in sections 3.2.1 through 3.3.

3.4.1 *Nonwater-heating clothes washers.*

3.4.1.1 Record the kilowatt-hours of electrical energy, M_E, consumed during the test to operate the clothes washer in section 3.2.1.1.

3.4.1.2 Record the individual gallons (liters) of hot and cold water consumption, Vh_i and Vc_i, measured at maximum fill level for each wash/rinse TUF combination setting in section 3.2.1.2, excluding any fresh make-up water required to complete the fill during a suds-return cycle.

3.4.1.3 Record the individual gallons (liters) of hot and cold water consumption, Vh_j and Vc_j, measured at minimum fill level for each wash/rinse TUF combination setting in section 3.2.1.3, excluding any fresh make-up water required to complete the fill during a suds-return cycle.

3.4.1.4 Record the individual gallons (liters) of hot and cold water, Sh_H and Sc_H, measured at maximum fill for the suds-return cycle.

3.4.1.5 Record the individual gallons (liters) of hot and cold water, Sh_L and Sc_L, measured at minimum fill for the suds-return cycle.

3.4.2 *Water-heating clothes washers.*

3.4.2.1 Record the kilowatt-hours of electrical energy E_{htmax}, $E_{h,max}$, $E_{w,max}$, and $E_{c,max}$ consumed at maximum fill level for each wash/rinse TUF combination setting in sections 3.2.2.1.1, 3.2.2.1.2, 3.2.2.1.3, and 3.2.2.1.4, respectively.

3.4.2.2 Record the total gallons (liters) of water consumption, V_{htmax}, $V_{h,max}$, $V_{w,max}$, and $V_{c,max}$, measured at maximum fill level for each wash/rinse TUF combination setting in section 3.2.2.2.

3.4.2.3 Record the kilowatt-hours of electrical energy, E_{htmin}, $E_{h,min}$, $E_{w,min}$, and $E_{c,min}$ consumed at minimum fill level for each wash/rinse TUF combination setting in section 3.2.2.3.1, 3.2.2.3.2, 3.2.2.3.3, and 3.2.2.3.4, respectively.

3.4.2.4 Record the total gallons (liters) of water consumption, V_{htmin}, $V_{h,min}$, $V_{w,min}$, and $V_{c,min}$, measured at minimum fill level for each wash/rinse TUF combination setting in section 3.2.2.4.

3.4.3 Record the weight of the test loads, W_{max} and W_{min}, after completion of test cycles in section 3.3.

4. Calculation of Derived Results From Test Measurements

4.1 *Energy consumption.*

4.1.1 *Nonwater-heating clothes washers.*

4.1.1.1 *Per-cycle temperature-weighted hot water consumption for maximum and minimum water fill levels.* Calculate for the cycle under test the per-cycle temperature weighted hot water consumption for the maximum water fill level, Vh_{max}, and for the minimum water fill level, Vh_{min}, expressed in gallons per cycle (liters per cycle) and defined as:

$$Vh_{max} = X_1 \sum_{i=1}^{n} \left[Vh_i \times TUF_i \right] + X_2 \left[TUF_W \times Sh_H \right]$$

Where:

Vh_i = reported hot water consumption in gallons per cycle (liters per cycle) at maximum fill for each wash/cycle TUF combination setting, as provided in section 3.4.1.2. (If a clothes washer is equipped with two different wash/rinse temperature selections that have the same basic TUF label (one of them has its water temperature controlled by thermostatically controlled valves and the other one does not), then the higher of the two V_i's shall be used for the calculation.)

TUF_i = applicable temperature use factor in section 5 or 6.

n = number of wash/rinse TUF combination setting available to the user for the clothes washer under test.
TUF_w = temperature use factor for warm wash setting.

For clothes washers equipped with the suds-saver feature:

X_1 = frequency of use without the suds-saver feature = 0.86.
X_2 = frequency of use with the suds-saver feature = 0.14.
Sh_H = fresh make-up water measured during suds-return cycle at maximum water fill level.

For clothes washers not equipped with the suds-saver feature:

$$X_1 = 1.0$$

$$X_2 = 0.0$$

and

$$Vh_{min} = X_1 \sum_{j=1}^{n} \left[Vh_j \times TUF_j \right] + X_2 \left[TUF_W \times Sh_L \right]$$

Where:

Vh_j = reported hot water consumption in gallons per cycle (liters per cycle) at minimum fill for each wash/rinse TUF combination setting, as provided in section 3.4.1.3. (If a clothes washer is equipped with two different wash/rinse temperature selections that have the same basic TUF label (one of them has its water temperature controlled by thermostatically controlled valves and the other one does not), then the higher of the two V_j's shall be used for the calculation.)
TUF_j = applicable temperature use factor in section 5 or 6.
Sh_L = fresh hot make-up water measured during suds-return cycle at minimum water fill level.
n = as defined above.
TUF_w = as defined above.
X_1 = as defined above.
X_2 = as defined above.

4.1.1.2 *Total per-cycle hot water energy consumption for maximum and minimum water fill levels.* Calculate the total per-cycle hot water energy consumption for the maximum water fill level, E_{max} and for the minimum water level, E_{min}, expressed in kilowatt-hours per cycle and defined as:

$$E_{max} = \left[Vh_{max} \times T \times K \times MF \right]$$

Where:

T = temperature rise = 90°F (50°C).
K = water specific heat = 0.00240 kWh/(gal·°F) [0.00114 kWh/(L·°C)].
Vh_{max} = as defined in section 4.1.1.1.
MF = multiplying factor to account for absence of test load=0.94 for top-loader vertical axis clothes washers that are sensor filled, 1.0 for all other clothes washers

and:

$$E_{min} = \left[Vh_{min} \times T \times K \times MF \right]$$

Where:

T = as defined above.
K = as defined above.
Vh_{min} = as defined in section 4.1.1.1.
MF = as defined in section 4.1.1.2.

4.1.1.3 *Total weighted per-cycle hot water energy consumption expressed in kilowatt-hours.* Calculate the total weighted per cycle hot water energy consumption, E_T, expressed in kilowatt-hours per cycle and defined as:

$$E_T = \left[E_{max} \times F_{max} \right] + \left[E_{min} \times F_{min} \right]$$

Where:

F_{max}=usage fill factor=0.72
F_{min}=usage fill factor=0.28
E_{max}=as defined in section 4.1.1.2.
E_{min}=as defined in section 4.1.1.2.

4.1.1.4 *Per-cycle machine electrical energy consumption.* The value recorded in section 3.4.1.1 is the per-cycle machine electrical energy consumption, M_E, expressed in kilowatt-hours per cycle.

4.1.1.5 *Per-cycle water energy consumption using gas-heated or oil-heated water.* Calculate for the normal cycle the per-cycle water consumption, E_{TG}, using gas heated or oil-heated water, expressed in BTU per cycle (megajoules per cycle) and defined as:

$$E_{TG} = E_T \times \frac{1}{e} \times \left[\frac{3412\ BTU}{kWh} \right]$$

$$\text{or } E_{TG} = E_T \times \frac{1}{e} \times \left[\frac{3.6\ MJ}{kWh} \right]$$

Where:

e = nominal gas or oil water heater efficiency=0.75.
E_T = as defined in section 4.1.1.3.

4.1.1.6 *Total per-cycle energy consumption when electrically heated water is used.* Calculate for the normal cycle the total per-cycle energy consumption, E_{TE}, using electrically heated water, expressed in kilowatt-hours per cycle and defined as:

$E_{TE}=E_T+M_E$

Where:

E_T = as defined in section 4.1.1.3
M_E = as defined in section 4.1.1.4.

4.1.2 *Water-heating clothes washers.*

4.1.2.1 *Per-cycle temperature-weighted energy consumption for maximum and minimum water fill levels.* Calculate for the cycle under test the per-cycle temperature weighted energy consumption for the maximum water fill level, E_{max}, and for the minimum water fill level, E_{min}, expressed in kilowatt-hours per cycle and defined as:

$$E_{max} = \left(0.05 \times E_{ht,max}\right) + \left(0.25 \times E_{h,max}\right) + \left(0.55 \times E_{w,max}\right) + \left(0.15 \times E_{c,max}\right)$$

and,

$$E_{min} = \left(0.05 \times E_{ht,min}\right) + \left(0.25 \times E_{h,min}\right) + \left(0.55 \times E_{w,min}\right) + \left(0.15 \times E_{c,min}\right)$$

Where:

$E_{ht,max}$ = as defined in section 3.2.2.1.1
$E_{h,max}$ = as defined in section 3.2.2.1.2
$E_{w,max}$ = as defined in section 3.2.2.1.3
$E_{c,max}$ = as defined in section 3.2.2.1.4
$E_{ht,min}$ = as defined in section 3.2.2.3.1
$E_{h,min}$ = as defined in section 3.2.2.3.2
$E_{w,min}$ = as defined in section 3.2.2.3.3
$E_{c,min}$ = as defined in section 3.2.2.3.4

4.1.2.2 *Total weighted per-cycle energy consumption expressed in kilowatt-hours.* Calculate the total weighted per cycle energy consumption, E_T, expressed in kilowatt-hours per cycle and defined as:

$$E_T = \left[E_{max} \times F_{max} \right] + \left[E_{min} \times F_{min} \right]$$

Where:

F_{max} = as defined in section 4.1.1.3.
F_{min} = as defined in section 4.1.1.3.
E_{max} = as defined in section 4.1.2.1.
E_{min} = as defined in section 4.1.2.1

4.2 *Per-cycle energy consumption for removal of moisture from test load.* Calculate the per-cycle energy required to remove the moisture of the test load, moisture removal energy, H_V, expressed in kilowatt-hours per cycle and defined as:

$$H_V = \left(W_2 - W_1\right) \times D_{EF}$$

Where:

W_2 = Weighted test load after normal cycles, in lbs (kg).
= $[(W_{max} \times F_{max})+(W_{min} \times F_{min})]$.
W_{max} = as defined in section 3.4.3.
W_{min} = as defined in section 3.4.3.
F_{max} = as defined in section 4.1.1.3.
F_{min} = as defined in section 4.1.1.3.
W_1 = weighted reference weight (bone dry) of test load.
= 5.88 lbs (2.42 kg) for standard size clothes washers.
= 3 lbs (1.36 kg) for compact size clothes washers.
D_{EF} = nominal energy required for a clothes dryer to remove moisture from clothes, 0.5 kWh/lbs (1.1 kWh/kg).

4.3 *Water consumption.*

4.3.1 *Nonwater-heating clothes washers.*

4.3.1.1 *Per-cycle temperature-weighted water consumption for maximum and minimum water fill levels.* Calculate for the cycle under test the per-cycle temperature-weighted total water consumption for the maximum water fill level, Q_{max}, and for the minimum water fill level, Q_{min}, expressed in gallons per cycle (liters per cycle) and defined as:

$$Q_{max} = X_1 \sum_{i=1}^{n} \left[\left(Vh_i + Vc_i\right) \times TUF_i \right] + X_2 \left[TUF_W \times \left(Sh_H + Sc_H\right) \right]$$

Where:

Vh_i = hot water consumption in gallons per-cycle at maximum fill for each wash/rinse TUF combination setting, as provided in section 3.4.1.2.
Vc_i = cold water consumption in gallons per-cycle at maximum fill for each wash/rinse TUF combination setting, as provided in section 3.4.1.2.
TUF_i = applicable temperature use factor in section 5 or 6.
n = number of wash/rinse TUF combination settings available to the user for the clothes washer under test.
TUF_w = temperature use factor for warm wash setting.

For clothes washers equipped with suds-saver feature:

X_1 = frequency of use without suds-saver feature=0.86
X_2 = frequency of use with suds-saver feature=0.14
Sh_H = fresh hot water make-up measured during suds-return cycle at maximum water fill level.
Sc_H = fresh cold water make-up measured during suds-return cycle at maximum water fill level.

For clothes washers not equipped with suds-saver feature:

$$X_1 = 1.0$$
$$X_2 = 0.0$$

and

$$Q_{min} = X_1 \sum_{j=1}^{n} \left[\left(Vh_j + Vc_j \right) \times TUF_j \right] + X_2 \left[TUF_w \times \left(Sh_L + SC_L \right) \right]$$

Where:

Vh_j = hot water consumption in gallons per cycle (liters per cycle) at minimum fill for each wash/rinse TUF combination setting, as provided in section 3.4.1.3.
Vc_j = cold water consumption in gallons per cycle (liters per cycle) at minimum fill for each wash/rinse TUF combination setting, as provided in section 3.4.1.3.
TUF_j = applicable temperature use factor in section 5 or 6.
Sh_L = fresh hot and cold make-up water measured during suds-return cycle at minimum water fill level.
Sc_L = fresh hot and cold make-up water measured during suds-return cycle at minimum water fill level.
n = as defined in section 4.3.1.1.
TUF_w = as defined in section 4.3.1.1.
X_1 = as defined in section 4.3.1.1.
X_2 = as defined in section 4.3.1.1.

4.3.1.2 *Total weighted per-cycle water consumption.* Calculate the total weighted per cycle water consumption, Q_T, expressed in gallons per cycle (liters per cycle) and defined as:

$$Q_T = \left[Q_{max} \times F_{max} \right] + \left[Q_{min} \times F_{min} \right]$$

Where:

F_{max} = as defined in section 4.1.1.3.
F_{min} = as defined in section 4.1.1.3.
Q_{max} = as defined in section 4.3.1.1.
Q_{min} = as defined in section 4.3.1.1.

4.3.2 *Water-heating clothes washers.*

4.3.2.1 *Per-cycle temperature-weighted water consumption for maximum and minimum water fill levels.* Calculate for the cycle under test the per-cycle temperature weighted total water consumption for the maximum water fill level, Q_{max}, and for the minimum water fill level, Q_{min}, expressed in gallons per cycle (liters per cycle) and defined as:

$$Q_{max} = \left(0.05 \times V_{ht,max}\right) + \left(0.25 \times V_{h,max}\right) + \left(0.55 \times V_{w,max}\right) + \left(0.15 \times V_{c,max}\right)$$

and,

$$Q_{min} = \left(0.05 \times V_{ht,min}\right) + \left(0.25 \times V_{h,min}\right) + \left(0.55 \times V_{w,min}\right) + \left(0.15 \times V_{c,min}\right)$$

Where:

$V_{ht,max}$ = as defined in section 3.2.2.2.
$V_{h,max}$ = as defined in section 3.2.2.2.
$V_{w,max}$ = as defined in section 3.2.2.2.
$V_{c,max}$ = as defined in section 3.2.2.2.
$V_{ht,min}$ = as defined in section 3.2.2.4.
$V_{h,min}$ = as defined in section 3.2.2.4.
$V_{w,min}$ = as defined in section 3.2.2.4.
$V_{c,min}$ = as defined in section 3.2.2.4.

4.3.2.2 *Total weighted per-cycle water consumption.* Calculate the total weighted per cycle water consumption, Q_T, expressed in gallons per cycle (liters per cycle) and defined as:

$$Q_T = \left[Q_{max} \times F_{max} \right] + \left[Q_{min} \times F_{min} \right]$$

Where:

F_{max} = as defined in section 4.1.1.3.
F_{min} = as defined in section 4.1.1.3.
Q_{max} = as defined in section 4.3.2.1.
Q_{min} = as defined in section 4.3.2.1.

4.3.3 *Water consumption factor.* Calculate the water consumption factor, WCF, expressed in cubic feet per gallon per cycle (liter per liter per cycle), as:

$$WCF = \frac{C}{Q_T}$$

Where:

C = as defined in section 3.1.1 or 3.1.2.
Q_T = as defined in section 4.3.1.2 for nonwater-heating clothes washers.

4.4 *Modified energy factor.*

4.4.1 *Nonwater-heating clothes washers.* Calculate the modified energy factor, MEF, expressed in cubic feet per kilowatt-hours per cycle (liters per kilowatt-hours per cycle), as:

$$MEF = \frac{C}{\left(M_E + E_T + H_V\right)}$$

Where:

C = as defined in section 3.1.1 or 3.1.2.
M_E = as defined in section 4.1.1.4.
E_T = as defined in section 4.1.1.3.
H_V = as defined in section 4.2.

4.4.2 *Water-heating clothes washers.* Calculate the modified energy factor, MEF, expressed in cubic feet per kilowatt-hours per cycle (liters per kilowatt-hours per cycle), as:

$$MEF = \frac{C}{\left(E_T + H_V\right)}$$

Where:

C = as defined in section 3.1.1 or 3.1.2.
E_T = as defined in section 4.1.2.2.
H_V = as defined in section 4.2.

5. Applicable Temperature Use Factors for Determining Hot Water Usage for Various Wash/Rinse Temperature Selections for All Automatic Clothes Washers

5.1 *Five-temperature selection (n=5).*

Wash/rinse temperature setting	Temperature use factor (TUF)
Hot/Warm	0.18
Hot/Cold	.12
Warm/Warm	.30
Warm/Cold	.25
Cold/Cold	.15

5.2 *Four-temperature selection (n=4).*

Wash/rinse temperature setting	Temperature use factor (TUF)
Alternate I:	
Hot/Warm	0.18
Hot/Cold	.12
Warm/Cold	.55
Cold/Cold	.15
Alternate II:	
Hot/Warm	0.18
Hot/Cold	.12
Warm/Warm	.30
Warm/Cold	.40
Alternate III:	
Hot/Cold	0.12
Warm/Warm	.18
Warm/Cold	.55
Cold/Cold	.15

5.3 *Three-temperature selection (n=3).*

Wash/rinse temperature setting	Temperature use factor (TUF)
Alternate I:	
Hot/Warm	0.30
Warm/Cold	.55
Cold/Cold	.15
Alternate II:	
Hot/Cold	0.30
Warm/Cold	.55
Cold/Cold	.15
Alternate III:	
Hot/Cold	0.30
Warm/Warm	.55
Cold/Cold	.15

6. Applicable Temperature Use Factors for Determining Hot Water Usage for Various Wash/Rinse Temperature Settings for All Semi-Automatic Clothes Washers

6.1 *Six-temperature settings (n=6).*

Wash/rinse temperature setting	Temperature use factor (TUF)
Hot/Hot	.15
Hot/Warm	.09
Hot/Cold	.06
Warm/Warm	.42
Warm/Cold	.13
Cold/Cold	.15

§ 430.62 [Amended]

7. Section 430.62 (a)(2) is amended by adding ''energy factor (for clothes washers, clothes dryers, and dishwashers)'' after ''(for pool heaters),'' and before ''and annual fuel utilization efficiency''.

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