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10 CFR Parts 429 and 430
Energy Conservation Program for Consumer Products: Test Procedures for Residential Furnaces and Boilers; Proposed Rule

DEPARTMENT OF ENERGY

10 CFR Parts 429 and 430

[Docket No. EERE–2012–BT–TP–0024]

RIN 1904–AC79

Energy Conservation Program for Consumer Products: Test Procedures for Residential Furnaces and Boilers

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

ACTION: Notice of proposed rulemaking and announcement of public meeting.

SUMMARY: The U.S. Department of Energy (DOE) proposes to revise its test procedure for residential furnaces and boilers established under the Energy Policy and Conservation Act. This rulemaking will fulfill DOE's obligation to review its test procedures for covered products at least once every seven years. The proposed rule generally considers revisions based on the latest industry standards incorporated by reference, clarifications to the set-up and methodology, as well as new procedures for verification of the design requirements for certain categories of boilers and for estimating electrical consumption of furnaces and boilers. DOE is also announcing a public meeting to discuss and receive comments on issues presented in this test procedure rulemaking.

DATES: *Meeting:* DOE will hold a public meeting on Thursday March 26, 2015 from 1 p.m. to 5 p.m., in Washington, DC. The meeting will also be broadcast as a webinar. See section V, ''Public Participation,'' for webinar registration information, participant instructions, and information about the capabilities available to webinar participants.

Comments: DOE will accept comments, data, and information regarding this notice of proposed rulemaking (NOPR) before and after the public meeting, but no later than May 26, 2015. See section V, ''Public Participation,'' for details.

ADDRESSES: The public meeting will be held at the U.S. Department of Energy, Forrestal Building, Room 8E–089, 1000 Independence Avenue SW., Washington, DC 20585. To attend, please notify Ms. Brenda Edwards at (202) 586–2945. Persons may also attend the public meeting via webinar. For more information, refer to section V, ''Public Participation,'' section near the end of this notice.

Interested parties are encouraged to submit comments using the Federal eRulemaking Portal at *www.regulations.gov.* Alternatively, interested parties may submit comments, by any of the following methods:

• *Email: ResFurnBoilers2013TP0008@ee.doe.gov* Include the docket number EERE–2012–BT–TP–0024 and/or RIN 1904–AC79 in the subject line of the message. Submit electronic comments in WordPerfect, Microsoft Word, PDF, or ASCII file format, and avoid the use of special characters or any form of encryption.

• *Postal Mail:* Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Office, Mailstop EE–5B, 1000 Independence Avenue SW., Washington, DC, 20585–0121. If possible, please submit all items on a compact disc (CD), in which case it is not necessary to include printed copies.

• *Hand Delivery/Courier:* Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Office, 950 L'Enfant Plaza, SW., Suite 600, Washington, DC, 20024. Telephone: (202) 586–2945. If possible, please submit all items on a CD, in which case it is not necessary to include printed copies.

No telefacsimiles (faxes) will be accepted. For detailed instructions on submitting comments and additional information on the rulemaking process, see section V of this document (Public Participation).

Docket: The docket is available for review at *www.regulations.gov,* including **Federal Register** notices, public meeting attendee lists and transcripts, comments, and other supporting documents/materials. All documents in the docket are listed in the *www.regulations.gov* index. However, not all documents listed in the index may be publicly available, such as information that is exempt from public disclosure.

A link to the docket Web page can be found at: *http://www.regulations.gov/#!docketDetail;D=EERE-2012-BT-TP-0024.* This Web page contains a link to the docket for this notice of proposed rulemaking on the *www.regulations.gov* site. The *www.regulations.gov* Web page contains simple instructions on how to access all documents, including public comments, in the docket. See section V, ''Public Participation,'' for information on how to submit comments through *www.regulations.gov.*

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

FOR FURTHER INFORMATION CONTACT: Ms. Ashley Armstrong, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Office, EE–5B, 1000 Independence Avenue SW., Washington, DC, 20585–0121. Telephone: (202) 586–6590. Email: *Ashley.Armstrong@ee.doe.gov.*

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

For information on how to submit or review public comments, contact Ms. Brenda Edwards, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Office, EE–5B, 1000 Independence Avenue SW., Washington, DC 20585–0121. Telephone: (202) 586–2945. Email: *Brenda.Edwards@ee.doe.gov.*

SUPPLEMENTARY INFORMATION:

DOE intends to incorporate by reference the following industry standards into 10 CFR part 430: ASTM–D2156—09 (Reapproved 2013).

Copies of ASTM–D2156—09 can be obtained from the American Society of Testing and Materials (ASTM) at ASTM Headquarters, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428–2959, (877) 909–2786 or (610) 832–9585, or go to *http://www.astm.org.*

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I. Authority and Background

Title III, Part B[1] of the Energy Policy and Conservation Act of 1975 (''EPCA'' or ''the Act''), Public Law 94–163 (42 U.S.C. 6291–6309, as codified) sets forth a variety of provisions designed to improve energy efficiency and established the Energy Conservation Program for Consumer Products Other Than Automobiles.[2] These products include residential furnaces and boilers, the subject of this notice. (42 U.S.C. 6292(a)(5))

Under EPCA, the energy conservation program generally consists of four parts: (1) Testing; (2) labeling; (3) Federal energy conservation standards; and (4) certification and enforcement procedures. The testing requirements consist of test procedures that manufacturers of covered products must use as the basis for: (1) Certifying to DOE that their products comply with the applicable energy conservation standards adopted pursuant to EPCA, and (2) making other representations about the efficiency of those products. (42 U.S.C. 6293(c); 42 U.S.C. 6295(s)) Similarly, DOE must use these test procedures to determine whether the products comply with any relevant standards promulgated under EPCA. (42 U.S.C. 6295(s))

Under 42 U.S.C. 6293, EPCA sets forth the criteria and procedures that DOE must follow when prescribing or amending test procedures for covered products. EPCA provides, in relevant part, that any test procedures prescribed or amended under this section shall be reasonably designed to produce test results which measure energy efficiency, energy use, or estimated annual operating cost of a covered product during a representative average use cycle or period of use, and shall not be unduly burdensome to conduct. (42 U.S.C. 6293(b)(3))

In addition, if DOE determines that a test procedure amendment is warranted, it must publish proposed test procedures and offer the public an opportunity to present oral and written comments on them. (42 U.S.C. 6293(b)(2)) Finally, in any rulemaking to amend a test procedure, DOE must determine to what extent, if any, the proposed test procedure would alter the product's measured energy efficiency as determined under the existing test procedure. (42 U.S.C. 6293(e)(1))

Further, the Energy Independence and Security Act of 2007 (EISA 2007), Public Law 110–140, amended EPCA to require that at least once every 7 years, DOE must review test procedures for all covered products and either amend the test procedures (if the Secretary determines that amended test procedures would more accurately or fully comply with the requirements of 42 U.S.C. 6293(b)(3)) or publish a notice in the **Federal Register** of any determination not to amend a test procedure. (42 U.S.C. 6293(b)(1)(A)) Under this requirement, DOE must review the test procedure for residential furnaces and boilers not later than December 19, 2014 (*i.e.,* 7 years after the publication of EISA 2007 on December 19, 2007). The final rule resulting from this rulemaking will satisfy this requirement.

DOE's current energy conservation standards for residential furnaces and boilers are expressed as a minimum Annual Fuel Utilization Efficiency (AFUE). AFUE is an annualized fuel efficiency metric that accounts for fuel consumption in active, standby, and off modes. The following discussion provides a brief history of the rulemakings underlying the existing test procedure for residential furnaces and boilers.

The existing DOE test procedure for determining the AFUE of residential furnaces and boilers is located at 10 CFR part 430, subpart B, appendix N, *Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers.* The existing DOE test procedure for residential furnaces and boilers was established by a final rule published in the **Federal Register** on May 12, 1997, and it incorporates by reference ASHRAE Standard 103–1993, *Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers.* 62 FR 26140, 26157 (incorporated by reference at 10 CFR 430.3(f)(10)). On October 14, 1997 DOE published an interim final rule in the **Federal Register** to revise a provision concerning the insulation of the flue collector box in order to ensure the updated test procedure would not affect the measured AFUE of existing furnaces and boilers. 62 FR 53508. This interim final rule was adopted without change in a final rule published in the **Federal Register** on February 24, 1998. 63 FR 9390.

On October 20, 2010 DOE amended its test procedure for furnaces and boilers to establish a method for measuring the electrical energy use in standby mode and off mode for gas-fired and oil-fired furnaces and boilers, as required by EISA 2007. 75 FR 64621. These test procedure amendments incorporated by reference, and were based primarily on, provisions of the International Electrotechnical Commission (IEC) Standard 62301 (First Edition), *Household electrical appliances—Measurement of standby power.* On December 31, 2012 DOE published a final rule in the **Federal Register** that updated the incorporation by reference of the standby mode and off mode test procedure provisions to refer to the latest edition of IEC Standard 62301 (Second Edition). 77 FR 76831. On July 10, 2013, DOE published a final rule in the **Federal Register** that amended its test procedure for residential furnaces and boilers by adopting needed equations that allow manufacturers the option to omit the heat-up and cool-down tests and still generate a valid AFUE measurement. 78 FR 41265. On August 30, 2013, DOE published a correction to the July 10,

[1] For editorial reasons, upon codification in the U.S. Code, Part B was redesignated Part A.

[2] All references to EPCA in this document refer to the statute as amended through the American Energy Manufacturing Technical Corrections Act (AEMTCA), Public Law 112–210 (Dec. 18, 2012).

2013 final rule that rectified errors in the redesignations of affected subsections within section 10 of appendix N. 78 FR 53625.

Most recently, on January 4, 2013, DOE published a request for information (RFI) in the **Federal Register** that sought comment and information on a variety of issues relating to the existing DOE residential furnace and boiler AFUE test method. 78 FR 675. Key issues discussed in the RFI include: (1) Test conditions impacting the AFUE metric; (2) test conditions impacting non-AFUE efficiency parameters; (3) the incorporation of a performance test to verify compliance with the design requirement that mandates the boiler must have a functioning automatic means for adjusting water temperature; (4) harmonization of standards; (5) reducing the test burden; (6) alternative methods for furnace/boiler efficiency determination; (7) scope of test procedure coverage; and (8) standby mode and off mode. By issuing the RFI, DOE began the process of fulfilling its obligation to periodically review its test procedures under 42 U.S.C. 6293(b)(1)(A).

II. Summary of the Notice of Proposed Rulemaking

In this NOPR, DOE proposes to modify the existing DOE test procedure for residential furnaces and boilers to improve the consistency and accuracy of test results generated using the DOE test procedure and to reduce test burden. DOE's proposals in the NOPR are based on data collected during product testing, as well as public comment received on the January 2013 RFI. A summary of the data analysis is included in the furnace and boiler development testing report (''Testing Report'').[3]

In overview, DOE proposes to amend the residential furnaces and boilers test procedure by incorporating by reference ASHRAE Standard 103–2007 (hereinafter referred to as ASHRAE 103–2007) in place of ASHRAE 103–1993, which currently is referenced in the existing test procedure. In addition, this notice proposes to adopt modifications that establish revised test procedures for two-stage and modulating products, as well as for boilers with long post-purge times that would not otherwise be included in the incorporation by reference of ASHRAE Standard 103–2007.

DOE also proposes to amend the test procedure to include: (1) Allowing the measurement of condensate under steady-state conditions during the steady-state test rather than requiring an additional 30 minutes of testing after the steady-state conditions are established; (2) revised annual electricity consumption equations to account for additional electrical components; (3) revised test procedure references to ''manufacturer recommendations'' or ''manufacturer's instructions'' that do not explicitly identify the source of the recommendations or instructions; (4) a test protocol for determining the functionality of the automatic means for adjusting water temperature, (5) adopting a test method to indicate the absence or presence of airflow to determine whether the minimum default draft factor may be used; (6) revised required reporting precision for AFUE; (7) specifying testing requirements for units that are installed without a return duct, and (8) testing requirements for units with multiposition configurations. The specific proposed changes to the test procedure are presented at the end of this notice.

In any rulemaking to amend a test procedure, DOE must determine to what extent, if any, the proposed test procedure would alter the measured efficiency of any covered product as determined under the existing test procedure. (42 U.S.C. 6293(e)(1)) For residential furnaces and boilers, DOE has tentatively determined that the proposed test procedure amendments would have a *de minimis* impact on the products' measured efficiency.

III. Discussion

In the January 2013 RFI, DOE sought input from interested parties on the following topics: (1) Test conditions impacting the AFUE metric; (2) test conditions impacting non-AFUE efficiency parameters; (3) the incorporation of a performance test to verify compliance with the design requirement that mandates the boiler must have a functioning automatic means for adjusting water temperature; (4) harmonization of standards; (5) reducing the test burden; (6) alternative methods for determining furnace/boiler efficiency; and (7) scope of test procedure coverage. 78 FR 675, 676–79 (Jan. 4, 2013). The following 14 interested parties submitted written comments: American Gas Association (AGA), National Propane Gas Association (NPGA), American Public Gas Association (APGA), Lennox Industries Inc.—PD&R (LII), United Technologies (UT) and Carrier (UT&C), Ingersoll Rand Residential Solutions (IRRS), Crown Boiler Company (CBC), U.S. Boiler Company (USBC), Energy Kinetics, Inc. (EKI), Rheem Manufacturing Company (RMC), the Air-Conditioning, Heating and Refrigeration Institute (AHRI), Natural Resources Defense Council (NRDC), Natural Resources Canada (NRCan), and Goodman Global, Inc. (GGI). Stakeholders provided comments on a range of issues, including those DOE identified in the January 2013 RFI, as well as several other pertinent issues related to the proposed test procedure changes and also clarification and consideration of some additional opportunities for improvement. The following discussion addresses the specific topics and provides DOE's responses to stakeholder comments.

A. Products Covered by the Proposed Rule

The proposed test procedure amendments cover those products that meet the definitions for residential furnaces and boilers, as codified in DOE's regulations at 10 CFR 430.2, which defines a furnace as a product that: (1) Utilizes only single-phase electric current, or single-phase electric current or direct current (DC) in conjunction with natural gas, propane, or home heating oil; (2) is designed to be the principal heating source for the living space of a residence; (3) is not contained within the same cabinet with a central air conditioner whose rated cooling capacity is above 65,000 Btu per hour; (4) is an electric central furnace, electric boiler, forced-air central furnace, gravity central furnace, or low pressure steam or hot water boiler; and (5) has a heat input rate of less than 300,000 Btu per hour for electric boilers and low pressure steam or hot water boilers and less than 225,000 Btu per hour for forced-air central furnaces, gravity central furnaces, and electric central furnaces.[4]

The definitions for the individual products covered in this test procedure, as codified in DOE's regulations at 10 CFR 430.2, include: (1) An *electric boiler* is an electrically powered furnace designed to supply low pressure steam or hot water for space heating application. A low pressure steam boiler operates at or below 15 pounds per

[3] U.S. Department of Energy—Office of Energy Efficiency and Renewable Energy. Energy Conservation Program for Consumer Products: Residential Furnace and Boiler Test Procedure Rulemaking: Testing Report: Energy Efficiency Standards for Consumer Products: Residential Furnaces and Boilers (February 2015) (Available in Docket #EERE–2012–BT–TP–0024 at *http://www.regulations.gov*).

[4] The definition of ''Furnace'' currently in the CFR at 10 CFR 430.2 mistakenly repeats the terms ''gravity central furnaces, and electric central furnaces'' at the end of the definition. In this NOPR, DOE proposes modifying the definition to correct this error and remove the duplicated language.

square inch gauge (psig) steam pressure; a hot water boiler operates at or below 160 psig water pressure and 250 °F water temperature; (2) an *electric central furnace* is a furnace that is designed to supply heat through a system of ducts with air as the heating medium, in which heat generated by one or more electric resistance heating elements is circulated by means of a fan or blower; (3) a *forced air central furnace* is a furnace that burns gas or oil and is designed to supply heat through a system of ducts with air as the heating medium. The heat generated by combustion of gas or oil is transferred to the air within a casing by conduction through heat exchange surfaces and is circulated through the duct system by means of a fan or blower; (4) a *gravity central furnace* is a gas-fueled furnace which depends primarily on natural convection for circulation of heated air and which is designed to be used in conjunction with a system of ducts; (5) A *low pressure steam or hot water boiler* is an electric, gas, or oil-burning furnace designed to supply low pressure steam or hot water for space heating applications. A low pressure steam boiler operates at or below 15 pounds psig steam pressure; a hot water boiler operates at or below 160 psig water pressure and 250 °F water temperature; (6) a *mobile home furnace* is a direct vent furnace that is designed for use only in mobile homes; (7) an *outdoor furnace or boiler* is a furnace or boiler normally intended for installation out-of-doors or in an unheated space (such as an attic or a crawl space); and (8) a *weatherized warm air furnace or boiler* is a furnace or boiler designed for installation outdoors, approved for resistance to wind, rain, and snow, and supplied with its own venting system.

B. Effective Date and Compliance Date for the Amended Test Procedure

This notice proposes amendments that would be made in 10 CFR 430.3, 10 CFR 430.23, and in 10 CFR part 430, subpart B, appendix N. Pursuant to 42 U.S.C. 6293(c)(2), effective 180 days after DOE prescribes or establishes a new or amended test procedure, manufacturers must make representations of energy efficiency, including certifications of compliance, using that new or amended test procedure.

C. Proposed Test Procedure Amendments

In the January 2013 RFI, DOE requested comments about improving the residential furnace and boiler test procedure's effectiveness in quantifying energy efficiency performance under typical field conditions. 78 FR 675, 677 (Jan. 4, 2013). DOE identified opportunities to reduce variability, eliminate ambiguity, and address discrepancies between the test procedure and actual field conditions. DOE received input on a variety of issues, including: (1) Updating the incorporated ASHRAE Standard 103 from the 1993 version to the 2007 version; (2) measurement of condensate under steady-state conditions; (3) measurement of additional electrical consumption for modulating products and auxiliary components; (4) installation and operational manual reference; (5) verification test for automatic means for adjusting water temperature; (6) AFUE reporting precision; (7) oversize factor; (8) supply and return water temperature; (9) default factors, including draft, jacket loss, and seasonal factors; (10) calculation simplification for burner cycling and draft losses; (11) room ambient temperature and humidity ranges; (12) burner operating hours determination; (13) alignment of vent stack configuration with American National Standards Institute (ANSI) standards; (14) harmonization of pressure drop requirements; (15) alternative methods for determining the efficiency of residential furnaces and boilers; (16) the scope of the test procedure; and (17) full-fuel-cycle (FFC) energy metrics in the AFUE test. In addition, DOE considered: (18) Specifying ductwork requirements for units that are installed without a return duct and (19) specifying testing requirements for units with multiposition configurations. The proposed test procedure amendments are addressed in further detail immediately following.

1. Updating ASHRAE Standard 103 From the 1993 Version to the 2007 Version

The DOE test procedure for determining the AFUE of residential furnaces and boilers currently references industry test standard ASHRAE 103–1993. The ASHRAE Standard 103–1982 test procedure was initially developed in 1982 based on the DOE test procedures for single-stage furnaces and boilers recommended by Kelly *et al.*[5] ASHRAE 103 was revised in 1988 and again in 1993 to include test procedures for condensing units, for two-stage and modulating units, and for units employing a short post-purge period after the burner is shut off. In 1998, ASHRAE organized Standard Project Committee (SPC) 103R to begin the revision process to ASHRAE 103–1993, which followed comments from the industry on the need to address some possible shortcomings of the standard based on user experiences. The 1993 ASHRAE Standard 103 was updated in 2007 (ASHRAE Standard 103–2007) to reflect product design improvements and other changes. Particular attention was given to the new classes of two-stage and modulating products, as well as products incorporating combustion chamber post-purge technology. The ASHRAE standard was also updated to reflect greater understanding of energy losses, as well as to incorporate changes to clarify nomenclature and definitions. In addition, the revisions included changes to parameters in appendix C of ASHRAE 103, impacting the determination of national average burner operating hours, average annual fuel energy consumption, and average annual auxiliary electrical energy consumption for gas or oil furnaces and boilers.

DOE received several comments regarding updating its incorporation by reference of ASHRAE 103–2007 in the DOE test procedure. Lennox, NRDC, and NRCan responded in favor of adopting the 2007 version of ASHRAE 103 without requesting specific changes. Additionally, Goodman, Carrier, AHRI, and Ingersoll Rand requested that DOE consider adopting the newer version, but with some exceptions. Rheem expressed concerns about the adoption of specific provisions of ASHRAE 103–2007 that in their view would not be an improvement to the current version DOE has incorporated by reference. These comments are addressed in further detail subsequently.

Lennox stated that the company generally supports incorporation by reference of the new version of the ASHRAE standard into the DOE test procedure. (Lennox, No. 6 at p. 2) NRDC also supports the use of ASHRAE 103–2007 to the extent that the standard is fully up-to-date and not controversial from a technical perspective. (NRDC, No. 14 at p. 1) NRCan also supports the use of ASHRAE 103–2007 and stated that Canada has already used it to update its oil-fired boiler regulations. (NRCan, No. 15 at p. 1) Goodman supports DOE's intent to update references to the most current edition of industry test procedures as well. Goodman also recommended better coordination between the development of DOE's and ASHRAE's test procedures to reduce the regulatory burden on

[5] Kelly, G.E., Chi, J., Kuklewicz, M.E., ''Recommended Testing and Calculation Procedures for Determining the Seasonal Performance of Residential Central Furnaces and Boilers,'' NBSIR 78–1543 (March 1978).

manufacturers. (Goodman, No. 16 at p. 2) Carrier agreed with the adoption of ASHRAE 103–2007, as long as it does not affect the measure of AFUE of existing furnaces and boilers. It added that DOE must maintain the exceptions allowed by ASHRAE 103–1993 because the burden of testing would increase significantly without the exceptions, while the effect on the result would be small. These exceptions include not needing to fully insulate the inducer and allowing for the 30-second post-purge of the inducer. (Carrier, No. 7 at p. 1)

AHRI conditionally agreed with updating the test procedure based on ASHRAE 103–2007 but stated that DOE must try to avoid making changes just for the sake of making changes. AHRI also recommended DOE consider: (1) Not incorporating sections 11.4.9.11 and 11.4.9.12 of ASHRAE 103–2007 because those provisions add a consequential burden to manufacturers without an obvious benefit; and (2) that the table of Design Heating Requirements (DHR) (Table 8 in the 1993 edition) has been deleted from the 2007 version, and the associated calculations,[6] which formerly used DHR values from that table, now rely solely on the oversize factor and heating capacity when operating under steady-state conditions (Q_{OUT}). AHRI stated that this change may have more of an effect on estimates of electric consumption than on the AFUE value. (AHRI, No. 13 at p. 2–3)

Ingersoll Rand acknowledged that on balance, adoption of ASHRAE 103–2007 in its entirety would be an improvement over currently referenced ASHRAE 103–1993. However, in its comments, Ingersoll Rand identified changes made to the 2007 version that are troublesome and need further study, such as the change to the on/off timings of two-stage and modulating products, which has been found to result in lower AFUE results for high-efficiency furnaces (90+ percent AFUE) and higher AFUE results for less-efficient furnaces (80+ percent AFUE). Ingersoll Rand also stated its view that the changes are significant enough require retesting and rerating of current equipment. In addition, the change to how DHR is determined would change the electrical usage calculation, which may require recalculating electrical usage estimates for all products and could result in delisting of many current Energy Star products. (Ingersoll Rand, No. 8 at p. 2)

Rheem also commented on ASHRAE 103–2007 provisions. Rheem stated that Table 7 (Average Burner On-Time and Off-Time Per Cycle for Furnaces and Boilers) from ASHRAE 103–2007 should not be included in the DOE test procedure. Rheem believes that the ASHRAE 103–2007 method for calculating the on and off cycle times based on a calculated oversize factor has value, but that the calculation is flawed due to the assumption that the thermostat cycle response at 50-percent load, N_{50}, is equal to 5 cycles per hour for furnaces (equations 11.4.9.11 and 11.4.9.12 of ASHRAE 103–2007). (Rheem, No. 12 at p. 4) Rheem believes that there should be a significant difference between the high-fire cycle time and reduced-fire cycle time. Rheem presented data to support this statement. (Rheem, No. 12 at p. 5)

In addition, according to Rheem, the elimination of the requirement to test the efficiency at maximum input rate for multi-stage products would significantly reduce the burden on manufacturers. Rheem argued that currently, the efficiency at the maximum input rate has very little, if any, effect on the overall AFUE rating and is not representative of operation of the furnace in the field. Rheem stated that an AFUE metric for multi-stage products, that incorporates measured values at a reduced input that is close to the design load is a more appropriate representation of furnace operation in the average home. Rheem suggested that multi-stage products be tested at the lowest reduced input rate and the highest reduced input rate below 60 percent of furnace rated capacity.[7] (Rheem, No. 12 at p. 8)

Rheem highlighted that ASHRAE 103–2007 and ASHRAE 103–1993 allow an option to collect condensate over an additional three cycles (ASHRAE 103–2007, section 9.8.5), but the standards do not sufficiently address the issue of variation of condensate flow at varying cycle rates. ASHRAE 103–2007 addresses variation within subsequent cycles at a single rate but does not address differences between cycle rates. (Rheem, No. 12 at p. 6–7)

In response to the stakeholder comments, DOE notes that results from testing to ASHRAE 103–2007 more accurately reflect the efficiency of two-stage/modulating models because the standard calculates the on/off cycle times for such models, as opposed to ASHRAE 103–1993, which assigned fixed values to these parameters. When tested under the ASHRAE 103–1993 test procedure, some two-stage/modulating units operate at reduced fire more than 95 percent of the time.[8] Thus, under the test procedure calculations, such units operate similarly to a single-stage unit operating at the reduced input capacity of the unit. As a check for consistency, the AFUE of a two-stage/modulating unit operating entirely at reduced input, as determined using the single-stage calculation method, should be very similar to the actual AFUE of that unit, as determined using the two-stage/modulating calculation method. However, the two-stage and modulating calculation method in ASHRAE 103–1993 can result in an AFUE of more than one percentage point higher than the AFUE resulting from the single-stage calculation method.[9] The reason for this discrepancy is that ASHRAE 103–1993 assigns different on/off times to single-stage and two-stage/modulating units. ASHRAE 103–2007 resolves the inconsistency between the two calculation methods by calculating the on/off cycle times for two-stage/modulating units while maintaining fixed on/off times for single-stage equipment. The resulting two-stage and modulating on/off cycle times are closer to those specified for single-stage units, as one would expect based upon their operation.

Another calculation revision addressed by ASHRAE 103–2007 is the equation used for determining off-period losses. ASHRAE 103–1993 limits the post-purge period to three minutes after the burner is shut off, thereby producing inaccurate flue loss results for oil-fired boilers that require a post-purge time longer than three minutes. ASHRAE 103–2007 addresses this issue by providing a calculation to account for greater flue losses for boilers with post-purge times longer than three minutes.

Additionally, ASHRAE 103–2007 provisions allow calculating AFUE for two-stage and modulating products based on the reduced fuel input only when the balance point temperature (T_C) value is less than or equal to 5 °F (ASHRAE 103–2007, section 11.4.8.4), which occurs when $Q_{OUT,R}/Q_{OUT}$ is greater than 0.59. This is the case for all two-stage furnaces currently on the market and for some modulating models. The adoption of this ASHRAE 103–2007 provision would allow testing of models that meet the balance point

[6] In ASHRAE 103–1993, in addition to being used in the calculations related to electricity use, DHR is also used in: (1) Calculating the oversize factor in section 11.4.8.3; (2) calculating $Effy_{SS,M}$ in section 11.4.8.8; and, (3) calculating $Q_{OUT,M}$ in section 11.4.8.10.

[7] The 60 percent rate cited by Rheem represents the capacity required to meet the design house heating load when using an oversize factor of 0.7 (100%/(1 + 0.7) = 59%).

[8] Liu, Stanley, ''Proposed Revisions of Part of the Test Procedures for Furnaces and Boilers in ASHRAE Standard 103–1993,'' NIST (September 2002).

[9] *Id.*

provision using only the steady-state test at low fire for many two-stage and modulating models, resulting in a reduction of test burden.

Finally, ASHRAE 103–2007 improved the accuracy of the determination of national average burner operating hours (BOH), average annual fuel energy consumption (E_F), and average annual auxiliary electrical energy consumption (E_{AE}), especially for two-stage and modulating products, based on a 2002 study from NIST.[10] A 2006 study[11] showed that the main improvements to these parameters in the 2007 ASHRAE test procedure are: (a) The approach used to calculate the heat generated by the product's electrical components; (b) properly accounting for maximum and reduced operating modes; (c) the approach used to determine the design heating requirement; and (d) the approach for calculating on-time ratios for the product's electrical components. This study showed that these updates significantly increase the accuracy of the two-stage and modulating calculations so that they can be more comparable to single-stage results and field studies.

Burner operating hours account for the heat provided by the fuel and electrical components. In the calculation for the number of annual burner operating hours (BOH_R and BOH_M) for two-stage and modulating furnaces (or boilers), respectively, the existing DOE test procedure estimates the BOH_R and BOH_M using heat provided by the fuel and electrical components, which are measured at the maximum operating mode only.[12] In practice, two-stage and modulating furnaces (or boilers) operate most of the time in a reduced mode, which lengthens the product's hours of operation. To make the test procedure for two-stage and modulating products more representative of actual operating conditions, the existing DOE text procedure incorporates the factor R calculated as the ratio of the duration of on-time of two-stage or modulating products during actual usage to the duration of on-time of single-stage products. The factor R is not included in the ASHRAE 103–2007 test procedure, as heat provided from the electrical components is determined separately for the burner operating hours at the maximum, reduced, and modulating modes, which results in reducing the fraction of heat from the electricity components. By adopting ASHRAE 103–2007, the proposed DOE test procedure eliminates the factor R.

In addition, the current DOE test procedure calculates E_F for two-stage and modulating products at the maximum operating mode only. In contrast, because the majority of the heating load is not delivered at the maximum input operating mode, ASHRAE 103–2007 calculates E_F for two-stage and modulating products by taking into account the fuel consumption at maximum, reduced, and modulating operating modes. This approach results in a more accurate calculation of E_F for two-stage and modulating products. Under the existing test procedure, DHR is calculated as a step function of output capacity, which causes a small rise in the heating capacity to impact the calculated DHR value in a way that results in higher, calculated, energy consumption for more-efficient furnaces. This causes the current DOE test procedure methodology to not always be suitable for comparing furnace energy use. ASHRAE 103–2007 improves the calculation of the house heating load in the BOH calculations by replacing the DHR step function in the existing DOE test procedure with a linear function of the oversize factor and heating capacity when operating under steady-state conditions (Q_{OUT}). Lastly, the on-time ratios for the product's electrical components (y_R and $y_{P,R}$) are included in ASHRAE 103–2007 to more accurately represent the duration of the electrical components operating in reduced operating mode when calculating BOH and E_{AE}.[13]

In conclusion, DOE has tentatively decided to incorporate by reference ASHRAE 103–2007 with amendments as set forth in this rulemaking. DOE has tentatively concluded that ASHRAE 103–2007 offers significant improvements over ASHRAE 103–1993 through the changes made to the AFUE calculation method for two-stage/modulating products, for products with a post-purge period longer than 3 minutes, and for the determination of BOH, E_F, and E_{AE} parameters. In addition, the majority of stakeholders responded in favor of adopting the 2007 version of ASHRAE Standard 103. The incorporation by reference of ASHRAE 103–2007 requires removing from 10 CFR 430.3 the section exceptions to ASHRAE 103–2007 associated with the residential furnaces and boilers test procedure and the residential furnace fans test procedure. Accordingly, DOE proposes to include the product-specific section exceptions in the definitions section in the corresponding appendix of subpart B of 10 CFR 430, (*i.e.,* appendix N for furnaces and boilers and appendix AA for furnace fans). Therefore, DOE proposes to revise section 2.2 of appendix N and section 2.3 of appendix AA of subpart B of 10 CFR 430 to include the product-specific section exceptions to ASHRAE 103–2007. DOE also proposes to modify the equations for determining BOH, E_F, and E_{AE} parameters adopted from ASHRAE 103–2007 to incorporate ignition power consumption, standby mode and off mode energy consumption, and electric components' useful heat parameter in the burner operating hours as a function of the installation location, all of which are incorporated into the current DOE test procedure.

2. Measurement of Condensate Under Steady-State Conditions

DOE considered the possibility of reducing test burden by providing that the condensate mass can be measured during the establishment of steady-state conditions, rather than after steady-state has been achieved. Section 9.2 of both ASHRAE 103–1993 and ASHRAE 103–2007 requires that the measurement of condensate shall be conducted during the 30-minute period after steady-state conditions have been established. To reduce test burden, DOE proposes to allow for the measurement of condensate during the establishment of the steady-state conditions (ASHRAE 103–2007, section 9.1) rather than during a 30-minute period after establishing steady-state conditions (ASHRAE 103–2007, section 9.2). DOE investigated the difference in condensate mass collected and the rate of condensate production during the two separate periods (*i.e.,* during the establishment of steady-state conditions and after steady-state conditions have been reached). Based on the comparison of the measurements, DOE has determined that there is no significant difference in the mass of condensate collected or the rate of condensate production during the two separate tests.

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[10] Liu, Stanley, ''Proposed Revisions of Part of the Test Procedures for Furnaces and Boilers in ASHRAE Standard 103–1993,'' NIST (September 2002).

[11] Lekov, A., V. Franco, and J. Lutz, ''Residential Two-Stage Gas Furnaces: Do They Save Energy?,'' Presented at 2006 ACEEE Summer Conference. LBNL (August 2006) (Available at: *http://aceee.org/files/proceedings/2006/data/papers/SS06_Panel1_Paper16.pdf*).

[12] ''BOH_R'' is defined as the national average number of burner operating hours at the reduced operating mode for furnaces and boilers equipped with two-stage or step-modulating controls. ''BOH_M'' is defined as the national average burner operating hours in the modulating mode for furnaces and boilers equipped with step-modulating controls.

[13] ''y'' is the ratio of blower or pump on-time to average burner on-time. ''y_P'' is the ratio of induced or forced draft blower on-time to average burner on-time. ''y_R'' and ''$y_{P,R}$'' are the equivalent parameters at reduced operating mode.

3. Electrical Consumption of Components

In the January 2013 RFI, DOE stated that it would consider amendments to account for the electrical consumption of additional components not already captured by the existing DOE test procedure. 78 FR 675, 678 (Jan. 4, 2013). Currently, the DOE residential furnace and boiler test procedure measures only the power supplied to the power burner motor, the ignition device, and the circulation pump. The existing DOE test procedure does not explicitly include other devices that use power during the active mode, such as the gas valve, safety and operating controls, and internal pumps used to maintain a minimum flow rate through the heat exchanger that do not function as system circulating pumps.

In the January 2013 RFI, DOE requested comment on whether the boiler average annual auxiliary electrical energy consumption calculations should include one system circulating pump and an additional pump (if present) that circulates water during burner operation, and how to address any electrical power consumption not already measured during the active mode. *Id.*

AHRI commented that the electrical consumption of any internal circulating pump should be included in the test procedure. However, AHRI stated that in most designs, the operation of this internal circulating pump is directly tied to the operation of the burner (*i.e.,* water must be flowing for the burner to fire). Thus, according to AHRI, it may be more appropriate to include the electrical consumption of the internal circulating pump in the ''BE'' term.[14] (AHRI, No. 13 at p. 5) NRCan also stated that the residential furnace and boiler test procedure provisions for electrical ratings should include all connected loads and ancillary components. (NRCan, No. 15 at p. 4)

The current DOE test procedure accounts for the power consumed by the ignition device, circulating pump, and power burner motors, but it does not account for the power used by other devices during the active mode (*e.g.,* gas valve operation and safety and operating controls). In the January 2013 RFI, DOE stated its intent to consider including any electrical power consumption not already measured during the active mode, and requested comment on how to address electrical power consumption by these additional components. 78 FR 675, 678 (Jan. 4, 2013).

Lennox, Rheem, and AHRI did not support measuring additional electrical power consumption that is not already measured during the active mode. Lennox stated that manufacturers typically connect two power cords to their furnaces for efficiency testing, one for the blower motor and one for the rest of the furnace; therefore, all the significant electrical power consumption is being recorded. (Lennox, No. 6 at p. 3) Rheem commented that the manufacturer has already included the power consumed by the gas valve and safety operating controls in the measurement of electrical power to the burner (PE). Rheem categorized the control, inducer, and gas valve as components of the burner system. (Rheem, No. 12 at p. 10) AHRI recommended that DOE not address this issue, as power consumed by other devices during the active mode may already be measured. (AHRI, No. 13 at p. 6) In contrast, Carrier recommended that all electrical power consumption needed to operate the appliance should be measured during active mode and included in the annual electrical consumption calculation. (Carrier, No. 7 at p. 2)

DOE performed electrical measurements to investigate the presence of auxiliary electrical energy consumption not accounted for in the existing test procedure. DOE concluded that there is significant measureable auxiliary electricity consumption associated with components such as controls, gas valves, and additional pumps (if present), which is not captured by the specific methods of electrical measurement prescribed in the existing DOE test procedure. Therefore, DOE proposes to expand the electricity use equations and the applicable parameter definitions to specifically capture all active mode electricity use. In particular, DOE proposes to add two new terms to the calculations of E_{AE} for single-stage, two-stage, and modulating products. The first new term (BE_S) accounts for a secondary boiler pump for units with such a device, and the second term (E_O) represents electrical power not captured in the existing terms.[15] If BE is determined by subtracting PE from the total measured power (or if PE is determined by subtracting BE from the total measured power), E_O would be zero. DOE believes that these changes would introduce only a small additional testing burden because the total electricity consumption is often being captured during testing. In addition, E_{AE} values already have to be recalculated due to ASHRAE 103–2007 changes; therefore, the proposed changes are not expected to introduce any additional burden in terms of recalculating and reporting.

DOE has tentatively concluded that the additional electrical components (secondary, pump, controls, and gas valve) represent a significant, measurable amount of the total electrical power. Therefore, DOE proposes to include electrical consumption of additional electrical components in the test procedure, as this would provide for a more accurate and complete measurement of the total electricity consumed by the furnaces and boilers.

4. Installation and Operation Manual Reference

The existing DOE test procedure specifies that the tested product is to be set up according to ''manufacturer's recommendations'' or ''manufacturer's instructions.''[16] In the January 2013 RFI, DOE sought comment on whether the test procedure should specify that the tested product is set up according to recommended field settings as defined in the product's installation and operation (I&O) manual. 78 FR 675, 677–78 (Jan. 4, 2013).

APGA, Lennox, Carrier, Rheem, AHRI, and NRDC all agreed that DOE should consider changes to its furnaces and boilers test procedure to better account for recommended field settings for those products. APGA stated that DOE should test appliances according to field settings because setting up products in a manner inconsistent with recommended field guide settings raises safety concerns for the testing professional as well as future customers, and testing appliances in a manner inconsistent with recommended field guide settings may yield inaccurate data. According to APGA, appropriate installation procedures are important to ensure proper furnace/boiler performance, especially with vent configurations. (APGA, No. 5 at p. 2) Lennox also stated that the test procedure should be revised to specify that the tested product be set up according to recommended field settings, as defined in the product's

[14] The term BE means ''the circulating air fan or water pump electrical energy input rate at full load steady state operation'' (ASHRAE 103–2007, p. 51).

[15] The existing DOE test procedure includes five terms for determining electrical consumption: (1) BE, which is the electrical power to the circulating air blower or water pump; (2) PE, which is the electrical power to the burner; (3) P_{IG} which is the electrical input to the interrupted ignition device, (4) $P_{W,SB}$ which is the standby mode power; and (5) $P_{W,OFF}$ which is the off mode power.

[16] See sections 7.2.3.1, 7.2.3.2, 7.8, 8.3.3.2, and 8.4.1.1.2 in ASHRAE 103–1993 for references to ''manufacturer's instructions''; see sections 7.2.2.2 and 8.4.1.1 in ASHRAE 103–1993 for references to ''manufacturer's recommendations.''

installation instructions or comparable documentation. (Lennox, No. 6 at p. 2) AHRI agreed that this issue should be considered. AHRI stated that there are some test set-up specifications that would need to be clarified and that they will provide specific recommendations in a subsequent submittal.[17] (AHRI, No. 13 at p. 5) NRDC stated that DOE should develop specifications that minimize the difference between test procedure conditions and field conditions, particularly for manufacturer-recommended settings for parameters like carbon dioxide (CO_2), part-load motor efficiency, and use of pumps that are included as part of the product. (NRDC, No. 14 at p. 2)

Carrier and Rheem offered specific instances in which manufacturer set-ups should be used in testing. Carrier specified that if a product has a unique and required set-up specified in the manufacturer's instructions such that the only way of using the product is as defined in the manufacturer's instructions, the DOE test procedure should allow for testing using these instructions. However, if the instructions for a unique set-up are merely optional for the use of a product, then the default should be to test per the DOE test procedure. (Carrier, No. 7 at p. 2) Rheem commented that if the operation manual requires that the furnace should be set at a low-fire rate, it would be appropriate to make the same adjustment in the DOE test procedure for the AFUE test. (Rheem, No. 12 at p. 9)

In response, DOE proposes changing the test procedure language to explicitly state that, where permitted by the test procedure, the testing recommendations should be drawn from the I&O manual shipped with the unit. The existing language (*e.g.,* ''manufacturer recommendations'' or ''manufacturer instructions'') is vague and ambiguous and can lead to the use of *ad hoc* instructions derived solely for AFUE testing purposes. DOE believes the proposed language will increase the repeatability and reproducibility of the existing test procedure and will not result in additional test burden. In particular, in relation to Carrier's comments, DOE believes that the proposed provision will allow a product to be tested with its own primary, unique, and required set-up specified in the manufacturer's instructions, and that the language is clear that testing may not be done using any other optional set-ups that may be available in the manufacturer's I&O manual. It also clarifies that the information provided in an I&O manual would not trump any portion of the DOE test procedure provisions. Concerning Rheem's comment, the test procedure requires two-stage and modulating furnace and boilers to be tested at high-fire and low-fire rates unless specific criteria are met, regardless of the operational manual recommendations. DOE is also proposing specific instructions for parameters such as combustion airflow ratio (*see proposed* 10 CFR part 430, subpart B, appendix N, sec. 7.3), and reduced fuel input rate (*see proposed* 10 CFR part 430, subpart B, appendix N, sec. 10.3), for instances where I&O recommendations are not provided. Further, DOE would clarify that when the DOE test procedure provisions and I&O manuals are not sufficient for testing a furnace or boiler, the manufacturer must request a test procedure waiver from DOE.

5. Verification Test for Automatic Means for Adjusting the Water Temperature in Boilers

In 2008, DOE published a technical amendment to the 2007 furnace and boiler final rule to add design requirements for boilers consistent with the provisions of EISA 2007.[18] 73 FR 43611 (July 28, 2008). These design requirements prohibit constant-burning pilot lights for gas-fired hot water boilers and gas-fired steam boilers, and require an automatic means for adjusting the water temperature for gas-fired hot water boilers, oil-fired hot water boilers, and electric hot water boilers (''automatic means''). The automatic means must automatically adjust the temperature of the water supplied by the boiler to ensure that an incremental change in inferred heat load produces a corresponding incremental change in the temperature of water supplied. For boilers that fire at a single input rate, the requirement that the boiler have an automatic means for adjusting water temperature may be satisfied by incorporating controls that allow the burner or heating element to fire only when the inferred heat load cannot be met by the residual heat of the water in the system. However, this prescriptive requirement lacks sufficient detail as to how a manufacturer may execute the control strategy for the means to be considered automatic. DOE reasons that the statute established these design requirements as a way to conserve energy, and DOE believes that proper functional testing will help to ensure these energy savings.

In the January 2013 RFI, DOE sought comment regarding any principles or tests currently used, or being considered for use, to evaluate whether a boiler design satisfies the automatic means requirement. 78 FR 675, 678 (Jan. 4, 2013).

AHRI recommended that DOE not consider this issue. AHRI commented that the designs being used to comply with the automatic means requirement are so diverse that it is not possible to develop a test that could properly evaluate all these design solutions. It stated that any benefit from this concept is overwhelmed by its potential for controversy. (AHRI, No. 13 at p. 6) NRCan provided a verification test it developed that is based on: (1) Identification of how the automatic control infers a change of load; (2) simulating a change to that variable; and (3) measuring the response from the control. (NRCan, No. 15 at p. 5–6)

DOE's RFI also sought comment on required inputs and types of technologies needed to project changes in demand, and the relationships between these inputs/technologies and supply temperature or pump/burner operation. 78 FR 675, 678 (Jan. 4, 2013). DOE received no comments regarding the technologies and/or strategies used for adjusting the boiler supply water temperature based on inferred heat load. The following describes DOE's understanding of the technologies used to address the boiler design requirements.

Outdoor Reset. The most prevalent technology for adjusting water temperature according to load is outdoor reset. Outdoor reset uses a simple outdoor temperature sensor, typically located on the north side of the home. Another sensor mounted at the boiler senses water temperature. A computer chip in the control system uses the outdoor temperature information to adjust the boiler's output by changing the boiler's supply water temperature. Some systems also employ a third internal room sensor to provide additional data for the control system.[19]

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[17] As of the date of issuance of this NOPR, DOE has not received any additional information from AHRI.

[18] EISA 2007 mandated, starting September 1, 2012, that all gas, oil, and electric hot water boilers (excluding those equipped with a tankless domestic water heating coil) must be equipped with automatic means for adjusting the boiler water temperature (codified at 42 U.S.C. 6295(f)(3)). This excludes boilers that are manufactured to operate without any need for electricity. 73 FR 43611, 43613 (July 28, 2008).

[19] TJ's Plumbing and Heating, ''Weather-Responsive Controls (Outdoor Reset Controls)'' (2013) (Available at: *http://www.tjsradiantheat.com/noteworthies/weather-responsive-controls/*); Weil-McLain, ''WM–ODR Outdoor Reset Control Instruction Manual'' (Available at: *http://www.weil-mclain.com/en/*

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Inferred Load. The adjustment of water temperature based on building load can also be achieved using software, rather than sensors, to predict the inferred heating load. Inferred heating load can be based on outdoor temperature information, thermostat demand patterns, indoor temperature information, or burner cycling and/or modulation patterns.[20] Under this approach, microprocessor-based algorithms monitor thermostat activity to track how much heat the building requires and adjust the supply water temperature accordingly.[21]

Thermal Pre-Purge. Thermal pre-purge is an automatic means that identifies the amount of residual heat available in the boiler following a call for heating. This strategy allows the pump to operate prior to the ignition of the burner.[22] Following an ''off'' cycle, the boiler's control system determines how much latent heat is still available from the previous ''on'' cycle, and only activates the burner when the measured latent heat cannot meet the heating demand.[23]

Based on the overall comments and the provided draft test methodologies, DOE proposes the use of two test methods—one for single-stage boilers and one for two-stage/modulating boilers—for verification of the functionality of the automatic means for adjusting the water temperature supplied by a boiler. These test methods are independent of the AFUE test because the automatic means requirement is a design requirement and is not part of the minimum efficiency requirements. The draft testing methodologies provided by NRCan, as well as the California mechanical codes section for non-residential boilers,[24] were used as bases for the proposed test methods. The proposed test methods can evaluate a variety of control strategies used to comply with the automatic means prescriptive requirement. The two separate tests have been developed to accommodate the various boiler control strategies.

As discussed previously, the requirement to incorporate an automatic means does not specify how a manufacturer must implement the automatic means. It only requires that an incremental change in inferred heat load produce a corresponding incremental change in heat output. Each of the proposed test methods allows for accommodation of technological advances in controls and designs and does not limit the innovation of this control type.

The proposed test methods for automatic means verification would confirm whether the boiler heat output responds to a change in inferred heat load, thereby verifying the functionality of the automatic means. Specifically, the single-stage boiler test captures the delayed burner reaction following a call for heating when residual heat is present within the boiler. The two-stage/modulating test monitors water temperature settings from the inferential load controller and/or supply water temperature measurements to determine whether these values properly respond to changes in the inferred load. The proposed tests would be added to 10 CFR part 429.134.

6. Off-Cycle and Power Burner Draft Factors

In the January 2013 RFI, DOE requested feedback on existing default draft factor values for furnaces and boilers. 78 FR 675, 676–77 (Jan. 4, 2013). Existing draft factors, as specified in the test procedure,[25] include the off-cycle draft factor for flue gas flow (D_F) and the power burner draft factor (D_P), the off-cycle draft factor for stack gas flow (D_S), and the off-cycle draft factor for stack gas flow without a stack damper ($D_S{}^O$). The existing DOE test procedure allows for the use of the default values for D_F of 0.4 for furnaces and boilers with power burners and 1.0 for furnaces and boilers with atmospheric burners.[26] The DOE test procedure also allows for D_F to be assigned a value equal to D_P, which is determined using optional testing.[27] Also, for furnaces and boilers employing a power burner, if the measured D_P is less than 0.1, then D_P is set at 0.05 because, based on input by industry experts and DOE testing, the tracer gas test is often inaccurate at flows lower than a D_P of 0.1.[28] Under the existing DOE test procedure, when there is no airflow through the flue side of the heat exchanger in the off cycle, manufacturers may apply a minimum default draft factor (D_F or D_P) of 0.05.[29] However, the existing test procedure does not provide a process to determine whether the tested model is designed with no measurable airflow through the combustion chamber and heat exchanger during the burner off-period. DOE sought comment on whether a minimum default draft factor may be applied at all, the conditions under which a minimum default draft factor may be applied, and how such conditions can be verified.

Ingersoll Rand commented that testing burden can be reduced by improving draft factor default values. (Ingersoll Rand, No. 8 at p. 1) Rheem indicated that the default draft factor for furnaces should be lowered for today's furnaces. (Rheem, No. 12 at p. 2) Rheem stated that for all furnaces, it uses a value for D_F and D_P of 0.05, although actual tested values may be lower. (Rheem, No. 12 at p.7) AHRI recommended that DOE reassess the default values for draft factors. AHRI also stated that information provided by their members indicates that the default draft factors are too high for current models of furnaces and boilers. (AHRI, No. 13 at p. 2) Energy Kinetics also stated that the off-cycle draft factor may be reduced due to the use of draft-controlling devices, controls, and control strategies. (Energy Kinetics, No. 11 at p. 2)

Lennox stated that the test procedure should specify the conditions under which it is appropriate to use the minimum default draft factor of 0.05, and also should include instructions explaining how to test for low or no flow through the heat exchanger. It added that furnaces designed with burners above the outlet of the heat exchanger/combustion air inducer usually have no flow through the heat exchanger and into the vent system. (Lennox, No. 6 at p. 2) AHRI recommended that the test procedure should continue to use a minimum

assets/pdf/outdoor_reset_controls_odr_manual.pdf); Tekmar, ''Outdoor Reset ARC'' (2008).

[20] AHRI, ''Residential Boilers Certification Program Operations Manual'' (Available at: *http://www.ahrinet.org/App_Content/ahri/files/Certification/OM%20pdfs/updated/RBLR%20OM-%202013.pdf*). (Last accessed January 16, 2015).

[21] Hydrolevel Company, ''Fuel Smart Hydrostat Sales Sheet Three Function Control'' (Available at: *http://www.hydrolevel.com/new/images/literature/sales_sheets/fuel_smart_hydrostat_sales_sheet.pdf*) (Last accessed January 16, 2015).

[22] Tekmar, ''Boiler Post Purge'' (2012) (Last accessed January 16, 2015).

[23] Hydrolevel Company, ''Fuel Smart Hydrostat Sales Sheet Three Function Control'' (Available at: *http://www.hydrolevel.com/new/images/literature/sales_sheets/fuel_smart_hydrostat_sales_sheet.pdf*) (Last accessed January 16, 2015).

[24] California Energy Commission, ''Reference Appendices for the 2008 Building Energy Efficiency Standards for Residential and Non-residential Buildings'', p. 332, (Available at: *http://www.energy.ca.gov/2008publications/CEC–400–2008–004/CEC–400–2008–004–CMF.PDF*) (Last accessed January 16, 2015).

[25] Sections 11.2.9.9, 11.2.9.10, 11.2.10.2 of ASHRAE 103–1993.

[26] See Table 6 of ASHRAE 103–1993.

[27] Sections 8.8.2 of ASHRAE 103–1993.

[28] Section 11.6.4 of ASHRAE 103–1993.

[29] See section 8.8.3 of ASHRAE 103–1993 (''On units whose design is such that there is absolutely no chance of airflow through the combustion chamber and heat exchanger when the burner(s) is off, DF and DP may be set equal to 0.05.'') and section 9.7.4 of ASHRAE 103–1993 (''On units having a design such that there is absolutely no chance of airflow through the combustion chamber and heat exchanger when the burner(s) is off, DF and DP may be set equal to 0.05.'').

default draft factor for products with restricted flueways. AHRI also requested that DOE consider identifying conditions under which the minimum default draft factor can be applied. AHRI additionally recommended that DOE consider revising the default draft factor value and reevaluating the tracer gas method, and it offered to provide information on some of these additional items based on experience obtained from their efficiency certification program.[30] (AHRI, No. 13 at p. 4)

DOE tested several furnaces and boilers and used the measured mass flow rate to calculate D_F. The calculated D_F ranged from 0.05 to 0.16 for five tested furnace models and from 0.15 to 1.00 for three tested boilers equipped with power burners or direct venting capabilities. DOE also analyzed data from manufacturer testing conducted in 2001 [31] for 10 two-stage or modulating furnaces, which showed that D_F varied from 0.05 to 0.22. Although it appears that the data support lower default factors for D_F (*i.e.,* the direction taken by ASHRAE), the development of entirely new default draft factors would require a larger representative sample than the data from the available test results. Therefore, DOE has tentatively concluded that the test data are not sufficient to support revising the default draft factors at this time. DOE did not receive comments from stakeholders regarding default values for D_S and D_S^O. Neither ASHRAE 103–1993 nor ASHRAE 103–2007 explain the derivation of the fixed default values when provided for these terms. In cases where default values for D_S and D_S^O are not used, these values are dependent on D_F, which, as discussed previously, DOE does not propose to change. Therefore, DOE tentatively proposes to adopt the default draft values as defined in ASHRAE 103–2007, which are unchanged from the existing DOE test procedure.

Additionally, DOE recognizes that stakeholders have indicated that they are interested in the test procedure providing better direction as to how to determine whether a boiler model design and/or performance would qualify the boiler to use the minimum default draft factor of 0.05 (*i.e.,* for units with no airflow through the combustion chamber and heat exchanger).[32] Two separate, but related, sections of the DOE test procedure address the conditions required for use of this minimum default draft factor. Specifically, section 8.8.3 of ASHRAE 103–1993, which is incorporated by reference into the DOE test procedure for residential furnaces and boilers, states that ''on units whose design is such that there is *absolutely* no chance for airflow . . ., D_F and D_P may be set equal to 0.05.'' Similarly, section 9.10 of ASHRAE 103–1993, which is also incorporated by reference in the DOE test procedure, states that ''for units designed with no *measurable* airflow . . ., D_F and D_P may be set equal to 0.05.'' DOE agrees that the existing DOE test procedure lacks specificity in terms of determining whether a boiler design allows for no measurable airflow through the combustion chamber and heat exchanger during the burner off-period. Without such details, it is unclear to DOE how the manufacturers of residential boilers determine whether a particular model satisfies this criterion.

Upon further inquiry, it is DOE's understanding that the commonly used test to prove ''no flow'' is based on tracer gas testing and/or identification of designs that ensure no chance of airflow. However, experience with the tracer gas testing applied to these types of product designs indicates that the tracer gas method does not produce consistent and repeatable results for very low to no-flow conditions. In addition, DOE is not aware of any existing design characteristics that provide for ''absolutely'' no chance of airflow.

DOE has not found a consistent and widely accepted test method to determine whether the use of the minimum default draft factor value is appropriate for a given model. To address this issue, DOE considered retaining the existing language in conjunction with the following methods:

(a) Define design characteristics which ensure no flow through the combustion chamber and heat exchanger;

(b) Use of commonly applied tracer gas method;

(c) Smoke stick protocol; and

(d) A combination of (b) and (c).

DOE considered defining product design characteristics, such as downflow heat exchangers and availability of combustion intake dampers, which would be used for identifying products, which meet the requirements of sections 8.8.3 and 9.10 of ASHRAE 103. However, DOE understands that identified design characteristics do not always guarantee that there will be no chance of measurable airflow through the combustion chamber and heat exchanger when the burner is off.

DOE also considered the use of the existing tracer gas test. As addressed in the previous discussion, in instances where the measured D_P is less than 0.1, D_P can be set at 0.05. Based on testing experience, DOE understands that the tracer gas test is often inaccurate at flows lower than a D_P of 0.1 and, therefore, may not provide clear evidence of the absence of flow.

After considering the alternatives, DOE proposes to incorporate a test based on the use of a smoke stick. The proposed test protocol would establish the absence of flow through the heat exchanger using a smoke stick device for products designed with no measurable airflow. If the smoke from the stick passes by the combustion air intake without visual disturbance, then it indicates that there is no measurable airflow through the heat exchanger. If the smoke from the stick is visually induced into the combustion air intake, then it indicates that there is measurable airflow through the heat exchanger. The smoke stick test is not intended to quantify the volume of air moving through the heat exchanger. If the smoke stick test indicates that there is an absence of flow through the heat exchanger, the use of the minimum default factor would be allowed (per sections 8.8.3 and 9.10 of incorporated ASHRAE Standard 103). In the event that the smoke stick test indicates the presence of airflow, the use of the optional tracer gas test [33] would be required for determining a draft factor value other than the default draft factor as specified in Table 6 of ASHRAE 103–2007.

Additionally, DOE proposes to include revisions to the incorporated requirements of sections 8.8.3 and 9.10 of ASHRAE 103–2007, specifically to accommodate the use of the smoke stick test and to eliminate use of the term ''absolutely'' in sections 8.8.3 and 9.7.4. See proposed sections 7.12, 8.10, and 8.11 of 10 CFR part 430, subpart B, appendix N for the detailed test protocol and language revisions.

[30] As of the date of issuance of this NOPR, DOE has not received any additional information from AHRI.

[31] Provided to DOE in 2002 by the National Institute of Standards and Technology (NIST).

[32] Verification of absolutely no flow through combustion chamber and heat exchanger is left to the discretion of ''the one testing'' (typically the manufacturer or testing agency), as set forth in sections 8.8.3 and 9.10 of ASHRAE 103–1993 and ASHRAE 103–2007.

[33] Per sections 8.8.2 (Optional Tracer Gas Method for Determining Draft Factors D_P and D_F for Systems Equipped with Power Burners or Direct Vent) and 9.7 (Optional Tracer Gas Method for Determining Draft Factors D_P, D_F, and D_S for Systems Equipped with Power Burners or Direct Vent and Not Equipped with Stack Dampers) of ASHRAE 103–2007.

7. AFUE Reporting Precision

DOE's existing furnaces and boilers test procedure specifies that the AFUE rating be rounded to the nearest whole percentage point (see 10 CFR 430.23(n)(2)). In the January 2013 RFI, DOE sought comment on how much precision is statistically possible when reporting AFUE. 78 FR 675, 678 (Jan. 4, 2013).

Lennox, Carrier, Rheem, and AHRI commented that the AFUE rating should be reported to the nearest tenth of a percent. (Lennox, No. 6 at p. 3; Carrier, No. 7 at p. 2; Rheem, No. 12 at p. 9; AHRI, No. 13 at p. 5) Rheem added that furnaces listed in the AHRI Directory report AFUE values at this level of specificity. (Rheem, No. 12 at p. 9) AHRI stated that rounding AFUE values to the nearest tenth of a percent has been common industry practice for furnaces and boilers, and it provides a sufficient level of accuracy to distinguish models that have different efficiencies. (AHRI, No. 13 at p. 5)

DOE understands that reporting AFUE values to the nearest tenth of a percent has been common industry practice for furnaces and boilers. DOE agrees with stakeholders that reporting AFUE values to the nearest tenth of a percent will provide a sufficient level of precision to distinguish models that have different efficiencies. Therefore, DOE proposes to update the existing requirement for residential furnaces and boilers to report AFUE to the nearest tenth of a percentage point.

8. Duct Work for Units That Are Installed Without a Return Duct

Section 7.2.1 of ASHRAE 103–1993, incorporated by reference in the existing DOE test procedure, specifies use of a return duct for all furnaces according to Figure 1 and Figure 2 in section 7.2.1. During DOE's furnace and boiler testing, it was observed that there could be some ambiguity about testing requirements for units that manufacturers have designed to be installed without a return duct. To eliminate such ambiguity, DOE proposes to add a provision in the test procedure clarifying that the return (inlet) duct is not required during testing for units intended to be installed without a return duct, according to the manufacturer's I&O manual.

9. Testing Requirements for Multiposition Configurations

The current DOE test procedure does not specify the testing requirements for multiposition furnaces.[34] During DOE's furnace and boiler testing, DOE observed ambiguity in testing requirements for multiposition furnaces, regarding which furnace orientation to use during testing and how to test the unit if there is no open inlet. Testing the furnace in different configurations (*i.e.,* upflow, downflow, or horizontal) often results in different AFUE ratings. In addition, some multiposition furnaces might be shipped without an open inlet. Instead, there may be perforated metal cutouts blocking the inlet options that correspond to the available installation configurations. In some cases, DOE understands that testing facilities remove the blower access door and use it as an inlet instead of one of the inlet configurations, even though the DOE test procedure does not provide this option. Using the blower access door opening on sealed cabinets preserves the value of the test unit and reduces the length of the set-up time.

To reduce ambiguity, DOE proposes to require that multiposition furnaces be tested using, at a minimum, the least-efficient position. DOE is also expressly allowing manufacturers to test multiposition furnaces in other configurations in addition to the least efficient if they wish. DOE understands that currently, most multiposition models are already tested using multiple configurations because the existing DOE test procedure has different requirements and test setup for each configuration, which can result in different AFUE ratings. Therefore, DOE believes that in most cases, there would be no additional testing burden to the manufacturer associated with this clarification. DOE notes that, under this proposal, the manufacturer must either: (1) represent the efficiency of each of the various configurations using the AFUE of the least-efficient configuration and certify them pursuant to the requirements in 10 CFR part 429 or (2) test and certify the various configurations pursuant to the requirements in 10 CFR part 429.

Regarding multiposition furnaces not shipped with an open inlet, DOE proposes to allow testing of the unit using only the blower access door. This testing approach allows the value of the test unit to be preserved and reduces the length of the set-up time.

D. Tolerances on Test Conditions and Measurements

In the RFI, DOE requested comment as to whether the existing statistical variability of AFUE is acceptable. 78 FR 675, 677 (Jan. 4, 2013). The statistical variability within the test procedure depends on the permissible variations in test conditions (room ambient temperature, return water temperature, and product hourly Btu nameplate input rating) and the existing equipment measurement error associated with the measurement of variables (such as firing rate, heating media temperatures, flow rates, fuel calorific value, weight of condensate, water flow and temperature, voltage, and flue gas composition). DOE sought comment and received input on whether the existing tolerance ranges for test conditions and statistical variability in the test procedure are acceptable or whether DOE should define different methods of measuring and recording such variables.

The DOE test procedure allows for variations in certain test conditions. While these conditions do not directly impact the accuracy of the of the test method, they may impact the reproducibility of the AFUE results determined under the range of allowable test conditions.[35]

Rheem commented that the firing rate varies with run time; having a wider tolerance ensures that a sample furnace may be set at an appropriate rate at the beginning of a test and stay within the tolerance for the duration of the test. (Rheem, No. 12 at p. 7) Lennox added that any additional narrowing of the firing rate tolerance range from ±2% could cause the product to drift out of range while conducting the steady-state, heat-up, and cyclic condensate collection tests. According to Lennox, variations in gas valve performance can cause gas manifold pressures to vary slightly over time while conducting the test, thereby affecting the firing rate. (Lennox, No. 6 at p. 2) Several of the stakeholders reiterated that DOE should only consider changing tolerances if DOE has data supporting the change. (Lennox, No. 6 at p. 2, Carrier, No. 7 at p. 1, Rheem, No. 12 at p. 7, AHRI, No. 13 at p. 3) NRDC commented that permissible variations for tests can be used, from a positive perspective, to avoid the need to control arbitrary conditions in an overly tight or an overly expensive way, or they can be used, from a negative perspective, as a way of influencing the results by choosing the end of the tolerance range that gives the best AFUE. The commenter stated that DOE should review existing certifications to make sure that the latter is not happening, and tighten the permissible variation ranges if it is. (NRDC, No. 14 at p. 1) Other

[34] A multiposition furnace is a furnace that can be installed in more than one airflow configuration (*e.g.,* upflow or horizontal; downflow or horizontal; and upflow, downflow or horizontal).

[35] See section III.E.5 of this notice for an example of how reproducibility is affected by the allowed tolerances.

stakeholders (NRCan, APGA, AHRI, Carrier, Lennox, Crown Boiler, APGA, and Energy Kinetics) also commented on this issue regarding specific variables, such as room ambient air conditions and boiler supply and return water temperature ranges.

DOE has addressed room ambient air conditions and boiler supply and return water temperature ranges in sections III.E.5 and III.E.7 of this notice. For product hourly Btu nameplate input rating, DOE agrees with Lennox that the variation in gas valve performance does not allow further narrowing of the tolerance range. Additionally, there are no data to support such a change. Therefore, DOE has decided not to propose changes to the allowable tolerance range on firing rate because of the increased manufacturer burden.

On the subject of the appropriateness of the existing test procedure tolerances on measured variables, AHRI, Rheem, Carrier, and Lennox all stated that they believe the existing tolerances for measured variables such as fuel calorific value, weight of condensate, water flow and temperature, voltage, flue gas composition, firing rate, heating media temperatures and flow rates, and ambient air temperatures are acceptable. (AHRI, No. 13 at p. 3; Rheem No. 12 at p. 7; Carrier, No. 7 at p. 1; Lennox, No. 6 at p. 2)

To establish the overall uncertainty of the test procedure, DOE developed an analytical tool that determines the AFUE of residential furnaces and boilers based on ASHRAE 103–1993 provisions. The methodology applies Monte Carlo simulations that use distributions of values for all variables with defined measurement error. The tool is implemented as a computer spreadsheet with an add-on program to perform 10,000 iterations of the simulation. The parameter uncertainty ranges were defined based on the tolerances specified in section 5 and section 8.6.1.3 (jacket loss) of ASHRAE 103–1993 and ASHRAE 103–2007, which are incorporated by reference or are proposed to be incorporated by reference, respectively, in the DOE test procedure.

Table 1 provides a summary of the maximum standard deviations by product type, using the existing DOE test procedure. For the models tested, AFUE uncertainty ranged from 0.1 (for modulating condensing boilers) to 0.4 (for single-stage non-condensing boilers). Detailed results of the uncertainty analysis are presented in the Testing Report, which can be found in the docket for this rulemaking.

TABLE 1—UNCERTAINTY ON AFUE BY PRODUCT TYPE, BASED ON EXISTING DOE TEST PROCEDURE

Control type	Boilers		Furnaces	
	Non-condensing	Condensing	Non-condensing	Condensing
Single-stage (1)	0.4	0.2	0.3	0.3
Two-stage (2)	0.2	....	0.3	0.3
Modulating (3)	....	0.2	0.3	0.3

Based on DOE's analysis of the uncertainty associated with AFUE and stakeholder input, DOE agrees that, overall, the tolerances as specified within the existing DOE test procedure (section 5 of 10 CFR part 430, subpart B, appendix N) allow for an acceptable level of uncertainty. Considering stakeholders' input, the lack of data supporting any other specific changes to the existing tolerances, and the results of the uncertainty analysis, DOE proposes no modifications to any of the measurement tolerances in the existing test procedure.

E. Other Test Procedure Considerations

1. Electrical Consumption for Modulating Products

In the January 2013 RFI, DOE considered incorporating a method to measure part-load efficiency for modulating products with variable-speed motors. 78 FR 675, 678 (Jan. 4, 2013). Modulating units are often equipped with electronically commutated motors that allow for variable-speed operation of circulating blowers and pumps and combustion blowers. Motor efficiency changes as a function of partial loading (operation at speeds other than the nominal speed), which occurs as a result of a change in firing rate. These types of motors consume less energy when the product is functioning at lower speeds (*i.e.,* reduced firing rates). However, for modulating units, ASHRAE 103–1993 and ASHRAE 103–2007 assume that motors always operate at the settings for the maximum input rate during the modulating mode. Including a method for determining the part-load electricity consumption into the total electricity consumption calculations for modulating equipment could improve the accuracy of the electricity consumption calculations for modulating products.

Carrier, Rheem, and AHRI all opposed incorporating in the proposed test procedure a method for calculating part-load motor efficiency into its electricity consumption calculations. Carrier stated that motor efficiency is fairly constant within the useable operating range and that the benefits attendant to adding part-load efficiency provisions is not worth complicating the calculations. (Carrier, No. 7 at p. 2) Rheem commented that the existing test procedure does not assume a fixed motor efficiency: the E_{AE} (average annual auxiliary electrical energy consumption) has always been a part-load efficiency descriptor because it applies to multistage products such as modulating furnaces. Rheem argued that expanding E_{AE} to include four levels of operations, similar to the approach used by IEER,[36] would require double the testing. Rheem does not believe that this added level of complexity would provide consumers with information that would help them to make more informed product purchase decisions. (Rheem, No. 12 at p. 10) AHRI recommended DOE not consider the issue of part-load efficiency because the proposed approach would not provide a significantly improved consumption calculation, and would only amount to a minor change to an electrical consumption value that is already insignificant compared to the total furnace or boiler energy consumption. (AHRI, No. 13 at p. 5) Lennox commented that incorporating an additional testing method beyond that in the incorporated ASHRAE 103–2007 could impose an undue burden on manufacturers without providing a significant benefit to the customer, as the electrical consumption is a small

[36] Integrated Energy Efficiency Ratio (IEER) is a metric that integrates cooling part-load EER efficiency for commercial unitary air conditioning and heat pump equipment on the basis of weighted operation at various load capacities for the equipment.

percentage of the overall energy consumption for a furnace, and even more so for furnaces that incorporate modulating power burners. (Lennox, No. 6 at p. 3) NRCan stated that the test procedure should incorporate measurement of electrical energy used by power burners and circulating pumps in modulating appliances as part of a ''connected load'' during active mode testing, rather than developing and incorporating a new part-load motor efficiency calculation. (NRCan, No. 15 at p. 4)

Modifying the method to include part-load testing (in addition to the required testing at full and reduced-load operation) for determining the electricity consumption for modulating products would result in a minor improvement of the accuracy of the electricity consumption calculations. However, incorporating part-load electricity consumption testing for modulating products would require a significant amount of additional testing in the modulating mode of operation. Therefore, DOE has tentatively concluded that including additional provisions for part-load testing for modulating products would impose an undue burden on manufacturers without providing a significant benefit to the customer. Thus, DOE does not propose to modify the existing method for determining the electricity consumption for modulating products.

2. Jacket Loss and Jacket Loss Factors

DOE's January 2013 RFI also requested feedback on parameters that account for heat losses through the furnace or boiler jacket, including: (1) An overall jacket loss value (L_J), which is either assigned a value of 1.0 percent or determined in accordance with 8.6 of ASHRAE 103–1993; and (2) the default factors that adjust the L_J based on installation location—jacket loss factor (C_J) and the factor that adjusts jacket losses measured in the laboratory to those that would be measured under outdoor design conditions (K).[37] 78 FR 675, 677 (Jan. 4, 2013).

Ingersoll Rand argued that the testing burden can be reduced by improving jacket loss default values. (Ingersoll Rand, No. 8 at p. 1) Rheem stated that the existing default jacket loss value is too high, and that a value more representative of the results of an actual jacket loss test may eliminate the need for this test. (Rheem, No. 12 at p. 2) Rheem stated that testing of current production furnaces indicates jacket losses (L_J) in the range of 0.3 to 0.4, far below the default value of 1.0. (Rheem, No. 12 at p. 2) AHRI also stated that the default jacket loss value for furnaces may be twice as high as the typical jacket loss of current models. (AHRI, No. 13 at p. 2)

Several stakeholders indicated that applying the existing jacket loss default factors may result in an overestimation of the AFUE rating of furnaces and boilers. NRCan commented that the definition of the permitted default jacket loss value and jacket loss factors should be re-examined to ensure that jacket losses from furnaces and boilers are accurately calculated and reflect the way that those products are typically installed in residential applications. NRCan also stated that DOE should clarify and review the definitions for ''isolated combustion system,'' ''direct vent system,'' and ''systems intended to be installed indoors'' to ensure that the definitions unambiguously lead to and clearly identify the appropriate jacket loss factors for residential furnaces and boilers. In addition, NRCan stated that the jacket loss factor (C_J) for non-weatherized boilers should not be set to zero. (NRCan, No. 15 at p. 2&3) NRDC suggested that DOE pursue conservatively chosen default factors, which would result in lower AFUE values that are more representative of the majority of real world situations. (NRDC, No. 14 at p. 1) Energy Kinetics indicated that steady-state jacket losses, which can range from 2 percent to 6 percent, are not accounted for in the AFUE rating and, therefore, could encourage manufacturers to minimally insulate boilers, which may contribute to inflated AFUE values. Energy Kinetics stated that DOE, as demonstrated by its test procedure and energy conservation standard, assumes that these losses contribute to heating the home, but in most instances, boilers are not located within the heated living space, so jacket losses are efficiency losses. (Energy Kinetics, No. 11 at p. 2)

DOE understands that determining jacket loss through testing presents a testing burden for manufacturers. The existing test procedure sets the default jacket loss value at 1 percent. Rheem and AHRI reported that the jacket losses determined through testing are about half the default value, which for non-weatherized furnaces represents an AFUE increase of up to 1.2 percent[38] when using the measured value as compared to using the default value.

Based on available test data, DOE has tentatively concluded that changing the jacket loss default value would be inappropriate at this time. DOE tested a number of residential furnaces and boilers according to the test methods prescribed in section 7 of the DOE test procedure and used the resulting measurements to calculate L_J, which ranged from 0.360 to 0.776 for the five furnace models tested. The 2001 manufacturer test data provided by NIST for 16 two-stage or modulating furnaces showed this value to range from 0.112 to 0.750. In DOE's view, there are not enough data to represent the more than 5,000 furnace and boiler models with diverse design characteristics currently on the market, and a larger, statistically representative market sample would be needed for DOE to consider such a major change. The preparation of such a sample would require a significant amount of manufacturer input that was not available for this notice. Therefore, DOE does not propose changing the existing default value for the jacket loss at this time.

The existing DOE test procedure identifies default jacket loss factors C_J and K based on product type (non-weatherized furnaces, non-weatherized boilers, and weatherized furnaces and boilers) and the assumed intended installation location. NRCan, NRDC, and Energy Kinetics commented that the values for these factors should be reevaluated on the basis that installation location assumptions within the existing test procedure do not reflect the way that those products are typically installed in residential applications. (NRCan, No. 15 at pp. 2–3; NRDC, No. 14 at p. 1; Energy Kinetics, No. 11 at p. 2) The installation locations associated with each product type are as established by the statute[39] and cannot be changed by DOE. Therefore, DOE is not proposing any changes to the existing default values for the jacket loss factors.

[37] See section 11.2.11 (C_J) and 11.2.8.1 (K) of ASHRAE 103–1993, which are incorporated by reference in the DOE test procedure.

[38] According to Rheem's results, which report measured jacket losses averaging of 0.3 to 0.4 percent compared to the default value of 1 percent.

[39] Under 42 U.S.C. 6291(a)(20), ''[t]he term 'annual fuel utilization efficiency' means the efficiency descriptor for furnaces and boilers, determined using test procedures prescribed under section 6293 of this title and based on the assumption that all—

(A) weatherized warm air furnaces or boilers are located out-of-doors;

(B) warm air furnaces which are not weatherized are located indoors and all combustion and ventilation air is admitted through grills or ducts from the outdoors and does not communicate with air in the conditioned space; and

(C) boilers which are not weatherized are located within the heated space.''

3. Use of Default Seasonal Factors To Replace ''Heat-Up'' and ''Cool-Down'' Tests

During the heat-up and cool-down tests, flue gas temperatures are measured at various time intervals throughout the test. These measurements are used when determining the impact of the cyclic conditions on AFUE. Several terms in the AFUE calculation are dependent on the measurements from the heat-up and cool-down tests. The use of default seasonal factors may reduce overall manufacturer test burden by making the ''heat-up'' and ''cool-down'' tests (and their associated calculations) unnecessary. In the January 2013 RFI, DOE requested input from stakeholders as to whether such default factors are a feasible alternative to testing and whether such factors correlate to the physical characteristics of the product. 78 FR 675, 677 (Jan. 4, 2013).

AHRI recommended that DOE consider replacing the heat-up and cool-down tests with default seasonal factors. (AHRI, No. 13 at p. 2) Both Lennox and Rheem stated that they were in favor of replacing the heat-up and cool-down tests with seasonal default factors to reduce the test burden. (Lennox, No. 6 at p. 1; Rheem, No. 12 at p. 2) Lennox agreed that the physical characteristics of the product may have a bearing on the heat-up and cool-down test values and their effect on the AFUE. (Lennox, No. 6 at p. 1) Rheem suggested that data from the heat-up test show a difference between condensing and non-condensing furnaces in the calculated value of AFUE. In contrast, Rheem also stated that data from the cool-down test do not show a difference between condensing and non-condensing furnaces and, in general, the cool-down test has a minimal effect on AFUE. (Rheem, No. 12 at p. 2) Rheem recommended separate default values for CT_{ON} (heat-up temperature profile correction factor for the effect of cycling) and CT_{OFF} (cool-down temperature profile correction factor for the effect of cycling) for both non-condensing and condensing products: 0.9 for CT_{ON} and 0.9 for CT_{OFF} for non-condensing products, and 0.6 for CT_{ON} and 0.9 for CT_{OFF} for condensing products. Rheem provided a statistical summary that showed low variability of cool-down and heat-up results in their testing and suggested DOE allow the use of default factors for CT_{ON} and CT_{OFF}.

In DOE's view, replacing CT_{ON} and CT_{OFF} with default values would simplify the AFUE calculation. However, DOE cannot establish representative default values for CT_{ON} and CT_{OFF} for all covered units based on data from only one manufacturer's products. Additionally, these two parameters are only two calculated values among several that depend on the time-temperature values measured during the cool-down and heat-up tests.[40] Completely eliminating the heat-up and cool-down would require replacing all of these values with default values. Therefore, DOE tentatively concludes that it cannot justify replacing the heat-up and cool-down tests with default factors.

4. Calculation Simplification for Burner Cycling and Draft Losses

In the January 2013 RFI, DOE requested comment on whether simplifying the calculation for determining the burner cycling and draft losses used to compute seasonal efficiency is a viable alternative to testing, and whether or not such a simplification would result in a less precise assessment of the efficiency rating. 78 FR 675, 677 (Jan. 4, 2013).

AHRI recommended that DOE try to simplify the calculation procedure for determining the burner cycling and draft losses. (AHRI, No. 13 at p. 2) Lennox likewise stated support for DOE's efforts in simplifying the calculation procedure for determining the burner cycling and draft losses. (Lennox, No. 6 at p. 2) Rheem suggested that, based on the minimal variation in CT_{ON} and CT_{OFF}, default values would be acceptable to use in place of performance testing. (Rheem, No. 12 at p. 3) However, Rheem recommended that non-condensing and condensing products should have different default values for CT_{ON}. (Rheem, No. 12 at p. 3)

Although stakeholder comments indicate agreement with simplification of the calculation process, data are required to substantiate a change to the values. Given the lack of proposed simplifications and supporting data, DOE does not propose to simplify the calculation for determining the burner cycling and draft losses at this time.

5. Room Ambient Air Temperature and Humidity Ranges

The DOE test procedure for residential furnaces and boilers set forth in 10 CFR part 430, subpart B, appendix N, which currently incorporates by reference ASHRAE 103–1993, includes a steady-state and a cyclic condensate collection test for modulating and two-stage condensing furnaces and boilers. The amount of condensate produced, which captures the latent energy of the flue gases, is a major determinant of AFUE for condensing products but is sensitive to the humidity and temperature of the room ambient air. Under the existing DOE test procedure, the room temperature may not fall below 65 °F or exceed 100 °F, except for condensing furnaces and boilers, for which the room temperature may not exceed 85 °F. Additionally, the existing test procedure specifies a maximum relative humidity limit of 80 percent. To improve the comparability of AFUE for models tested under different conditions within the allowable range of room ambient conditions, DOE considered revisions to these conditions as set forth in the current DOE test procedure. In particular, in the RFI, DOE requested comment as to the appropriateness of tightening the allowable room air temperature range. 78 FR 675, 677 (Jan. 4, 2013). Several stakeholders provided comments in response to this request.

NRCan stated that the ambient room temperature tolerance for testing condensing furnaces should be tightened. NRCan stated that in the DOE test procedure for water heaters, the ambient air temperature is required to be maintained between 65.0 °F and 70.0 °F (18.3 °C and 21.1 °C) on a continuous basis. An ambient temperature range from 65 °F to 85 °F, as currently permitted for condensing furnaces and boilers, might be too wide, resulting in greater variation of AFUE for models tested under different temperature conditions. (NRCan, No. 15 at p 1–2) APGA stated that a furnace test may produce higher AFUE results during a hot summer day; to aid customers in comparing products, the testing conditions (with regards to ambient air temperature) should be similar. (APGA, No. 5 at p. 2)

Carrier supported consideration of a narrower window for allowable room air temperature range, provided that the low temperature limit is not increased above 65 °F. (Carrier, No. 7 at p. 1) AHRI commented that the topic merits consideration but also that DOE must recognize that any tightening of the range may either require test facility changes to control temperature or limit a manufacturer to conducting this test only during certain times of the year when the outside ambient conditions allow the test facility to be within the specified range. AHRI suggested that if DOE's inclination is to tighten this range, this consideration should include the option of a mathematical correction to adjust results when a test is conducted with the room temperature

[40] Section 8.0 of Appendix N to Subpart B of Part 430, which refers to ASHRAE 103–1993, sections 9.5, 9.6; and section 10 of Appendix N, which refers to ASHRAE 103–1993, sections 11.2.9.4—11.2.9.8.

outside the specified range. (AHRI, No.13 at p. 3)

Lennox similarly commented that tightening the allowable ambient air temperature range may require some test facilities to implement test facility temperature control. In the case of non-condensing furnaces, this would prove costly and burdensome to manufacturers while providing little value to consumers, because AFUE is not significantly impacted by ambient room temperatures for such products. (Lennox, No. 6 at p. 2)

The AFUE of condensing boilers is also affected by room ambient humidity ratio because the amount of condensate produced depends in part on the moisture content of the ambient air: The higher the humidity ratio, the more condensate is available from which a boiler can extract heat. Crown Boiler stated that the current humidity limit significantly increases the amount of condensate a condensing boiler can collect compared to what is theoretically possible under typical operating conditions. Crown Boiler stated that most residential condensing boilers are designed so that they can be directly vented to outside the home; in addition, AFUE is currently calculated based on venting using outdoor air at a temperature assumed to be 42 °F. Based on this, in Crown Boiler's view, the upper limit for humidity for testing condensing boilers should be the humidity ratio at 100 percent relative humidity at 42 °F. According to Crown Boiler, this equates to a room humidity of slightly more than 20 percent at the current maximum allowable 85 °F ambient temperature. Limiting the relative humidity would help to ensure that the testing conditions accurately reflect the assumptions made in the test procedure calculations. However, Crown Boiler also stated that the decision to limit room humidity should not be taken lightly, as it could create a significant new test burden for manufacturers who may need to construct environmental chambers in order to continue performing AFUE testing during humid weather. Given the burden associated with restricting room humidity, Crown Boiler requested that even if such changes prove warranted for condensing boilers, DOE should not change the limitations for room humidity for furnaces or non-condensing boilers, unless there are data to justify such a change for these types of products. Crown Boiler stated that the imposition of this burden may be justified for condensing boilers in order to ensure that the energy performance is more accurately represented in the marketplace. Crown Boiler stated that it would also support the adoption of a computational technique for correcting results from testing done at higher relative humidity (RH) levels back to a standard RH that can be realistically expected in the field. (Crown Boiler, No. 9 at pp. 1–2)

AHRI stated that DOE should give careful consideration before amending the DOE test procedure to specify a relative humidity range. AHRI also recommended that mathematical corrections should be taken into consideration in lieu of tightening the room air humidity range. (AHRI, No. 13 at p. 3)

The stakeholder comments discussed two options for addressing the room ambient conditions during testing: (a) Introduce a mathematical correction methodology that normalizes condensate production during the AFUE test to a standard set of ambient conditions while retaining the existing ambient temperature ranges and (b) further restrict temperature and humidity ranges during testing.

DOE investigated the impact of ambient conditions on AFUE of non-condensing units by testing one non-condensing furnace and one non-condensing boiler under several sets of ambient conditions. Based on the testing results, DOE concluded that the room ambient air temperature and humidity do not have a statistically significant impact on the AFUE of non-condensing furnaces and boilers. (See Testing Report.) Therefore, for non-condensing products, DOE has tentatively decided not to propose revisions to the existing ambient temperature and humidity ranges.

To evaluate the impact of varying room ambient conditions on condensing product efficiency, DOE conducted eight separate AFUE tests on one modulating condensing boiler and one two-stage condensing furnace (four tests per unit) based on the existing DOE test procedure. For the tested furnace model, the AFUE difference between the tests conducted at varying ambient conditions shows that AFUE may vary as much as 2.3 percent. This variation in AFUE is greater than the uncertainty associated with the measurement error and is attributed to changes in ambient conditions between the tests. For the tested boiler model, the test results show that the AFUE of the tests conducted at varying ambient conditions are within the overall measurement uncertainty; therefore, the variation in AFUE cannot be attributed to changes in ambient conditions based on the data. The details of the test results can be found in the Testing Report.

DOE investigated a computational method for normalizing condensate mass to a set of standard ambient conditions in order to limit the variability in reported AFUE from tests conducted at various ambient temperatures and humidity levels. To assess the validity of the normalization methodology, DOE utilized the test data from the eight AFUE tests performed at different temperature and humidity conditions.

Applying the normalization approach to the test data resulted in significant differences in the calculated AFUE values at different room ambient conditions, particularly for the furnace models. DOE conducted a statistical evaluation to determine whether the differences in the adjusted AFUE values at different room ambient conditions can be solely attributed to measurement tolerances. For the statistical evaluation, DOE assumed that only two factors impacted condensate collection: Room ambient conditions and measurement accuracy. Based on the results from the statistical evaluation, which are described in the Testing Report, DOE concluded that the normalization methodology does not eliminate the variability of AFUE due to the room ambient conditions.

Based on the analyzed test data and the outcome of the statistical test, the normalization approach appears to be ineffective. Therefore, DOE is not proposing to implement a mathematical approach for normalizing condensate production to a standard set of conditions during the AFUE test.

Alternatively, DOE assessed whether to further restrict the currently required room temperature and humidity ranges during testing. To determine whether narrowing the admissible range of ambient conditions would impact the ability of the test facility to perform testing, DOE assessed the average ambient conditions (dry-bulb temperature and relative humidity) using Typical Meteorological Year 3 (TMY3) data [41] for all TMY weather stations across the United States. The results of this assessment, which are included in the Testing Report, show that 75 percent of the stations currently within the allowable range would fall outside the considered restricted allowable range of ambient test conditions. Based on this assessment, DOE agrees with AHRI, Lennox, and Crown Boiler that tightening the allowable ambient air temperature and humidity range may force some test facilities that currently do not use

[41] See *http://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/*.

mechanical space conditioning to incorporate environmental controls or limit the testing to only certain times of the year, thereby resulting in additional testing burden for these facilities. Therefore, based on the potentially significant burden to manufacturers, DOE is not proposing to restrict the currently required room ambient conditions ranges.

6. Oversize Factor

In the January 2013 RFI, DOE sought comment as to whether the use of the existing oversize factor[42] (0.7, or 170 percent of the house heating load) remains appropriate for current field installations. 78 FR 675, 677 (Jan. 4, 2013). This request was primarily focused on use of the oversize factor for single-stage boilers, as the adoption of ASHRAE 103–2007 should adequately address the oversize factor issues related to two-stage/modulating products.

Energy Kinetics, Rheem, NRCan, and NRDC all agreed that the existing 0.7 oversize factor merits review. Energy Kinetics stated that the fixed 0.7 oversizing factor provides misleading information to the marketplace: A boiler that is perfectly sized will have no benefit in the AFUE rating compared to a system that is oversized by a factor of five. (Energy Kinetics, No. 11 at p. 2) Rheem would appreciate clarification from DOE on the definition of ''average oversizing'' and the specific assumptions that lead to a national value. Rheem stated that it has seen no indication that replacement furnaces are less oversized than in the past, but there is an important effect due to the increasing market share of multistage products. (Rheem, No. 12 at p. 8) DOE acknowledges that when units operate at the reduced input rate in the cycling mode, the unit is considered to be properly sized at the reduced rate to meet the heating load.[43]

Energy Kinetics, Rheem, and NRDC each offered recommended adjustments to the existing oversize factor. Energy Kinetics stated that fuel consumption data coupled with degree-day analysis indicate that an oversize factor of 2.0 (*i.e.,* an additional 200 percent of the house heating load, resulting in a total sizing of 300 percent of the house heating load) or more is not only common, but the norm. (Energy Kinetics, No. 11 at p. 2) NRDC commented that DOE should review the concept of oversizing as a multiplicative factor, as opposed to a more nuanced adjustment. NRDC stated that a more sophisticated approach may make more sense in light of thermal upgrades to the International Energy Conservation Code (IECC),[44] both those already adopted and those anticipated in the future. (NRDC, No. 14 at p 1) The commenter stated that for such an approach, DOE should investigate whether an oversize factor that varies as a function of furnace sizing would provide a more accurate representation of expected field results. (NRDC, No. 14 at p. 2)

In contrast, Carrier and AHRI commented that the oversize factor, as set forth in the existing test procedure, does not need to be reviewed. However, Carrier recommended, in the event that DOE does not adopt ASHRAE 103–2007, DOE should use the same fixed oversize factor for maximum input on modulating products, which is currently not the way the incorporated modulating section of ASHRAE 103–1993 assigns an oversize factor. (Carrier, No. 7, p. 2) AHRI commented that the heating loads of today's residences tend to be lower because of tighter building envelopes and weatherization improvements, but this does not correlate directly to any change in the oversize factor. It added that the increased use of two-stage and multistage models reduces the significance of having an accurate oversize factor in the test procedure. AHRI stated that in the field, the oversize factor only relates to the full input rate of the furnace or boiler. When the unit is operating at the reduced rate, it will fire at an input much closer to the estimated design heating load of the house. (AHRI, No. 13 at p. 4)

A literature review conducted by DOE in response to stakeholder comments revealed a variety of recommended oversize factors. Some sources recommended lower values. For example, the Cold Climate Housing Research Center stated that, although the assumed national oversize factor is 0.7, recent developments in software and sizing techniques have allowed installers to size appliances more closely to the Air Conditioners Contractors of America (ACCA) guidelines of using an oversize factor of 0 to 0.4 (*i.e.,* 100 percent to 140 percent of the house heating load).[45] The Center cited both the March 2012 Partnership for Advanced Residential Retrofit[46] oversize factor of 0.4, which is based on the ACCA recommendation, and the 2009 Alaska Building Energy Efficiency Standards[47] value of 0.20, as more representative of current field installations. Research released later in 2012 by the Partnership for Advanced Residential Retrofit also stated that high-efficiency furnaces are insensitive to oversizing when AFUE is evaluated according to the ASHRAE standard (*i.e.,* not varying by more than 0.5 percent AFUE when tested between 70 percent and 120 percent oversizing).[48] A report by the Minnesota Department of Commerce State Energy Office stated that 47 percent of their field studies revealed oversizing of 50 percent or more, which it considers a significant problem because oversized units cycle more often, resulting in less-efficient operation.[49]

Other researchers found a higher range of oversize factors. Research by Arctic Energy Systems of South Central Alaskan Homes found that forced-air furnace oversizing ranged from 66 percent to 223 percent, with an average of 121 percent.[50] A report by the Minnesota Department of Commerce State Energy Office also found that ACCA's Manual J computer software[51] currently incorporates an oversizing safety factor of around 25 percent, so safety factors added by contractors and wholesalers can oversize units even more drastically (*i.e.,* in the

[42] ''Oversize factor'' accounts for the national average oversizing of equipment that occurs when a heating product is sized to satisfy more than the heating load of the household. This is typically done to size the equipment so that it is able to satisfy the days in which the house heating requirements might be exceeded and/or to take into account uncertainties regarding house heating load. For example, a 0.7 oversize factor is equivalent to 170-percent oversizing of the heating equipment (*i.e.,* 70 percent greater input capacity than is required).

[43] Kweller, E. and Thomas, F., ''An Analysis of United States Weather Data for the Calculation of Average Outdoor Temperatures and Fractional Heating Loads for Furnaces and Boilers Equipped with Fuel-Modulating Controls, National Bureau of Standards'' (1982).

[44] International Code Council, *2012 International Energy Conservation Code* (2011) (Available at: *https://law.resource.org/pub/us/code/ibr/icc.iecc.2012.pdf*).

[45] Cold Climate Housing Research Center, ''Annual Fuel Utilization Efficiency, A Review for Cold Climate Applicability'' (2013).

[46] Brand, Larry, ''Achieving the Best Installed Performance from High-Efficiency Residential Gas Furnaces,'' Partnership for Advanced Residential Retrofit (March 2012).

[47] Alaska Housing Finance Corporation, *Alaska-Specific Amendments to the IECC 2009* (2011) (Available at: *http://www.ahfc.us/files/1013/7393/1537/ak_bees_2009_ashrae_std_62_2_2010.pdf*).

[48] Brand, Larry, and Rose, William, *Measure Guideline: High Efficiency Natural Gas Furnaces,* U.S. Department of Energy Building America program (2012) (Available at: *http://www.nrel.gov/docs/fy13osti/55493.pdf*).

[49] Krigger, John, and Dorsi, Chris, Minnesota Mechanical Systems Field Guide, Minnesota Department of Commerce State Energy Office (2005).

[50] Kaluza, Phil, ''Over-Sizing of Residential Forced-Air Heating Systems in Southcentral Alaska Homes,'' Arctic Energy Systems (June 2002).

[51] ACCA's Manual J software produces equipment sizing loads (heating and cooling) for single-family-detached homes, small multi-unit structures, condominiums, town houses and manufactured homes.

neighborhood of 50 to 200 percent).[52] Additionally, the heating, ventilation, and air conditioning (HVAC) industry oftentimes scales predicted loads up to take into account unmeasured window performance, envelope construction, insulation, and duct system efficiency information. Integrated Building and Construction Solutions (IBACOS) modeled two baseline houses in Chicago, Illinois, and Orlando, Florida, and applied common ''safety factors'' to determine their effect on oversizing. Combining all the considered outdoor/indoor design, building component, ductwork and ventilation/infiltration safety factors resulted in 55 percent total oversizing for the Chicago house, and 141 percent total oversizing for the Orlando house.[53] A report in *Home Energy* magazine stated that the assumed amount of oversizing varies with the size of the furnace, but averages about 100 percent.[54]

Another study was conducted by the city of Fort Collins, Colorado, to assess the impact of the city's 1996 energy code (implementation experience, compliance rates, and energy-saving results).[55] The study focused on homes built between 1994 and 1999. The major components of the study were: (1) Inspections of 20 homes under construction; (2) market research interviews with 20 builders and 150 homeowners; (3) energy inspections, energy modeling, and utility bill analysis for 80 completed homes; and (4) performance testing of 40 completed homes. The study concluded that the furnaces installed in the homes surveyed were sized an average of 158 percent of the minimum required size with oversizing observed for 70 percent of the furnaces.

After considering the available information, DOE tentatively concludes that the revisions incorporated in ASHRAE 103–2007 have effectively addressed oversize factor corrections for two-stage and modulating products, and that the literature supports the continued use of an oversize factor of 0.7. Although Energy Kinetics, Rheem, NRCan, and NRDC commented that there is merit in reviewing the oversize factor, no data were provided that would support a change to the existing oversize factor. Moreover, based on recent research evaluating the sensitivity of AFUE to a change in oversize factor,[56] DOE found that furnace AFUE is generally insensitive to oversizing in the 70 percent to 120 percent oversizing range. Considering the conclusions and widely varying results presented by the studies discussed previously, DOE has tentatively determined the existing value of 0.7 continues to be representative of the oversized factor applicable to the average U.S. household. Therefore, DOE proposes to maintain the existing oversize factor.

7. Boiler Supply and Return Water Temperatures

Currently, the DOE test procedure sets the temperature of water delivered to the boiler (*i.e.,* return water) during the steady-state and heat-up tests between 120°F and 124°F [57] for non-condensing hot water boilers, and 120°F ± 2°F for condensing hot water boilers.[58] In the January 2013 RFI, DOE sought comment on these temperatures, and whether DOE should revise the values to more accurately reflect the average water temperatures of non-condensing and condensing boiler installations. 78 FR 675, 677 (Jan. 4, 2013).

APGA, Energy Kinetics, and NRCan agreed that the boiler water supply temperatures merit review. APGA commented that supply water temperatures can vary in different regions and seasons, and these regional and seasonal variations should be taken into account when measuring boiler performance. (APGA, No. 5 at p. 2) NRCan stated that for boilers, the supply and return water temperatures used to determine AFUE should approximate the temperatures that will be used after the appliance is installed. (NRCan, No. 15 at p. 4) Energy Kinetics stated that the nominal test return water temperature of 120 °F and supply water temperature of 140 °F used for determining AFUE are not representative of the supply and return water temperatures used in typical hydronic heating system installations, and the actual operational and off cycle temperatures may vary based on boiler controls. Energy Kinetics also stated that the performance of these controls is not assessed in the test method because of the fixed water temperatures used for the test, and that the exception for low-temperature radiant applications referenced in the RFI has very limited relevance to American homes because of the small fraction of boilers installed in low-temperature radiant systems. (Energy Kinetics, No. 11 at p. 2–3)

AHRI did not agree that the supply water temperatures specified for testing boilers need to be changed. AHRI recommended that DOE consider including the low-water-temperature test in Appendix F of ASHRAE 103–2007 as an additional test for use by manufacturers if they choose to provide supplemental information. (AHRI, No. 13 at p. 4–5)

The supply water temperature in the existing DOE test procedure has been used to represent average supply temperature conditions of various boiler designs and applications. DOE acknowledges that return water temperatures may vary by application for different types of products; however, DOE has tentatively concluded that the existing temperature value allows for consistent comparison of AFUE between non-condensing and condensing models. Therefore, DOE does not plan to change the supply/return water temperatures for boilers in the DOE test procedure.

DOE acknowledges AHRI's suggestion of identifying Appendix F of ASHRAE 103–2007 as the test method for use in determining seasonal efficiency testing at low supply water temperatures in the event that a manufacturer chooses to publish this efficiency information. In denying a prior waiver request from PB Heat, DOE clarified that it is permissible for a manufacturer conducting low-water-temperature seasonal efficiency (LWTSE) testing to present such results in product literature and to make related supplemental statements; however, AFUE test results generated under the DOE test procedure must continue to be disclosed, and LWTSE results must provide reasonable, clear, and distinguishable representations of those results to the consumer. 75 FR 25228 (May 7, 2010). While DOE permits publication of these data as supplemental information, these measurements are not part of DOE's test procedure.

8. Burner Operating Hours Determination

In the January 2013 RFI, DOE explored whether the parameters used to calculate the burner operating hours in the DOE test procedure (national average home-heating loads) should be amended due to changes in housing construction and climate conditions. 78 FR 675, 678 (Jan. 4, 2013). DOE sought comment on whether revised national

[52] Krigger, John, and Dorsi, Chris, Minnesota Mechanical Systems Field Guide, Minnesota Department of Commerce State Energy Office. (2005).

[53] Burdick, Alan, ''Accurate Heating and Cooling Load Calculations'' IBACOS, Inc. (June 2011).

[54] Pigg, Scott, ''Electricity Use by New Furnaces,'' Energy Center of Wisconsin (October 2003).

[55] Evaluation of New Home Energy Efficiency, Summary Report, City of Fort Collins (June 2002).

[56] Brand, Larry, and Rose, William, *Measure Guideline: High Efficiency Natural Gas Furnaces,* U.S. Department of Energy Building America program (2012) (Available at: *http://www.nrel.gov/docs/fy13osti/55493.pdf*).

[57] Section 8.4.2.3 of ASHRAE 103–1993.

[58] Section 8.4.2.3.2 of ASHRAE 103–1993.

average values should be used to calculate burner operating hours.

Carrier, Rheem, and AHRI did not support changing the burner operating hours. Carrier commented that unless there are compelling data showing the average conditions have changed significantly from what is currently the basis for the test procedure, it does not see a need to change the burner operating hours calculations. (Carrier, No. 7 at p. 2) Rheem admitted that it has not studied climatic conditions that would affect the burner operating hours, but it recommended that the national average heating load hours should not change. (Rheem, No. 12 at p. 10) AHRI recommended that DOE not consider this issue, as using a different average burner operating hours just moves the scale of comparison but provides no added value to consumers. (AHRI, No. 13 at p. 6) In contrast, NRCan commented that operating times used to determine annual fuel and electrical energy consumption ratings should be based on representative loads for the specific types of products. (NRCan, No. 15 at pp. 4–5)

DOE does not believe that there is sufficient evidence to substantiate a change in the national average heating load hours that are used to calculate the burner operating hours in the existing DOE test procedure. Therefore, DOE is not proposing changes to the existing value of the national average heating load hours.

9. Aligning Vent Stack Configuration With ANSI Standards

The installation configuration of a furnace or boiler vent stack depends on the type of product and the intended installation location. Currently, the configuration requirements for vent stacks used during testing differ between ANSI Z21.13 [59]/ANSI Z21.47 [60] and the DOE test procedure. ANSI Z21.47 and ANSI Z21.13 are standards for safe operation, substantial and durable construction, and acceptable performance of gas-fired central furnaces and gas-fired low-pressure steam and hot water boilers, respectively. These standards are intended to be used by manufacturers and those responsible for its proper installation. In the January 2013 RFI, DOE sought comment on whether there is a significant difference in efficiency rating related to the differences in vent stack configurations and whether it should consider adopting the vent stack requirements as set forth in ANSI Z21.13 and/or ANSI Z21.47. 78 FR 675, 678 (Jan. 4, 2013).

Lennox, Carrier, and AHRI stated that DOE should keep the existing test procedure vent stack configuration. (Lennox, No. 6 at p. 3; Carrier, No. 7 at p. 2; AHRI, No. 13 at p. 5) Lennox stated that changes to the vent stack configuration provisions would shift the AFUE values and provide no practical benefit to consumers. (Lennox, No. 6 at p. 3) AHRI stated that the existing configuration is appropriate for efficiency testing and that the vent configurations in safety standards are different because they focus on safety considerations. (AHRI, No. 13 at p. 5)

Rheem and NRCan commented that the requirements in the identified ANSI standards merit consideration. Rheem stated that aligning the test procedure with the ANSI Z21.47 vent stack configuration, which is meant to represent a marginal installation and not a typical installation, would require the use of uninsulated and slightly shorter vents for AFUE testing. This change would affect the vent temperature slightly, lowering the test AFUE. Rheem suggested that DOE should consider adopting the same vent stack requirements as used in the ANSI Z21.47 standard in order to reduce the number of test vents that must be maintained in the laboratory. (Rheem, No. 12 at p. 9) NRCan commented that the test procedure should adopt the same vent stack requirements as set forth in ANSI Z21.13 or ANSI Z21.47. NRCan stated that ultimately, the test procedure should incorporate whichever vent stack configurations are the most representative of typical field installations. (NRCan, No. 15 at p. 4)

In response, DOE recognizes that there is a potential opportunity for reducing testing burden associated with the storage and mounting of multiple vent stacks, and reducing the testing differences between ANSI Z21.13/ANSI Z21.47 and DOE's test procedure. However, several stakeholders expressed the opinion that any reduction in test burden would not be significant enough to outweigh the potential impacts to AFUE and any re-testing required as a result of new stack configurations. DOE also agrees with Rheem's comment that the change in stack configuration has the ability to impact AFUE in a way that may make the AFUE results less representative of actual field conditions. Because the ANSI standards address both safety and performance, the tests specify the minimum configurations for safe installation, and are not necessarily representative of product field installations. Furthermore, DOE believes the potential reduction in test burden associated with this change is not significant enough to offset the impact to the AFUE rating. Based on these considerations, DOE proposes not to pursue changes to the DOE test procedure that would require the use of the stack configuration as specified in ANSI Z21.13 and ANSI Z21.47 standards for boiler and furnace products.

10. Harmonization of External Static Pressure Requirements

In the January 2013 RFI, DOE sought comment on differences in efficiency performance caused by differences in minimum static pressure requirements between ASHRAE 103–2007 (Table IV) and DOE's recently published furnace fan test procedure,[61] as well as any drawbacks or advantages associated with harmonizing the requirements. DOE also requested information on any other national or international standards that should be considered for this cycle of residential furnaces and boilers test procedure rulemaking. 78 FR 675, 678–79 (Jan. 4, 2013).

Lennox expressed support for harmonizing to the minimum static pressure requirements listed in ASHRAE Standard 103–2007, rather than the much higher static pressures in DOE's furnace fan test procedure. (Lennox, No. 6 at p. 3) NRCan stated that it is difficult to predict the effects of revising the reference system in appendix N to match the proposed reference system in the furnace fan test procedure or vice versa. It commented that ideally the air duct reference system in both appendix N and the proposed furnace fan test procedure should be revised and harmonized to reflect realistic installations. NRCan went on to state that DOE should also consider harmonizing the minimum duct static pressures for gas furnaces and oil furnaces. (NRCan, No. 15 at p. 6) Rheem stated that the evaporator coils used in today's Rheem products have a pressure drop of close to 0.3 in. w.c. for an airflow rate of 350 cfm/ton and 0.4 in. w.c. at an airflow rate of 400 cfm/ton. Since the introduction of the 13 Seasonal Energy Efficiency Ratio (SEER) minimum efficiency regulations, Rheem argued that the assumptions supporting the minimum static pressure in Table 4 of ASHRAE 103–1993 are no longer true and that higher static

[59] American National Standards Institute, *American National Standard/CSA Standard for Gas-Fired Low Pressure Steam and Hot Water Boilers* (2010) Report No. ANSI Z21.13–2010, CSA 4.9–2010.

[60] American National Standards Institute, *American National Standard/CSA Standard for Gas-Fired Central Furnaces* (2006) Report No. ANSI Z21.47–2006, CSA 2.3–2006.

[61] 79 FR 500 (Jan. 3, 2014).

pressures are appropriate. Rheem commented that the static pressure values that were proposed in the furnace fan test procedure are more than double the existing test condition, and the effect on AFUE and the current product standards would require further study. (Rheem, No. 12 at p. 11)

AHRI recommended that DOE not consider this issue because it does not affect the AFUE measurement, so any change would have little to no value. It added that DOE should wait until the furnace fan test procedure is finalized before any further consideration is given to this issue. (AHRI, No. 13 at p. 6)

Stakeholders' input indicates that the impact of harmonizing the static pressure requirements in the residential furnaces and boilers test procedure and the furnace fan test static pressure conditions in the furnace fans test procedure is uncertain and would require further study. DOE investigated a method applied in the furnace fan test procedure for the purposes of measuring the airflow at the required static pressure. This method was proposed by AHRI and uses procedures and a test setup consistent with those used for the DOE test procedure for furnaces. However, the method specifies a maximum airflow-control setting that is consistent with operation in cooling mode but may not be suitable in heating mode operation, which is required for determining AFUE. Therefore, DOE proposes not to change the minimum static pressure requirements from those set forth in the existing furnaces and boilers test procedure.

11. Alternative Methods for Furnace/Boiler Efficiency Determination

As noted in the January 2013 RFI, DOE is aware of alternative methods to measure the heating efficiency of residential furnaces and boilers. In particular, DOE sought input on Brookhaven National Laboratory's test procedure for combination boilers,[62] which determines the thermal efficiency of boilers operating under various space heating and domestic hot water loads, as well as any other test methods worthy of consideration. 78 FR 675, 679 (Jan. 4, 2013).

Energy Kinetics offered an extensive critique of the current DOE furnace efficiency metric (AFUE), maintaining that the metric restrains progress in the residential boiler market, fails to provide insight about a product's energy performance and actual field performance, does not reflect the real performance efficiencies of boilers, is based on incorrect concepts of hydronic heating systems, and potentially rewards poor performing boilers with high ratings. Energy Kinetics commented that the AFUE test for boilers is obsolete and should be replaced with a more appropriate metric such as the linear input/output method developed by Brookhaven National Laboratory (BNL). Energy Kinetics believes that this method provides several benefits, including greater accuracy, accounting for design improvements in products, and better differentiation between poorly performing and better performing products. Energy Kinetics commented that BNL's linear input/output metric also much more closely reflects annual efficiency than AFUE alone, and could also replace the heat-up/cool-down tests, which do not capture seasonal efficiency. (Energy Kinetics, No. 11 at p. 4) AHRI recommended that DOE not consider any other procedures for measuring furnace and boiler efficiency. It stated that there is no value in considering wholesale changes to the current test procedure, and the effects on manufacturers and others would be significant and negative. (AHRI, No. 13 at p. 7)

Energy Kinetics recommended that DOE should abandon the current AFUE procedure and replace it with BNL's thermal efficiency test. Energy Kinetics identified the advantages of the BNL test in broad terms, but did not attempt to quantify the benefits that would result from its implementation. DOE understands that BNL's test accounts for jacket losses, which gives an efficiency advantage to well-insulated boilers. However, by definition, most boilers under DOE's test procedure are assumed to be indoor boilers, and, therefore, considers all jacket losses to be useful heat.[63] Boilers that utilize designs for minimizing jacket losses during the off-season will be more efficient in the BNL test than under DOE's test procedure. However, DOE's test procedure is intended to be a measurement of the energy efficiency for space heating alone.

DOE considered the stakeholders' input about adopting alternative test procedures, specifically the test method developed by BNL. However, there are insufficient data regarding the accuracy and applicability of the linear input/output method to determine its feasibility as a measure of efficiency for residential furnaces and boilers. Additionally, DOE is statutorily required to use the metric of AFUE to calculate the efficiency of all residential furnace and boiler products.[64] It is unclear how the AFUE metric could incorporate the thermal efficiency metric that is central to the BNL method. Therefore, DOE tentatively concludes that it will not modify the DOE test procedure to incorporate the BNL test procedure or other alternative test methods.

12. Test Procedure Scope

Currently, there is no DOE test procedure for determining the efficiency of combination products that can provide both space heating and domestic hot water. However, there are DOE test procedures for the individual components (boiler and water heater) of a combined appliance to determine efficiency ratings for each primary function (space heating and domestic water heating). ASHRAE has an existing test procedure, ASHRAE 124–2007 (Methods of Testing for Rating Combination Space-Heating and Water-Heating Appliances), which provides a test method to rate the performance of a combination space-heating and water-heating appliance. In the January 2013 RFI, DOE sought input on expanding the scope of the existing DOE test procedure to include definitions and test methods for combination products. 78 FR 675, 679 (Jan. 4, 2013).

AHRI supported the concept of covering combination products in general, but voiced concern as to whether a test procedure appropriate for all such types of combination products can be developed. (AHRI, No. 13 at p. 7) Rheem commented that it may be difficult to measure energy use of modular components in combination products. Rheem believes that the market for combination products is too new to support combined energy efficiency ratings. (Rheem, No. 12 at p.11–12) NRCan stated that an expansion of the scope of the test procedure to include definitions and test methods for combination products may not be advisable. It noted that because the characteristics of one component of a combination system can strongly influence the performance of others, it is vital that the appliance be tested as a system rather than as separate components. NRCan suggested that combination appliances are different enough to warrant a separate rulemaking rather than trying to include them within appendix N. (NRCan, No. 15 at p. 7) Energy Kinetics stated that a rating for combination heat and domestic water heating systems has

[62] T. Butcher, ''Performance of Integrated Hydronic Heating Systems,'' BNL–79814–2008–IR (December 2007) (Available at: *http://www.bnl.gov/isd/documents/41399.pdf*).

[63] 42 U.S.C. 6291(20).

[64] 42 U.S.C. 6291(20) and (22)(A).

significant potential for energy conservation improvements. It noted that the existing state of ASHRAE 124 for combined heating and hot water products is not satisfactory; AFUE for heating season creates a conflict in considering jacket losses under the hot water portion of the test, while the heating portion considers them again. (Energy Kinetics, No. 11 at p. 1–4)

DOE agrees that the concept of covering combination products has merit. However, DOE prefers not to delay or complicate this rulemaking in pursuit of test procedure requirements for combination products. DOE plans to continue to seek input about the development of a test procedure for combination appliances. DOE may consider a separate rulemaking devoted specifically to combination appliances in the future.

Regarding another test procedure issue, Energy Kinetics commented that the well-established impact of idle losses[65] on boiler operation was not addressed in the December 31, 2012 test procedure final rule for residential furnaces and boilers related to standby mode and off mode energy consumption. (Energy Kinetics, No. 11 at p. 3)

In response, the DOE test procedure accounts for idle losses associated with boiler space heating in the heating season efficiency value. DOE recognizes that the idle losses during non-space heating operation (*i.e.,* domestic water heating) are not captured in the existing DOE test procedure. However, the scope of this test procedure rulemaking does not account for the efficiency of the products that are used for both space heating and domestic water heating. For the reasons discussed, DOE is not considering provisions at this time to address non-space heating boiler operations, including idle losses.

13. Standby Mode and Off Mode

On December 31, 2012 DOE published a test procedure final rule for residential furnaces and boilers to address the standby mode and off mode energy consumption of these products. 77 FR 76831. In the January 2013 RFI, DOE requested comments on test procedure provisions for determining standby mode and off mode energy use. 78 FR 675, 679 (Jan. 4, 2013).

AHRI stated it had no specific comments regarding standby mode and off mode energy consumption at the time, though it generally agreed that these modes should be considered as part of this rulemaking. (AHRI, No. 13 at p. 7) NRCan stated that standby mode and off mode power should include all ''connected loads'' rather than selected loads from a few identified components. It noted that a default value could be considered for a control thermostat and/or automatic temperature reset control to account for the fact that different furnace and boiler controls (with different electricity consumption characteristics) may be installed with the appliance. It added that a control transformer that is included with a furnace or boiler should be included within the base electric measurements, as it will be a part of the connected load after installation. (NRCan, No. 15 at p. 8)

DOE conducted a review of the IEC Standard 62301 and did not identify any changes or revisions to that standard that would necessitate updating sections of the DOE test procedure pertaining to standby mode or off mode calculations. DOE's standby mode and off mode power measurements include only auxiliary components that are part of the furnace and boiler, including the automatic temperature reset. The standby mode or off mode power of components such as the furnace controls that respond to the house thermostat input are included; however, the electricity consumption of the house thermostat device itself is not considered in the overall standby mode and off mode electricity consumption, because it is independent of the furnace or boiler. Furthermore, DOE is not aware of representative electricity consumption values that could be used as default values for the house thermostat.[66] DOE's residential furnace and boiler test procedure only applies to covered products as defined in 42 U.S.C. 6291(23) and does not include other equipment and/or components installed in specific installations. For these reasons, DOE does not plan to modify the standby mode and off mode energy consumption provisions of the furnace and boiler test procedure.

14. Full-Fuel-Cycle Energy Metrics

In comments on the January 2013 RFI, AGA stated that DOE should continue the transition toward use of full-fuel-cycle (FFC) energy metrics by developing a secondary energy descriptor for residential furnaces and boilers that reflects either extended site or FFC energy metrics. (AGA, No. 3 at pp. 1–4) AGA stated that EPCA does not preclude the use of additional or secondary energy descriptors that provide useful information to consumers on the energy consumption and environmental impacts of their appliance choices. It stated that implementing an extended site or FFC energy descriptor would not require alteration of any test methods for the appliances, as a simple calculation can be done using the primary (site-based) energy descriptor as an independent variable.

AGA pointed out that in DOE's August 2011 FFC Statement of Policy, DOE committed to working with other Federal agencies to make readily available to consumers improved information on energy consumption and emissions impacts of comparable products.[67] AGA urged DOE to take the opportunity in this proceeding to formulate metrics that can be incorporated into a FFC descriptor and used on Energy Guide labels. According to AGA, the Federal Trade Commission (FTC) has previously noted that energy consumption information on the Energy Guide labels must be derived from DOE's test procedures.[68] The FTC acknowledged that it may be possible to derive fuel cycle emissions information from the DOE test procedures, but suggested that such procedures would need to specify the means for calculating fuel cycle impacts.[69] AGA contends that adding a secondary FFC energy descriptor to appliance test procedures is an essential step in enabling the FTC to include such information on the Energy Guide labels to allow consumers to make better informed appliance choices, consistent with the recommendations of the National Academy of Sciences and DOE's FFC Statement of Policy.

AGA also contends that adding an FFC energy descriptor to the test procedures for residential furnaces and

[65] ''Idle loss,'' as the term applies to residential heating boilers, is heat wasted when the burner is not firing. For combination appliances, the idle losses occur following space heating and/or domestic hot water heating operations. The idle losses include the heat from combustion that is not transferred to the heating water and includes the products of combustion up the flue, the loss out of the heat exchanger walls and boiler's jacket in the form of radiant, conductive, or convective transfer, and the loss down the drain as a condensate. Since no fuel is being consumed during the off-cycle, off-cycle losses are important only to the extent that they must be replaced during the on-cycle by the burning of extra fuel (*i.e.,* longer burner on times or higher firing rates).

[66] 10 CFR part 430, subpart B, appendix N, sections 8.6.1 and 8.6.2.

[67] Statement of Policy for Adopting Full-Fuel-Cycle Analyses Into Energy Conservation Standards Programs, 76 FR 51281 (Aug. 18, 2011).

[68] *See* Rule Concerning Disclosures Regarding Energy Consumption and Water Use of Certain Home Appliances and Other Products Required Under the Energy Policy and Conservation Act (''Appliance Labeling Rule''), 72 FR 49948, 49961 (Aug. 29, 2007).

[69] *Id.* at 49961–62.

boilers to establish FFC AFUE ratings for such appliances provides an important ability to compare the energy efficiency of heating systems that use different fuels. Finally, AGA stated that a secondary FFC energy descriptor could also be used to more accurately reflect the energy consumption of products within the same product class. It noted that because the electric energy consumption of natural gas furnaces is not currently included in the AFUE ratings, the current AFUE rating alone does not provide consumers with a measure of the true efficiency of a particular gas furnace product, nor allow consumers to properly compare products that use different fuels.

DOE agrees with AGA that an FFC energy descriptor for furnaces could provide consumers and other parties with useful information for comparing products. Indeed, in its FFC Statement of Policy, DOE stated its intention to ''work with other Federal agencies to make readily available to consumers improved information on the energy use, life-cycle cost and associated emissions of comparable products, even if those products use different forms of energy.'' 76 FR 51281, 51289 (Aug. 18, 2011). However, DOE is not convinced that this test procedure is the appropriate vehicle for deriving an FFC energy descriptor for furnaces (or other products). As discussed in the Notice of Policy Amendment Regarding Full-Fuel-Cycle Analyses, DOE intends to use the National Energy Modeling System (NEMS) as the basis for deriving the energy and emission multipliers used to conduct FFC analyses in support of future energy conservation standards rulemakings. 77 FR 49701 (Aug. 17, 2012). DOE also uses NEMS to derive factors to convert site electricity use or savings to primary energy consumption by the electric power sector. NEMS is updated annually in association with the preparation of the Energy Information Administration's (EIA) *Annual Energy Outlook.* Based on its experience to date, DOE expects that the energy and emission multipliers used to conduct FFC analyses will change each year. If DOE were to include a secondary FFC energy descriptor as part of the furnace and boiler test procedure, DOE would need to update the test procedure annually.

DOE believes that there are more suitable means to derive an FFC energy descriptor for residential furnaces and boilers, and, more generally, to provide consumers improved information on the energy use and associated emissions of furnaces and other products. DOE remains committed to work with the FTC and other interested parties to develop such information. Furthermore, DOE intends to estimate FFC energy savings in future energy conservation standards rulemakings for furnaces, and to take those savings into account in proposing and selecting amended standards.

15. Test Burden

EPCA requires that the test procedures DOE prescribes or amends be reasonably designed to produce test results that measure the 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. These procedures must also not be unduly burdensome to conduct. *See* 42 U.S.C. 6293(b)(3).

Under the proposed test procedure, the cycle on and off times are calculated as a function of high and reduced input capacity, as opposed to under the existing test procedure, which specifies a burner on time of 10 minutes and off time of 10 minutes for two-stage and step-modulating furnaces, and a burner on time of 15 minutes and off time of 15 minutes for two-stage and step-modulating boilers. In DOE's view, the proposal requiring manufacturers to perform calculations to determine burner cycling times as opposed to using standard fixed values would impose a small additional burden on manufacturers. However, the additional time necessary to calculate the cycle times would likely be offset by the shorter cycling times during testing, which may result in overall shorter test duration. In addition, the proposed calculation method for determining AFUE for two-stage and modulating products would allow the use of reduced fuel input only, allowing manufacturers to bypass the high fire test for many of these units. Therefore, on average, DOE expects little or no additional burden as the result of this proposed revision.

Allowing the condensate to be measured during the establishment of steady-state conditions rather than during an additional 30-minute period once steady-state conditions have been established would reduce the time required to measure condensate mass and, thus, would reduce the test burden to manufacturers while still providing accurate results.

DOE believes that capturing the total electrical consumption will significantly improve the accuracy and consistency of the reported electricity consumption across different models as well as align the test procedure with current field practices. Furthermore, in many cases, the total electricity consumption is already being captured during testing. Therefore, for most manufacturers, including additional measurements of electrical consumption would introduce little to no additional test burden.

The proposed inclusion of reference to the approved I&O manual could provide additional guidance and clarity to the test procedure. DOE believes that this proposal would reduce the burden and time requirements by allowing the manufacturers to utilize information already available in the manufacturers' literature instead of instructions derived solely for AFUE testing purposes. Therefore, DOE expects that there would be no additional costs associated with this revision.

Included within the proposed test procedure is the adoption of a method for verifying the functionality of the design requirement that requires an automatic means for adjusting water temperature. This test would be conducted independently of the AFUE test and would require additional time and labor beyond the existing AFUE test procedure. DOE expects that the required measurements should be able to be conducted using the same components and material required for the existing AFUE test. DOE has also tentatively concluded that the extra test is warranted to verify that the various controls for automatic means for adjusting water temperature operate as expected.

DOE assumes that manufacturers currently perform the tracer gas test to determine whether the minimum default draft factor of 0.05 may be used. DOE believes that when establishing the absence of flow through the heat exchanger, the use of the smoke stick test will reduce the test burden to manufacturers by eliminating, in some cases, the need for the tracer gas test.

For these reasons, DOE concludes that the amended test procedures proposed in the NOPR would not be unduly burdensome to conduct.

16. Changes in Measured Energy Use

When DOE modifies test procedures, it must determine to what extent, if any, the new test procedure would alter the measured energy efficiency or energy use of any covered product. (42 U.S.C. 6293(e)(1)) For the reasons described subsequently, DOE has determined that none of the proposed test procedure amendments would significantly alter the projected measured energy efficiency or energy use of the covered products that are the subject of this rulemaking.

The test procedure amendments in this proposed rule would affect the test procedures that will be required for certifying compliance with the amended energy conservation standards. Many of the changes that would be made to appendix N through this proposed rule would clarify the manner in which the test is conducted, or would otherwise represent minor changes or additions to the test or reporting requirements that would not affect measured energy use. These amendments include: (1) Revisions in instances where the test procedure references ''manufacturer recommendations'' or ''manufacturer's instructions;'' (2) allowing the measurement of condensate under steady-state conditions during the steady-state test; (3) a test protocol for determining the functionality of the automatic means for adjusting water temperature; (4) adopting a test method to indicate the absence or presence of airflow to determine whether the minimum default draft factor may be used; (5) revised annual electricity consumption equations; (6) increasing AFUE reporting precision; (7) specifying ductwork for units that are installed without a return duct; and (8) specifying testing requirements for units with multiposition configurations.

The one amendment in this proposed rule that might alter the AFUE of covered products is the incorporation by reference of ASHRAE 103–2007. DOE does not believe that the resulting changes in AFUE would require amending the applicable energy conservation standard or affect compliance with the standard. The impact on AFUE from the incorporation mentioned previously for two-stage and modulating non-condensing residential furnaces or boilers is small and tends to increase the AFUE. Furthermore, two-stage and modulating features are usually associated with premium or higher efficiency products. The product tests performed by DOE and stakeholder comments confirm that a model that would need to be re-rated using the provisions adopted in this notice would have a resulting AFUE above the current minimum required efficiency.

IV. Procedural Issues and Regulatory Review

A. Review Under Executive Order 12866

The Office of Management and Budget has determined that test procedure rulemakings do not constitute ''significant regulatory actions'' under section 3(f) of Executive Order 12866, ''Regulatory Planning and Review,'' 58 FR 51735 (Oct. 4, 1993). Accordingly, this regulatory action was not subject to review under the Executive Order by the Office of Information and Regulatory Affairs (OIRA) in the Office of Management and Budget (OMB).

B. Review Under the Regulatory Flexibility Act

The Regulatory Flexibility Act (5 U.S.C. 601 *et seq.,* as amended by the Small Business Regulatory Enforcement Fairness Act of 1996) requires preparation of an initial regulatory flexibility analysis (IRFA) for any rule that by law must be proposed for public comment and a final regulatory flexibility analysis (FRFA) for any such rule that an agency adopts as a final rule, unless the agency certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. A regulatory flexibility analysis examines the impact of the rule on small entities and considers alternative ways of reducing negative effects. Also, as required by Executive Order 13272, ''Proper Consideration of Small Entities in Agency Rulemaking,'' 67 FR 53461 (August 16, 2002), DOE published procedures and policies on February 19, 2003, to ensure that the potential impacts of its rules on small entities are properly considered during the DOE rulemaking process. 68 FR 7990. DOE has made its procedures and policies available on the Office of the General Counsel's Web site: *http://energy.gov/gc/office-general-counsel.*

DOE reviewed the proposed rule under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003. 68 FR 7990. DOE has concluded that the rule would not have a significant impact on a substantial number of small entities. The factual basis for this certification is as follows:

For manufacturers of residential furnaces and boilers, the Small Business Administration (SBA) has set a size threshold, which defines those entities classified as ''small businesses'' for the purposes of the Act. DOE used the SBA's small business size standards to determine whether any small entities would be subject to the requirements of the rule. 65 FR 30836, 30848 (May 15, 2000), as amended at 65 FR 53533, 53544 (Sept. 5, 2000) and codified at 13 CFR part 121. These size standards and codes are established by the North American Industry Classification System (NAICS) and are available at *http://www.sba.gov/sites/default/files/files/Size_Standards_Table.pdf.* Residential boiler manufacturing is classified under NAICS 333414, ''Heating Equipment (Except Warm Air Furnaces) Manufacturing,'' for which the maximum size threshold is 500 employees or fewer. Residential furnace manufacturing is classified under NAICS 333415, ''Air-conditioning and warm air heating equipment and commercial and industrial refrigeration equipment manufacturing'' for which the maximum size threshold is 750 employees or fewer. To estimate the number of companies that could be small business manufacturers of products covered by this rulemaking, DOE conducted a market survey using available public information to identify potential small manufacturers. DOE's research involved reviewing several industry trade association membership directories (*e.g.,* AHRI [70]), SBA databases,[71] individual company Web sites, and marketing research tools (*e.g.,* Hoovers [72] reports) to create a list of all domestic small business manufacturers of residential furnaces and boilers covered by this rulemaking.

After DOE identified manufacturers of residential furnaces and residential boilers, DOE then consulted publically-available data and contacted companies, as necessary, to determine if they both meet the SBA's definition of a ''small business'' manufacturer and have their manufacturing facilities located within the United States. DOE screened out companies that did not offer products covered by this rulemaking, did not meet the definition of a ''small business,'' or are foreign-owned and operated. Based on this analysis, DOE identified 9 small businesses that manufacture residential furnaces and 9 small businesses that manufacture residential boilers (two of which also manufacture residential furnaces), for a total of 16 small businesses potentially impacted by this rulemaking.

This notice proposes amendments to DOE's test procedure by incorporating several changes that modify the existing test procedure for furnaces and boilers. This proposal includes the following changes: (1) Incorporation by reference of the ASHRAE 103–2007; (1) allowing the measurement of condensate under steady-state conditions during the steady-state test; (1) a revised annual electricity consumption test protocol and calculation methodology; (1) revisions to how the test procedure references ''manufacturer recommendations'' or ''manufacturer's instructions;'' (1) a test protocol for verifying the functionality of the automatic means for adjusting water temperature; (1) a smoke stick method

[70] For more information on the boiler and furnace directories, see *http://www.ahridirectory.org/ahridirectory/pages/home.aspx.*

[71] For more information see: *http://dsbs.sba.gov/dsbs/search/dsp_dsbs.cfm.*

[72] For more information see: *http://www.hoovers.com/.*

for determining whether the minimum default draft factor may be used; (1) revising the reporting precision for AFUE to the nearest tenth of a percentage point; (1) specifying ductwork for units that are installed without a return duct; and (1) specifying testing requirements for units with multiposition configurations. The estimated costs of testing/rating and potential impact to manufacturer burden resulting from use of the proposed test procedure are discussed subsequently. The estimated costs and potential impacts apply to all manufacturers, including the manufacturers identified as small businesses.

Most of the proposed test procedure amendments in this notice would have little or no impact on test burden. As stated in section III.E.15, updating the ASHRAE 103 reference from the 1993 to the 2007 version would, in DOE's view, result in little or no additional burden on average, while improving the accuracy of the test procedure. Revising the language to reference Installation and Operation Manuals would not impose any additional burden on manufacturers. Revising the reporting precision for AFUE also would not impose any additional burden on manufacturers. DOE notes that allowing the measurement of condensate under steady-state conditions during the steady-state test, rather than requiring an additional 30-minute period for measuring condensate after steady-state conditions have been established, would reduce the test burden, as it would lessen the overall duration of the test. Additionally, the proposed smoke stick method for determining whether the minimum default draft factor may be used is intended to reduce the test burden to manufacturers.

With respect to the proposal to include additional measurements of electrical consumption, DOE has evaluated the impact of measuring the electricity consumption of one additional component—the secondary pump—as part of the auxiliary electrical measurements. DOE has determined that this extra measurement would require 30 minutes of additional time to conduct the AFUE test. DOE has tentatively concluded that manufacturers would not have any additional material or component costs resulting from this proposal because these measurements should be able to be conducted using the same components and materials required for the existing measurements. DOE has estimated that at an assumed cost of $60 per hour for a lab technician, the cost to perform this additional electrical measurement is approximately $30 per unit tested.

The proposed method for verifying the functionality of the design requirement that requires an automatic means for adjusting water temperature would require additional time and labor beyond the existing AFUE test procedure. DOE expects that manufacturers would not have any major material or component costs associated with the required measurements and that they should be able to be conduct such testing using the same components and material required for the existing AFUE test. DOE expects that all affected parties should have this type of capability readily available. DOE has estimated that at an assumed cost of $60 per hour for a lab technician, the cost to perform these additional test measurements is approximately $90 per unit tested.

While DOE has estimated that the additional electrical measurements and the verification of automatic means would result in additional testing costs, two other proposed amendments—allowing the measurement of condensate under steady-state conditions during the steady-state test and the smoke stick method for determining the minimum default draft factor—would offset a portion of these additional test costs. For condensing furnaces and boilers that would benefit from the time and labor savings attributed to the measurement of condensate during the steady-state test, DOE estimates that the overall duration of the test would be reduced by 30 minutes. DOE has estimated that at an assumed cost of $60 per hour for a lab technician, the cost savings attributed to the measurement of condensate during the steady-state test is approximately $30 per unit tested. DOE estimated that condensing furnaces and boilers will account for about 40 percent and 36 percent of the market in 2015, respectively. Furthermore, DOE estimated that the smoke stick method for determining the minimum default draft factor would reduce the overall duration of the test by about 15 minutes for units designed to have no flow through the heat exchanger. However, DOE does not have sufficient information to support estimating the fraction of units that have been designed such that there is no flow through the heat exchanger. Therefore, DOE has not included the cost savings associated with the smoke stick test but has included the cost savings associated with the measurement of condensate.

To determine the potential cost of the proposed test procedure amendments on small furnace and boiler manufacturers, DOE estimated the cost of testing per basic model. DOE has estimated that the proposed test procedure changes would result in an additional testing cost of $30 per basic model for non-condensing furnaces, no additional cost per basic model for condensing furnaces, an additional testing cost of $120 per basic model for non-condensing boilers, and an additional testing cost of $90 per basic model for condensing boilers. (The cost savings attributed to the measurement of condensate during the steady-state test have been accounted for in the cost estimates.) DOE estimated that on average, each furnace small business would have 51 basic models, and each boiler small business would have 70 basic models. DOE applied the condensing product market shares to the basic model counts to account for the difference in cost estimates between non-condensing and condensing products. Then the additional testing cost associated with the proposed test procedure amendments was multiplied by the estimated number of basic models produced by a small manufacturer. DOE has estimated a total added cost of testing of $916 per furnace manufacturer and a total added cost of testing of $7,640 per boiler manufacturer.

When considering the costs just discussed, DOE believes they are very small relative to the overall cost of manufacturing, testing, and certifying residential furnace and boiler products. DOE seeks comment on its tentative conclusion.

For the reasons stated previously, DOE certifies that this rule, if adopted, would not have a significant economic impact on a substantial number of small entities. Therefore, DOE did not prepare an initial regulatory flexibility analysis for the proposed rule. DOE will transmit its certification and a supporting statement of factual basis to the Chief Counsel for Advocacy of the SBA for review pursuant to 5 U.S.C. 605(b).

C. Review Under the Paperwork Reduction Act of 1995

Manufacturers of residential furnaces and boilers must certify to DOE that their products comply with all applicable energy conservation standards. In certifying compliance, manufacturers must test their products according to the DOE test procedures for residential furnaces and boilers, including any amendments adopted for those test procedures, on the date that compliance is required. DOE has established regulations for the certification and recordkeeping requirements for all covered consumer products and commercial equipment, including residential furnaces and boilers. 76 FR 12422 (March 7, 2011); 80 FR 5099 (Jan. 30, 2015). The collection-of-information requirement for certification and recordkeeping is subject to review and approval by OMB under the Paperwork Reduction Act (PRA). This requirement has been approved by OMB under OMB control number 1910–1400. Public reporting burden for the certification is estimated to average 20 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Notwithstanding any other provision of the law, no person is required to respond to, nor shall any person be subject to a penalty for failure to comply with, a collection of information subject to the requirements of the PRA, unless that collection of information displays a currently valid OMB Control Number.

D. Review Under the National Environmental Policy Act of 1969

In this proposed rule, DOE proposes amendments to its test procedure for residential furnaces and boilers. DOE has determined that this rule falls into a class of actions that are categorically excluded from review under the National Environmental Policy Act of 1969 (42 U.S.C. 4321 *et seq.*) and DOE's implementing regulations at 10 CFR part 1021. Specifically, this proposed rule would amend the existing test procedure without affecting the amount, quality or distribution of energy usage, and, therefore, would not result in any environmental impacts. Thus, this rulemaking is covered by Categorical Exclusion A5 under 10 CFR part 1021, subpart D, which applies to any rulemaking that interprets or amends an existing rule without changing the environmental effect of that rule. Accordingly, neither an environmental assessment nor an environmental impact statement is required.

E. Review Under Executive Order 13132

Executive Order 13132, ''Federalism,'' 64 FR 43255 (August 10, 1999) imposes certain requirements on Federal agencies formulating and implementing policies or regulations that preempt State law or that have Federalism implications. The Executive Order requires agencies to examine the constitutional and statutory authority supporting any action that would limit the policymaking discretion of the States, and to carefully assess the necessity for such actions. The Executive Order also requires agencies to have an accountable process to ensure meaningful and timely input by State and local officials in the development of regulatory policies that have Federalism implications. On March 14, 2000, DOE published a statement of policy describing the intergovernmental consultation process it will follow in the development of such regulations. 65 FR 13735. DOE examined this proposed rule and has tentatively determined that it would not have a substantial direct effect on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the products that are the subject of this proposal. States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (42 U.S.C. 6297(d)) No further action is required by Executive Order 13132.

F. Review Under Executive Order 12988

Regarding the review of existing regulations and the promulgation of new regulations, section 3(a) of Executive Order 12988, ''Civil Justice Reform,'' 61 FR 4729 (Feb. 7, 1996), imposes on Federal agencies the general duty to adhere to the following requirements: (1) Eliminate drafting errors and ambiguity; (2) write regulations to minimize litigation; (3) provide a clear legal standard for affected conduct rather than a general standard; and (4) promote simplification and burden reduction. Regarding the review required by section 3(a), section 3(b) of Executive Order 12988 specifically requires that Executive agencies make every reasonable effort to ensure that the regulation: (1) Clearly specifies the preemptive effect, if any; (2) clearly specifies any effect on existing Federal law or regulation; (3) provides a clear legal standard for affected conduct while promoting simplification and burden reduction; (4) specifies the retroactive effect, if any; (5) adequately defines key terms; and (6) addresses other important issues affecting clarity and general draftsmanship under any guidelines issued by the Attorney General. Section 3(c) of Executive Order 12988 requires Executive agencies to review regulations in light of applicable standards in sections 3(a) and 3(b) to determine whether they are met or it is unreasonable to meet one or more of them. DOE has completed the required review and tentatively determined that, to the extent permitted by law, the proposed rule meets the relevant standards of Executive Order 12988.

G. Review Under the Unfunded Mandates Reform Act of 1995

Title II of the Unfunded Mandates Reform Act of 1995 (UMRA) requires each Federal agency to assess the effects of Federal regulatory actions on State, local, and Tribal governments and the private sector. Public Law 104–4, sec. 201 (codified at 2 U.S.C. 1531). For a regulatory action likely to result in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted annually for inflation), section 202 of UMRA requires a Federal agency to publish a written statement that estimates the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a), (b)) The UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a ''significant intergovernmental mandate,'' and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect them. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR 12820. (This policy is also available at *http://energy.gov/gc/office-general-counsel*). DOE examined the proposed rule according to UMRA and its statement of policy and has tentatively determined that the rule contains neither an intergovernmental mandate, nor a mandate that may result in the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector, of $100 million or more in any year. Accordingly, no further assessment or analysis is required under UMRA.

H. Review Under the Treasury and General Government Appropriations Act, 1999

Section 654 of the Treasury and General Government Appropriations Act, 1999 (Pub. L. 105–277) requires Federal agencies to issue a Family Policymaking Assessment for any rule that may affect family well-being. This rule would not have any impact on the autonomy or integrity of the family as an institution. Accordingly, DOE has concluded that it is not necessary to prepare a Family Policymaking Assessment.

I. Review Under Executive Order 12630

Pursuant to Executive Order 12630, ''Governmental Actions and Interference with Constitutionally Protected Property Rights,'' 53 FR 8859 (March 18, 1988), DOE has determined that this proposed rule would not result in any takings that might require compensation under the Fifth Amendment to the U.S. Constitution.

J. Review Under Treasury and General Government Appropriations Act, 2001

Section 515 of the Treasury and General Government Appropriations Act, 2001 (44 U.S.C. 3516 note) provides for Federal agencies to review most disseminations of information to the public under information quality guidelines established by each agency pursuant to general guidelines issued by OMB. OMB's guidelines were published at 67 FR 8452 (Feb. 22, 2002), and DOE's guidelines were published at 67 FR 62446 (Oct. 7, 2002). DOE has reviewed the proposed rule under the OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

K. Review Under Executive Order 13211

Executive Order 13211, ''Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use,'' 66 FR 28355 (May 22, 2001), requires Federal agencies to prepare and submit to OIRA at OMB, a Statement of Energy Effects for any significant energy action. A ''significant energy action'' is defined as any action by an agency that promulgated or is expected to lead to promulgation of a final rule, and that: (1) Is a significant regulatory action under Executive Order 12866, or any successor order; and (2) is likely to have a significant adverse effect on the supply, distribution, or use of energy; or (3) is designated by the Administrator of OIRA as a significant energy action. For any proposed significant energy action, the agency must give a detailed statement of any adverse effects on energy supply, distribution, or use should the proposal be implemented, and of reasonable alternatives to the action and their expected benefits on energy supply, distribution, and use.

This regulatory action to amend the test procedure for measuring the energy efficiency of residential furnaces and boilers is not a significant regulatory action under Executive Order 12866 or any successor order. Moreover, it would not have a significant adverse effect on the supply, distribution, or use of energy, nor has it been designated as a significant energy action by the Administrator of OIRA. Therefore, it is not a significant energy action, and, accordingly, DOE has not prepared a Statement of Energy Effects for this rulemaking.

L. Review Under Section 32 of the Federal Energy Administration Act of 1974

Under section 301 of the Department of Energy Organization Act (Pub. L. 95–91; 42 U.S.C. 7101 *et seq.*), DOE must comply with all laws applicable to the former Federal Energy Administration, including section 32 of the Federal Energy Administration Act of 1974 (Pub. L. 93–275), as amended by the Federal Energy Administration Authorization Act of 1977 (Pub. L. 95–70). (15 U.S.C. 788; FEAA) Section 32 essentially provides in relevant part that, where a proposed rule authorizes or requires use of commercial standards, the notice of proposed rulemaking must inform the public of the use and background of such standards. In addition, section 32(c) requires DOE to consult with the Attorney General and the Chairman of the Federal Trade Commission (FTC) concerning the impact of the commercial or industry standards on competition.

As discussed in section III.C.1 of this document, the proposed rule incorporates testing methods contained in the following commercial standard: ASHRAE Standard 103–2007, *Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers.* While this proposed test procedure is not exclusively based on this standard, DOE test procedure adopts several provisions from this standard without amendment. DOE has evaluated this standard and is unable to conclude whether it fully complies with the requirements of section 32(b) of the FEAA (*i.e.,* that it was developed in a manner that fully provides for public participation, comment, and review). DOE's previous test procedure incorporated testing methods from the earlier version of the same standard (ASHRAE Standard 103–1993). The modifications reflected in ASHRAE Standard 103–2007 were developed as part of ASHRAE's public comment and review process. DOE will consult with the Attorney General and the Chairwoman of the FTC concerning the impact of these test procedures on competition prior to prescribing a final rule.

M. Description of Materials Incorporated by Reference

DOE is proposing to incorporate by reference the test standard published by ASTM, titled ''Standard Test Method for Smoke Density in Flue Gases from Burning Distillate Fuels,'' ASTM–D2156–09 (Reapproved 2013). ASTM–D2156 is an industry accepted test procedure that establishes uniform test methods for the evaluation of smoke density in the flue gases from burning distillate fuels. The test procedure proposed in this NOPR incorporates by reference in its entirety which includes terminology, methods of testing, materials, apparatus, procedures, reporting, and precision and bias. ASTM–D2156–09 is readily available for purchase on ASTM's Web site at *http://www.astm.org/Standards/D2156.htm.*

V. Public Participation

A. Attendance at the Public Meeting

The time, date, and location of the public meeting are listed in the **DATES** and **ADDRESSES** sections at the beginning of this document. If you plan to attend the public meeting, please notify Ms. Brenda Edwards at (202) 586–2945 or *Brenda.Edwards@ee.doe.gov.*

Please note that foreign nationals visiting DOE Headquarters are subject to advance security screening procedures. If a foreign national wishes to participate in the public meeting, please inform DOE of this fact as soon as possible by contacting Ms. Regina Washington at (202) 586–1214 or by email (*Regina.Washington@ee.doe.gov*) so that the necessary procedures can be completed.

DOE requires visitors to have laptops and other devices, such as tablets, checked upon entry into the Forrestal Building. Any person wishing to bring these devices into the building will be required to obtain a property pass. Visitors should avoid bringing these devices, or allow an extra 45 minutes to check in. Please report to the visitor's desk to have devices checked before proceeding through security.

Due to the REAL ID Act implemented by the Department of Homeland Security (DHS), there have been recent changes regarding identification (ID) requirements for individuals wishing to enter Federal buildings from specific States and U.S. territories. As a result, driver's licenses from several States or territory will not be accepted for building entry, and instead, one of the alternate forms of ID listed below will be required. DHS has determined that regular driver's licenses (and ID cards) from the following jurisdictions are not acceptable for entry into DOE facilities: Alaska, American Samoa, Arizona, Louisiana, Maine, Massachusetts, Minnesota, New York, Oklahoma, and Washington. Acceptable alternate forms of Photo-ID include: U.S. Passport or Passport Card; an Enhanced Driver's License or Enhanced ID-Card issued by the States of Minnesota, New York, or Washington (Enhanced licenses issued by these States are clearly marked Enhanced or Enhanced Driver's License); a military ID or other Federal government-issued Photo-ID card.

In addition, you can attend the public meeting via webinar. Webinar registration information, participant instructions, and information about the capabilities available to webinar participants will be published on DOE's Web site at: *http://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx/ruleid/55.* Participants are responsible for ensuring their systems are compatible with the webinar software.

B. Procedure for Submitting Requests To Speak and Prepared General Statements for Distribution

Any person who has an interest in the topics addressed in this notice of proposed rulemaking, or who is representative of a group or class of persons that has an interest in these issues, may request an opportunity to make an oral presentation at the public meeting. Such persons may hand-deliver requests to speak to the address show in the **ADDRESSES** section at the beginning of this notice between 9:00 a.m. and 4:00 p.m., Monday through Friday, except Federal holidays. Requests may also be sent by mail or email to Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Office, Mailstop EE–5B, 1000 Independence Avenue SW., Washington, DC 20585–0121, or *Brenda.Edwards@ee.doe.gov.* Persons who wish to speak should include in their request a computer diskette or CD–ROM in WordPerfect, Microsoft Word, PDF, or text (ASCII) file format that briefly describes the nature of their interest in this rulemaking and the topics they wish to discuss. Such persons should also provide a daytime telephone number where they can be reached.

DOE requests persons selected to make an oral presentation to submit an advance copy of their statements at least one week before the public meeting. DOE may permit persons who cannot supply an advance copy of their statement to participate, if those persons have made advance alternative arrangements with the Building Technologies Program. As necessary, request to give an oral presentation should ask for such alternative arrangements.

Any person who has plans to present a prepared general statement may request that copies of his or her statement be made available at the public meeting. Such persons may submit requests, along with an advance electronic copy of their statement in PDF (preferred), Microsoft Word or Excel, WordPerfect, or text (ASCII) file format, to the appropriate address shown in the **ADDRESSES** section at the beginning of this notice of proposed rulemaking. The request and advance copy of statements must be received at least one week before the public meeting and may be emailed, hand-delivered, or sent by mail. DOE prefers to receive requests and advance copies via email. Please include a telephone number to enable DOE staff to make follow-up contact, if needed.

C. Conduct of the Public Meeting

DOE will designate a DOE official to preside at the public meeting and may also use a professional facilitator to aid discussion. The meeting will not be a judicial or evidentiary-type public hearing, but DOE will conduct it in accordance with section 336 of EPCA (42 U.S.C. 6306). A court reporter will be present to record the proceedings and prepare a transcript. DOE reserves the right to schedule the order of presentations and to establish the procedures governing the conduct of the public meeting. There shall not be discussion of proprietary information, costs or prices, market share, or other commercial matters regulated by U.S. anti-trust laws. After the public meeting, interested parties may submit further comments on the proceedings, as well as on any aspect of the rulemaking, until the end of the comment period.

The public meeting will be conducted in an informal, conference style. DOE will present summaries of comments received before the public meeting, allow time for prepared general statements by participants, and encourage all interested parties to share their views on issues affecting this rulemaking. Each participant will be allowed to make a general statement (within time limits determined by DOE), before the discussion of specific topics. DOE will allow, as time permits, other participants to comment briefly on any general statements.

At the end of all prepared statements on a topic, DOE will permit participants to clarify their statements briefly and comment on statements made by others. Participants should be prepared to answer questions by DOE and by other participants concerning these issues. DOE representatives may also ask questions of participants concerning other matters relevant to this rulemaking. The official conducting the public meeting will accept additional comments or questions from those attending, as time permits. The presiding official will announce any further procedural rules or modification of the above procedures that may be needed for the proper conduct of the public meeting.

A transcript of the public meeting will be posted on the DOE Web site and will be included in the docket, which can be viewed as described in the *Docket* section at the beginning of this notice. In addition, any person may buy a copy of the transcript from the transcribing reporter.

D. Submission of Comments

Instructions: DOE will accept comments, data, and information regarding this proposed rule before or after the public meeting, but no later than the date provided in the **DATES** section at the beginning of this notice of proposed rulemaking. Interested parties may submit comments using any of the methods described in the **ADDRESSES** section at the beginning of this notice of proposed rulemaking.

All submissions must include the agency name and docket number EERE–2012–BT–TP–0024 and/or regulatory information number (RIN) 1904–AC79. No telefacsimilies (faxes) will be accepted.

Submitting comments via www.regulations.gov. The *www.regulations.gov* Web page will require you to provide your name and contact information. Your contact information will be viewable to DOE Building Technologies staff only. Your contact information will not be publicly viewable except for your first and last names, organization name (if any), and submitter representative name (if any). If your comment is not processed properly because of technical difficulties, DOE will use this information to contact you. If DOE cannot read your comment due to technical difficulties and cannot contact you for clarification, DOE may not be able to consider your comment.

However, your contact information will be publicly viewable if you include it in the comment itself or in any documents attached to your comment. Any information that you do not want to be publicly viewable should not be included in your comment, nor in any document attached to your comment. Otherwise, persons viewing comments will see only first and last names, organization names, correspondence containing comments, and any documents submitted with the comments.

Do not submit to *www.regulations.gov* information for which disclosure is restricted by statute, such as trade secrets and commercial or financial information (hereinafter referred to as Confidential Business Information (CBI)). Comments submitted through *www.regulations.gov* cannot be claimed as CBI. Comments received through the Web site will waive any CBI claims for the information submitted. For information on submitting CBI, see the Confidential Business Information section.

DOE processes submissions made through *www.regulations.gov* before posting. Normally, comments will be posted within a few days of being submitted. However, if large volumes of comments are being processed simultaneously, your comment may not be viewable for up to several weeks. Please keep the comment tracking number that *www.regulations.gov* provides after you have successfully uploaded your comment.

Submitting comments via email, hand-delivery/courier, or mail. Comments and documents submitted via email, hand-delivery/courier, or mail also will be posted to *www.regulations.gov.* If you do not want your personal contact information to be publicly viewable, do not include it in your comment or any accompanying documents. Instead, provide your contact information in a cover letter. Include your first and last names, email address, telephone number, and optional mailing address. The cover letter will not be publicly viewable as long as it does not include any comments.

Include contact information each time you submit comments, data, documents, and other information to DOE. If you submit via mail or hand delivery/courier, please provide all items on a compact disk (CD), if feasible, in which case it is not necessary to submit printed copies. No telefacsimiles (faxes) will be accepted.

Comments, data, and other information submitted to DOE electronically should be provided in PDF (preferred), Microsoft Word or Excel, WordPerfect, or text (ASCII) file format. Provide documents that are not secured, written in English, and are free of any defects or viruses. Documents should not contain special characters or any form of encryption and, if possible, they should carry the electronic signature of the author.

Campaign form letters. Please submit campaign form letters by the originating organization in batches of between 50 to 500 form letters per PDF or as one form letter with a list of supporters' names compiled into one or more PDFs. This reduces comment processing and posting time.

Confidential Business Information. Pursuant to 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit via email, postal mail, or hand delivery/courier two well-marked copies: One copy of the document marked ''confidential'' including all the information believed to be confidential, and one copy of the document marked ''non-confidential'' with the information believed to be confidential deleted. Submit these documents via email or on a CD, if feasible. DOE will make its own determination about the confidential status of the information and treat it according to its determination.

Factors of interest to DOE when evaluating requests to treat submitted information as confidential include: (1) A description of the items; (2) 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) 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.

It is DOE's policy that all comments may be included in the public docket, without change and as received, including any personal information provided in the comments (except information deemed to be exempt from public disclosure).

E. Issues on Which DOE Seeks Comment

Although DOE welcomes comments on any aspect of this proposal, DOE is particularly interested in receiving comments and views of interested parties concerning the following issues:

1. ASHRAE 103 Update From Version 1993 to 2007

DOE requests comment from stakeholders on the proposed changes to the DOE test procedure resulting from incorporating the 2007 version of ASHRAE 103 with some limited modifications.

2. Measurement of Condensate Under Steady-State Conditions

DOE requests comment from stakeholders on the proposed changes to allow for the measurement of condensate during the establishment of steady-state conditions (ASHRAE 103–2007, section 9.1).

3. Additional Auxiliary Electrical Consumption

In this NOPR, DOE proposes changes to the test procedure by updating the incorporation by reference of ASHRAE 103 to the 2007 version and by incorporating testing of auxiliary electricity components. DOE requests comment from stakeholders on these proposed changes.

4. Installation and Operation Manual Reference

DOE requests comment on its proposal to clarify the test procedure language to explicitly state that testing recommendations should be drawn from each product's approved I&O manual, and to provide a specific combustion airflow ratio, reduced fuel input rate, and draft settings when the manufacturer does not provide recommended values in the I&O manual provided with the unit.

5. Automatic Means for Adjusting Water Temperature Testing

DOE seeks stakeholder comment on any additional methods for inferring building heat load to ensure that DOE's proposed test method validates the functionality of all strategies currently available in the market used to provide an automatic means for adjusting water temperature.

6. Test Method for Indicating the Absence of Flow Through the Heat Exchanger

DOE is interested in whether, in addition to the proposed smoke stick test, other options exist for measuring or indicating the absence of flow through the heat exchanger.

7. AFUE Reporting Precision

DOE's existing furnaces and boilers test procedure specifies that the AFUE rating be rounded to the nearest whole percentage point. DOE requests comment on its proposal to update the existing requirement for residential furnaces and boilers to report AFUE to the nearest tenth of a percentage point.

8. Duct Work for Units That Are Installed Without a Return Duct

DOE requests comments on the proposal to add a provision in the test procedure clarifying that the return (inlet) duct is not required during testing for units which, according to the manufacturer's I&O manual, are intended to be installed without a return duct.

9. Testing Requirements for Multiposition Configurations

DOE requests comment on its proposal to allow testing of units configured for multiple position installations to use the blower access door as an option instead of one of the inlet openings.

10. Room Ambient Air Temperature and Humidity Ranges

DOE requests comment from stakeholders on DOE's preliminary determination not to propose changes to the test procedure regarding room ambient temperature and humidity, neither in the form of a mathematical correction methodology nor by limiting the existing ambient condition ranges.

11. Oversize Factor Value

DOE did not receive data supporting a change to the existing oversize factor of 0.7. DOE proposes to maintain the existing oversize factor and seeks comment on the appropriateness of this strategy.

VI. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this notice of proposed rulemaking.

List of Subjects

10 CFR Part 429

Confidential business information, Energy conservation, Household appliances, Imports, Reporting and recordkeeping requirements.

10 CFR Part 430

Administrative practice and procedure, Confidential business information, Energy conservation, Household appliances, Imports, Incorporation by reference, Intergovernmental relations, Small businesses.

Issued in Washington, DC, on February 13, 2015.

Kathleen B. Hogan,

Deputy Assistant Secretary for Energy Efficiency, Energy Efficiency and Renewable Energy.

For the reasons stated in the preamble, DOE proposes to amend parts 429 and 430 of Chapter II, Subchapter D of Title 10, Code of Federal Regulations, as set forth below:

PART 429—CERTIFICATION, COMPLIANCE, AND ENFORCEMENT FOR CONSUMER PRODUCTS AND COMMERCIAL AND INDUSTRIAL EQUIPMENT

■ 1. The authority citation for part 429 continues to read as follows:

Authority: 42 U.S.C. 6291–6317.

■ 2. Section 429.134 is amended by adding paragraphs (c), (d), and (e) to read as follows:

§ 429.134 Product-specific enforcement provisions.

* * * * *

(c) [Reserved].

(d) [Reserved].

(e) *Test protocols for functional verification of automatic means for adjusting water temperature.* These tests are intended to verify the functionality of the design requirement that a boiler has an automatic means for adjusting water temperature for single-stage, two-stage, and modulating boilers. These test methods are intended to permit the functional testing of a range of control strategies used to fulfill this design requirement. Section 2 *Definitions* and paragraph 6.1.a of appendix N to subpart B of part 430 of this title apply for the purposes of this paragraph.

(1) *Test protocol for single-stage products.* This test is intended to verify the functionality of the automatic means for establishing a burner delay upon a heat call in single-stage boiler products. The nature of this test method allows the functional testing of the control strategy that allows the burner or heating element to fire only when the means has determined that the inferred heat load cannot be met by the residual heat of the water in the system.

(i) Boiler setup. (A) Boiler installation. For boilers subject to this testing, boiler installation in the test room shall be in accordance with the setup and apparatus requirements by section 6.0 of appendix N to subpart B of 10 CFR part 430.

(B) *Activation of controls.* Adjust the boiler controls (in accordance with the I&O manual to the default setting that allows for activation of the means for adjusting water temperature.

(C) *Adjustment of water flow and temperature.* The flow and temperature of return (inlet) water to the boiler shall be capable of being adjusted manually.

(ii) *Boiler heat-up.* (A) *Boiler start-up.* Power up the boiler and initiate a call for heat.

(B) *Adjustment of firing rate.* Adjust the boiler's firing rate to within ±5% of its maximum rated input.

(C) *Establishing flow rate and temperature rise.* Adjust the water flow through the boiler to achieve a ΔT of 20 °F (±2 °F) or greater with a supply water temperature equal to 120 °F (±2 °F).

(D) *Terminate the call for heating.* Terminate the call for space heating, stop the flow of water through the boiler, and record the time at termination.

(iii) *Verify burner delay.* (A) Reinitiate call for heat. Within three (3) minutes of termination (paragraph (e)(1)(i)(H) of this section) and without adjusting the inlet water flow rate or heat load as specified in paragraph (e)(1)(i)(G) of this section, reinitiate the call for heat and water flow and record the time.

(B) *Verify burner ignition.* At 15-second intervals, record time and outlet water temperature until the main burner ignites.

(C) Terminate the call for heat.

(2) Test protocol for two-stage and modulating products. This test is intended to verify the functionality of the design requirement that a boiler has an automatic means for adjusting water temperature. The nature of this test method allows the functional testing of the control strategy that ensures that an incremental change in inferred heat load produces a corresponding incremental change in temperature of water supplied.

(i) *Boiler setup.* (A) *Boiler installation.* Boiler installation in the test room shall be in accordance with the setup and apparatus requirements of section 6 of appendix N to subpart B of 10 CFR part 430.

(B) Establishing flow rate and temperature rise.

(*1*) Start the boiler without enabling the means for adjusting water temperature. Establish a water flow rate that allows for a water temperature rise of greater than or equal to 20 °F at maximum input rate.

(*2*) Adjust the inferential load controller in accordance with the I&O manual.

(C) *Temperature stabilization.* Following stabilization of boiler operations and water temperatures, continue to paragraph (e)(2)(ii) of this section.

(ii) Establishing inferred load conditions for reduced boiler output.

(A) *Adjust the inferential load controller.* (*1*) While the boiler is still operational, adjust the boiler controls (in accordance with the I&O manual) to the default setting that allows for activation of the means for adjusting water temperature. (For boiler controls that do not allow for control adjustment during active mode operation, terminate call for heating and adjust the inferential load controller in accordance with the I&O manual. Then reinitiate call for heating.)

(*2*) If the means for adjusting water temperature uses outdoor temperature reset, the maximum outdoor temperature setting (if equipped) should be set to a temperature high enough that the boiler operates continuously during the duration of this test (*i.e.,* if the conditions in paragraph (e)(2)(ii)(B) of this section equal room ambient temperature, then the maximum outdoor temperature should be set at a temperature greater than the normal variation in the room ambient air temperature).

(B) *Establish inferred load conditions.* (*1*) Establish the inferred load conditions (simulated using a controlling parameter) so that the supply water temperature is maintained at the lowest supply water temperature (±4 °F) prescribed by the boiler manufacturer's temperature reset control strategy found in the I&O manual.

(*2*) The minimum supply water temperature of the default temperature reset curve is usually provided within the I&O manual. If there is no recommendation, set the minimum supply water temperature equal to 20 °F less than the high supply water temperature specified in paragraph (e)(2)(iii)(A).

(C) *Supply water temperature condition.* (*1*) Maintain the call for heating until the boiler supply water temperature has stabilized.

(*2*) For this test, a stabilized temperature control setting is deemed to be obtained when the setting does not vary by more than ±3 °F over a period of 5 minutes. The duration of time required to stabilize the supply water, following the procedure in paragraph (e)(2)(ii)(B) of this section, is dependent on the reset strategy and may vary from model to model.

(D) *Supply temperature verification.* (*1*) Verify that the resulting supply water temperature corresponds to the low boiler water temperature as required in paragraph (e)(2)(ii)(B) of this section.

(*2*) Record the stabilized boiler supply water temperature.

(iii) *Verify Water Temperature Reset for Change in Inferred Load.* (A) *Adjust inferred load conditions.* Establish the inferred load conditions so that the supply water temperature is set to the highest allowable supply water temperature (±2 °F) as prescribed in the I&O manual or if there is no recommendation, set to a temperature greater than 170 °F.

(B) *Temperature stabilization.* (*1*) Maintain the call for heating until the boiler supply water temperature has stabilized.

(*2*) Record the boiler supply water temperature while the temperature is stabilized.

(3) Terminate the call for heating.

PART 430—ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS

■ 3. The authority citation for part 430 continues to read as follows:

Authority: 42 U.S.C. 6291–6309; 28 U.S.C. 2461 note.

■ 4. Section 430.2 is amended by revising the definition of ''Furnace'' to read as follows:

§ 430.2 Definitions.

* * * * *

Furnace means a product which utilizes only single-phase electric current, or single-phase electric current or DC current in conjunction with natural gas, propane, or home heating oil, and which—

(1) Is designed to be the principal heating source for the living space of a residence;

(2) Is not contained within the same cabinet with a central air conditioner whose rated cooling capacity is above 65,000 Btu per hour;

(3) Is an electric central furnace, electric boiler, forced-air central furnace, gravity central furnace, or low-pressure steam or hot water boiler; and

(4) Has a heat input rate of less than 300,000 Btu per hour for electric boilers and low-pressure steam or hot water boilers and less than 225,000 Btu per hour for forced-air central furnaces, gravity central furnaces, and electric central furnaces.

* * * * *

■ 5. Section 430.3 is amended by:

■ a. Revising paragraph (f)(10);

■ b. Removing paragraph (f)(11);

■ c. Redesignating paragraph (f)(12) as (f)(11);

■ d. Revise paragraph (i).

The revisions read as follows:

§ 430.3 Materials incorporated by reference.

* * * * *

(f) * * *

(10) ASHRAE Standard 103–2007, (''ASHRAE 103–2007''), Methods of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers, ANSI approved March 25, 2008, IBR approved for § 430.23, appendix N, and appendix AA to subpart B.

* * * * *

(i) *ASTM.* American Society of Testing and Materials*,* ASTM Headquarters, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428–2959, (877) 909–2786 or (610) 832–9585, or go to *http://www.astm.org.*

(1) ASTM–D2156—09 (Reapproved 2013), Method of Test for Smoke Density in the Flue Gases from Distillate Fuels, approved December 1, 2009, IBR approved for appendix N to subpart B.

(2) [Reserved]

* * * * *

■ 6. Revise § 430.23(n)(2) to read as follows:

§ 430.23 Test procedures for the measurement of energy and water consumption.

* * * * *

(n) * * *

(2) The annual fuel utilization efficiency for furnaces, expressed in percent, is the ratio of the annual fuel output of useful energy delivered to the heated space to the annual fuel energy input to the furnace determined according to section 10.1 of appendix N of this subpart for gas and oil furnaces and determined in accordance with section 11.1 of the American National Standards Institute/American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard 103–2007 (incorporated by reference, see § 430.3) for electric furnaces. Round the annual fuel utilization efficiency to the nearest one-tenth of a percentage point.

* * * * *

■ 7. Revise section 2.3 of Appendix AA to subpart B to read as follows:

Appendix AA to Subpart B of Part 430—Uniform Test Method for Measuring the Energy Consumption of Furnace Fans

* * * * *

2.0 *Definitions.* * * *

2.3 *ASHRAE Standard 103–2007* (incorporated by reference; see § 430.3) means the test standard published in 2007 by ASHRAE, approved by the American National Standards Institute (ANSI) on March 25, 2008, and titled ''Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers,'' except for sections 3.0, 7.2.2.5, 8.6.1.1, 9.1.2.2, 9.5.1.1, 9.5.1.2.1, 9.5.1.2.2, 9.5.2.1, 9.7.1, 10.0, 11.2.12, 11.3.12, 11.4.12, 11.5.12 and appendices B and C. Only those sections of ASHRAE 103–2007 specifically referenced in this test procedure are part of this test procedure. In cases where there is a conflict, the language of the test procedure in this appendix takes precedence over ASHRAE 103–2007.

* * * * *

■ 8. Revise appendix N to subpart B to read as follows:

Appendix N to Subpart B of Part 430—Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers

Note: On and after [*180 days after publication of the final rule in the* **Federal Register**], any representations made with respect to the energy use or efficiency of residential furnaces and boilers must be made in accordance with the results of testing pursuant to this appendix. On and after this date, if a manufacturer makes representations of standby mode and off mode energy consumption, then testing must also include the provisions of this appendix related to standby mode and off mode energy consumption (*i.e.,* sections 8.12 and 10.12 of this appendix N).

Until [*180 days after the publication of the final rule in the* **Federal Register**], representations must be made in accordance with the results of testing pursuant to either this appendix, or appendix N as it appeared at 10 CFR part 430, subpart B revised as of January 1, 2015. Any representations made with respect to the energy use or efficiency of such residential furnaces and boilers must be in accordance with whichever version is selected. DOE notes that, because testing under this appendix N must be completed as of [*180 days after publication of the final rule in the* **Federal Register**], manufacturers may wish to begin using this test procedure immediately.

1.0 *Scope.* This appendix provides the test procedures for furnaces and boilers subject to the standards specified at 10 CFR 430.32(e).

2.0 *Definitions.* Definitions include those specified in section 3 of ASHRAE 103–2007 (incorporated by reference, see § 430.3) and the following additional and modified definitions. In cases where there is a conflict, these definitions take precedence over the definitions specified in ASHRAE 103–2007.

2.1 *Active mode* means the condition in which the furnace or boiler is connected to the power source, and at least one of the burner, electric resistance elements, or any electrical auxiliaries such as blowers or pumps, are activated.

2.2 *ASHRAE* means the American Society of Heating, Refrigerating, and Air-Conditioning Engineers.

2.3 *ASHRAE 103–2007* (incorporated by reference; see § 430.3) means the test standard published in 2007 by ASHRAE, approved by the American National Standards Institute (ANSI) on March 25, 2008, and titled ''Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers'' (incorporated by reference, see § 430.3), except for sections 2, 7.1, 7.2.2.2, 7.2.2.5, 7.2.3.1, 7.8, 8.2.1.3, 8.3.3.1, 8.4.1.1, 8.4.1.1.2, 8.4.1.2, 8.4.2.1.4, 8.4.2.1.6, 8.6.1.1, 8.7.2, 8.8.3, 9.1.2.1, 9.1.2.2.1, 9.1.2.2.2, 9.2, 9.5.1.1, 9.5.1.2.1, 9.5.1.2.2, 9.5.2.1, 9.7.6, 9.7.4, 9.10, 11.5.11.1, 11.5.11.2 and appendices B and C. Only those sections of ASHRAE 103–2007 specifically referenced in this test procedure are part of this test procedure. In cases where there is a conflict, the language of the test procedure in this appendix takes precedence over ASHRAE 103–2007.

2.4 *ASTM–D2156* means the test standard published by the American Society for Testing and Materials (ASTM), titled ''Method of Test for Smoke Density in the Flue Gases from Distillate Fuels,'' published in 2009 (reapproved 2013). (incorporated by reference, see § 430.3)

2.5 *Controlling Parameter* means a measurable quantity (such as temperature or usage pattern) used for inferring heating load, which would then result in incremental changes in supply water temperature.

2.6 *IEC 62301* means the test standard published by the International Electrotechnical Commission (IEC), titled ''Household electrical appliances—Measurement of standby power,'' Publication 62301 (Edition 2.0 2011–01). (incorporated by reference, see § 430.3)

2.7 *Installation and operation (I&O) manual* means instructions for installing, commissioning, and operating the furnace or boiler, which are approved as part of the product's safety listing and are supplied with the product when shipped by the manufacturer.

2.8 *Multiposition furnace* means a furnace that can be installed in more than one airflow configuration (*i.e.,* upflow or horizontal; downflow or horizontal; and upflow, downflow, or horizontal).

2.9 *Off mode* means a mode in which the furnace or boiler is connected to a mains power source and is not providing any active or standby mode function, and where the mode may persist for an indefinite time. The existence of an off switch in off position (a disconnect circuit), is included within the classification of an off mode.

2.10 *Off switch* means the switch on the furnace or boiler that, when activated, results in a measurable change in energy consumption between the standby and off modes.

2.11 *Standby mode* means any mode in which the furnace or boiler is connected to a mains power source and offers one or more of the following space heating functions that may persist for an indefinite time:

a. To facilitate the activation of other modes (including activation or deactivation of active mode) by remote control (including thermostat or use patterns) or internal or external sensors (temperature);

b. Continuous functions, including information or status displays (where present).

2.12 *Thermal stack damper* means a type of stack damper which is dependent for operation exclusively upon the direct conversion of thermal energy of the stack gases to open the damper.

3.0 *Classifications.* Classifications are as specified in section 4 of ASHRAE 103–2007 (incorporated by reference, see § 430.3).

4.0 *Requirements.* Requirements are as specified in section 5 of ASHRAE 103–2007 (incorporated by reference, see § 430.3).

5.0 *Instruments.* Instruments must be as specified in section 6 of ASHRAE 103–2007 (incorporated by reference, see § 430.3).

6.0 *Apparatus.* The apparatus used in conjunction with the furnace or boiler during the testing shall be as specified in section 7 of ASHRAE 103–2007 (incorporated by reference, see § 430.3) except for sections 7.1, 7.2.2.2, 7.2.2.5, 7.2.3.1, and 7.8, and as specified in sections 6.1 through 6.5 of this appendix.

6.1 *General.*

a. Install the furnace or boiler in the test room in accordance with the I&O manual, as defined in section 2.7 of this appendix, unless a specific provision of the referenced test procedure applies. The exception to this case is that if additional provisions within this appendix have been specified, then the provisions herein drafted and prescribed by DOE shall govern. If the I&O manual and any additional provisions are not sufficient for testing a furnace or boiler, the manufacturer must request a waiver from the test procedure pursuant to 10 CFR 430.27.

b. If the I&O manual indicates the unit should not be installed with a return duct, then the return (inlet) duct specified in section 7.2.1 of ASHRAE 103–2007 is not required.

c. Test multiposition furnaces in the least-efficient configuration. Testing of multiposition furnaces in other configurations is permitted if represented pursuant to the requirements in 10 CFR 429. If a multiposition furnace is not shipped with an open inlet, testing of the unit would use the blower access door instead of removing one of the designed inlet cut-outs.

d. The apparatus described below is used in conjunction with the furnace or boiler during testing. Each piece of apparatus shall conform to material and construction specifications and the reference standards cited.

e. Test rooms containing equipment must have suitable facilities for providing the utilities (including but not limited to environmental controls, sufficient fluid source(s), applicable measurement equipment, and any other technology or tools) necessary for performance of the test and must be able to maintain conditions within the limits specified.

6.2 *Forced Air Central Furnaces (Direct Vent and Direct Exhaust).*

a. Units not equipped with a draft hood or draft diverter shall be provided with the minimum-length vent configuration recommended in the I&O manual or a 5-ft flue pipe if there is no recommendation (see Figure 4 of ASHRAE 103–2007). For a direct exhaust system, insulate the minimum-length vent configuration or the 5-ft flue pipe with insulation having an R-value not less than 7 and an outer layer of aluminum foil. For a direct vent system, see section 7.5 of ASHRAE 103–2007 for insulation requirements.

b. For units with power burners, cover the flue collection box with insulation having an R-value of not less than 7 and an outer layer of aluminum foil before the cool-down and heat-up tests described in sections 9.5 and 9.6 of ASHRAE 103–2007, respectively. However, do not apply the insulation for the jacket loss test (if conducted) described in section 8.6 of ASHRAE 103–2007 or the steady-state test described in section 9.1 of ASHRAE 103–2007.

c. For power-vented units, insulate the shroud surrounding the blower impeller with insulation having an R-value of not less than 7 and an outer layer of aluminum foil before the cool-down and heat-up tests described in sections 9.5 and 9.6 of ASHRAE 103–2007. Do not apply the insulation for the jacket loss test (if conducted) described in section 8.6 of ASHRAE 103–2007 or the steady-state test described in section 9.1 of ASHRAE 103–2007. Do not insulate the blower motor or block the airflow openings that facilitate the cooling of the combustion blower motor or bearings.

6.3 *Downflow furnaces.* Install an internal section of vent pipe the same size as the flue collar for connecting the flue collar to the top of the unit, if not supplied by the manufacturer. Do not insulate the internal vent pipe during the jacket loss test (if conducted) described in section 8.6 of ASHRAE 103–2007 or the steady-state test described in section 9.1 of ASHRAE 103–2007. Do not insulate the internal vent pipe before the cool-down and heat-up tests described in sections 9.5 and 9.6, respectively, of ASHRAE 103–2007. If the vent pipe is surrounded by a metal jacket, do not insulate the metal jacket. Install a 5-ft test stack of the same cross-sectional area or perimeter as the vent pipe above the top of the furnace. Tape or seal around the junction connecting the vent pipe and the 5-ft test stack. Insulate the 5-ft test stack with insulation having an R-value not less than 7 and an outer layer of aluminum foil. (See Figure 3–A & B of ASHRAE 103–2007.)

6.4 *Units with Draft Hoods or Draft Diverters.* Install the stack damper in accordance with the I&O manual. Install five feet of stack above the damper.

a. For units with an integral draft diverter, cover the 5-ft stack with insulation having an R-value of not less than 7 and an outer layer of aluminum foil.

b. For units with draft hoods, insulate the flue pipe between the outlet of the furnace and the draft hood with insulation having an R-value of not less than 7 and an outer layer of aluminum foil.

c. For units with integral draft diverters that are mounted in an exposed position (not inside the overall unit cabinet), cover the diverter boxes (excluding any openings through which draft relief air flows) before the beginning of any test (including jacket loss test) with insulation having an R-value of not less than 7 and an outer layer of aluminum foil.

d. For units equipped with integral draft diverters that are enclosed within the overall unit cabinet, insulate the draft diverter box with insulation as described above before the cool-down and heat-up tests described in sections 9.5 and 9.6, respectively, of ASHRAE Standard 103–2007. Do not apply the insulation for the jacket loss test (if conducted) described in section 8.6 of ASHRAE 103–2007 or the steady-state test described in section 9.1 of ASHRAE 103–2007.

6.5 *Condensate Collection.* Condensate drain lines shall be attached to the unit as specified in the I&O manual. A continuous downward slope of drain lines from the unit shall be maintained. Additional precautions (such as eliminating any line configuration or position that would otherwise restrict or block the flow of condensate or checking to ensure a proper connection with condensate drain spout that allows for unobstructed flow) shall be taken to facilitate uninterrupted flow of condensate during the test. Collection containers must be glass or polished stainless steel to facilitate removal of interior deposits. The collection container shall have a vent opening to the atmosphere.

7.0 *Testing conditions.* The testing conditions shall be as specified in section 8 of ASHRAE 103–2007 (incorporated by reference, see § 430.3), except for section 8.2.1.3, 8.3.3.1, 8.4.1.1, 8.4.1.1.2, 8.4.1.2, 8.4.2.1.4, 8.4.2.1.6, 8.6.1.1, 8.7.2, and 8.8.3; and as specified in sections 7.1 to 7.10 of this appendix, respectively.

7.1 *Fuel Supply, Gas.* In conducting the tests specified herein, gases with characteristics as shown in Table 1 of ASHRAE 103–2007 shall be used. The gas supply, ahead of all controls for a furnace, shall be maintained at a test pressure between the normal and increased values shown in Table 1 of ASHRAE 103–2007. Maintain the regulator outlet pressure at a level approximating that recommended in the I&O manual, as defined in section 2.7 of this appendix, or, in the absence of such recommendation, to the nominal regulator settings used when the product is shipped by the manufacturer. Use a gas having a specific gravity as shown in Table 1 and with a higher heating value within ±5% of the higher heating value shown in Table 1 of ASHRAE 103–2007. Determine the actual higher heating value in Btu per standard cubic foot for the gas to be used in the test with an error no greater than 1%.

7.2 *Installation of Piping.* Install piping equipment in accordance with the I&O manual. In the absence of such specification, install piping in accordance with section 8.3.1.1 of ASHRAE 103–2007.

7.3 *Gas Burner.* Adjust the burners of gas-fired furnaces and boilers to their maximum Btu input ratings at the normal test pressure specified by section 8.2.1.3 of ASHRAE 103–2007. Correct the burner input rate to reflect gas characteristics at a temperature of 60 °F and atmospheric pressure of 30 in. of Hg and adjust to within ±2 percent of the hourly Btu nameplate input rating as measured during the steady-state performance test described below. Adjust the combustion airflow to achieve an excess air ratio, flue O_2 percentage, or flue CO_2 percentage to within the middle 30th percentile of the acceptable range specified in the I&O manual. In the absence of such specification, adjust the combustion airflow to provide between 6.9 percent and 7.1 percent dry flue gas O_2, or the lowest dry flue gas O_2 percentage that produces a stable flame, no carbon deposits, and an air-free flue gas CO ratio below 400 parts per million during the steady-state test described in section 9.1 of ASHRAE 103–2007, whichever is higher. After the steady-state performance test has been started, do not make additional adjustments to the burners during the required series of performance tests specified in section 9 of ASHRAE 103–2007. If a vent-limiting means is provided on a gas pressure regulator, keep it in place during all tests.

7.4 *Modulating Gas Burner Adjustment at Reduced Input Rate.* For gas-fired furnaces and boilers equipped with modulating-type controls, adjust the controls to operate the unit at the nameplate minimum input rate. If the modulating control is of a non-automatic type, adjust the control to the setting recommended in the I&O manual. In the absence of such recommendation, the midpoint setting of the non-automatic control shall be used as the setting for determining the reduced fuel input rate. Start the furnace or boiler by turning the safety control valve to the ''ON'' position. For boilers, use a supply water temperature that will allow for continuous operation without shutoff by the control. If necessary to achieve such continuous operation, supply water may be increased above 120 °F; in such cases, gradually increase the supply water temperature to determine what minimum supply water temperature, with a 20 °F temperature rise across the boiler, will be needed to adjust for the minimum input rate at the reduced input rate control setting. Monitor regulated gas pressure out of the modulating control valve (or entering the burner) to determine when no further reduction of gas pressure results. The flow rate of water through the boiler shall be adjusted to achieve a 20 °F temperature rise.

7.5 *Oil Burner.* Adjust the burners of oil-fired furnaces or boilers to give a CO_2 reading within the middle 30th percentile of the acceptable range specified in the I&O manual. In the absence of such specification, adjust the airflow through the burner to achieve a dry flue gas CO_2 percentage between 10.0 percent and 10.4 percent, or a dry flue gas CO_2 percentage that results in flue gas smoke that does not exceed No. 1 smoke during the steady-state performance test as measured by the procedure in ASTM–D2156 (incorporated by reference; see § 430.3), whichever is lower. Adjust the fuel input rate to within ±2 percent of the highest nameplate input rate. Maintain the average draft over the fire and in the flue during the steady-state performance test within the middle 30th percentile of the ranges specified in the I&O manual. In the absence of such specification, maintain the lowest draft that produces either flue CO_2 levels or smoke values within the ranges stipulated in this paragraph. Do not allow draft fluctuations exceeding 0.005 in. water. Do not make additional adjustments to the burner during the required series of performance tests. The instruments and measuring apparatus for this test are described in section 6 of this appendix and shown in Figure 8 of ASHRAE 103–2007.

7.6 Air throughputs shall be adjusted to a temperature rise that is the higher of a and b, unless c applies.

a. 15 °F less than the nameplate maximum temperature rise or

b. 15 °F higher than the minimum temperature rise specified in the I&O manual.

c. A furnace with a non-adjustable air temperature rise range and an automatically controlled airflow that does not permit a temperature rise range of 30 °F or more shall be tested at the midpoint of the rise range.

A tolerance of ±2 °F is permitted.

7.7 The specified temperature rise shall be established by adjusting the circulating airflow. This adjustment shall be accomplished by symmetrically restricting the outlet air duct and varying blower speed selection to obtain the desired temperature rise and minimum external static pressure, as specified in Table 4 of ASHRAE 103–2007. If the required temperature rise cannot be obtained at the minimum specified external static pressure by adjusting blower speed selection and duct outlet restriction, then the following applies.

a. If the resultant temperature rise is less than the required temperature rise, vary the blower speed by gradually adjusting the blower voltage so as to maintain the minimum external static pressure listed in Table 4 of ASHRAE 103–2007. The airflow restrictions shall then remain unchanged. If static pressure must be varied to prevent unstable blower operation, it shall be varied on the plus side but shall not exceed the maximum external static pressure as specified by the manufacturer in the I&O manual.

b. If the resultant temperature rise is greater than the required temperature rise, then the unit can be tested at a higher temperature rise value, but one not greater than nameplate maximum temperature rise. In order not to exceed the maximum temperature rise, the speed of a direct-driven blower may be increased by increasing the circulating air blower motor voltage.

7.8 *Measurement of Jacket Surface Temperature.* The jacket of the furnace or boiler shall be subdivided into 6-inch squares when practical, and otherwise into 36-square-inch regions comprising 4 in. × 9 in. or 3 in. × 12 in. sections, and the surface temperature at the center of each square or section shall be determined with a surface thermocouple. The 36-square-inch areas shall be recorded in groups where the temperature differential of the 36-square-inch area is less than 10 °F for temperature up to 100 °F above room temperature, and less than 20 °F for temperature more than 100 °F above room temperature. For forced air central furnaces, the circulating air blower compartment is considered as part of the duct system, and no surface temperature measurement of the blower compartment needs to be recorded for the purpose of this test. For downflow furnaces, measure all cabinet surface temperatures of the heat exchanger and combustion section, including the bottom around the outlet duct and the burner door, using the 36-square-inch thermocouple grid. The cabinet surface temperatures around the blower section do not need to be measured (See figure 3–E of ASHRAE 103–2007.)

7.9 *Installation of Vent System.* Keep the vent or air intake system supplied by the manufacturer in place during all tests. Test units intended for installation with a variety of vent pipe lengths shall be tested with the minimum vent length as specified in the I&O manual, or a 5-ft flue pipe if there are no recommendations. Do not connect a furnace or boiler employing a direct vent system to a chimney or induced-draft source. Vent combustion products solely by using the venting incorporated in the furnace or boiler and the vent or air intake system supplied by the manufacturer. For units that are not designed to significantly preheat the incoming air, see 7.5 and Figure 4a or 4b of ASHRAE 103–2007. For units that do significantly preheat the incoming air, see Figure 4c or 4d of ASHRAE 103–2007.

7.10 *Additional Optional Method of Testing for Determining D_P and D_F for Furnaces and Boilers.* On units whose design is such that there is no measurable airflow through the combustion chamber and heat exchanger when the burner(s) is (are) off (as determined by the optional test procedure in section 7.10.1 of this appendix), D_F and D_P may be set equal to 0.05.

7.10.1 *Optional Test Method for Indicating the Absence of Flow through the Heat Exchanger.* Manufacturers may use the following test protocol to determine whether air flows through the combustion chamber and heat exchanger when the burner(s) is (are) off using a smoke stick device. The minimum default draft factor (as allowed per sections 8.8.3 & 9.10 of ASHRAE 103–2007) may be used only for units determined pursuant to this protocol to have no airflow through the combustion chamber and heat exchanger.

7.10.1.1 *Test Conditions.* Wait for two minutes following the termination of the furnace or boiler on-cycle before beginning the optional test method for indicating the absence of flow through the heat exchanger.

7.10.1.2 *Location of the Test Apparatus.* After all air currents in the test location have been minimized, position the operable smoke stick/pencil accordingly based on the following equipment configuration: (a) For horizontal combustion air intakes, approximately 4 inches from the vertical plane at the termination of the intake vent and 4 inches below the bottom edge of the combustion air intake, or (b) for vertical combustion air intakes, approximately 4 inches horizontal from vent perimeter at the termination of the intake vent and 4 inches down (parallel to the vertical axis of the vent). In the instance where the boiler combustion air intake is closer than 4 inches to the floor, place the smoke device directly on the floor without impeding the flow of smoke.

Monitor the presence and the direction of the smoke flow.

7.10.1.3 *Duration of Test.* Continue monitoring the release of smoke for 30 seconds.

7.10.1.4 *Test Results.* During visual assessment, determine whether there is any draw of smoke into the combustion air intake vent.

If absolutely no smoke is drawn into the combustion air intake, the furnace or boiler meets the requirements to allow use of the minimum default draft factor pursuant to section 8.8.3 and/or section 9.10 of ASHRAE 103–2007.

If there is any smoke drawn into the intake, proceed with the methods of testing as prescribed in section 8.8 of ASHRAE 103–2007.

8.0 *Test procedure.* Testing and measurements shall be as specified in section 9 of ASHRAE 103–2007 (incorporated by reference, see § 430.3) except for sections 9.1.2.1, 9.1.2.2.1, 9.1.2.2.2, 9.2, 9.5.1.1, 9.5.1.2.1, 9.5.1.2.2, 9.5.2.1, 9.7.6, 9.7.4, and 9.10; and as specified in sections 8.1, 8.2, 8.3, 8.4, 8.5, 8.6, 8.7, 8.8, 8.9, 8.10, and 8.11 of this appendix, respectively.

8.1 *Conditions.* Begin the steady-state performance test by operating the burner and the circulating air blower or water pump until steady-state conditions are attained, as indicated by visual confirmation of condensate production and a temperature variation in three successive readings, taken 15 minutes apart, of not more than any of the following:

a. 3 °F in the stack gas temperature for furnaces and boilers equipped with draft diverters;

b. 5 °F in the flue gas temperature for furnaces and boilers equipped with either draft hoods, direct exhaust, or direct vent systems;

c. 4 °F in the outlet water temperature for hot water boilers;

d. 1 °F in the flue gas temperature for condensing furnaces and boilers; and

e. 1 °F in the supply (outlet) water temperatures for condensing hot water boilers.

8.2 *Gas.* Measure and record the steady-state gas input rate, including pilot gas, corrected to standard conditions of 60 °F and 30 in. Hg. Use measured values of gas temperature and pressure at the meter and barometric pressure to correct the metered gas flow rate to the above standard conditions. Measure the steady-state electric power to the burner (PE) on units so equipped. For furnaces, measure the steady-state electrical power to the conditioned air blowers (BE). For hot water boilers, use a steady-state water pump power of BE = pump nameplate kW or 0.13 kW, if no pump is supplied. Measure the steady-state electric power to the secondary pump (BE_S) on units so equipped. Measure the steady-state electric power to the controls and gas valve (E_O) on units so equipped.

8.3 *Oil.* Measure and record the steady-state fuel input rate and the steady-state electrical power to the burner, PE, on units so equipped. For furnaces, measure the steady-state electrical power to the conditioned air blower, BE. For hot water boilers, use a steady-state water pump power of BE = pump nameplate kW or 0.13 kW, if no pump is supplied. Measure the steady-state electric power to the secondary pump (BE_S) on units so equipped. Measure the steady-state electric power to the controls and gas valve (E_O) on units so equipped.

8.4 *Condensing Furnaces and Boilers, Measurement of Condensate Under Steady-State Conditions.* For units with step-modulating or two-stage controls, the test shall be conducted at both the maximum and reduced inputs. Begin a steady-state condensation collection after steady-state conditions are attained. Perform steady-state condensate collection for at least 30 minutes. Condensate mass shall be measured immediately at the end of the collection period to prevent evaporation loss from the sample. Fuel input shall be recorded for the 30-minute condensate collection steady-state test period. Fuel higher heating value (HHV), temperature, and pressures necessary for determining fuel energy input ($Q_{C,SS}$) will be observed and recorded. The fuel quantity and HHV shall be measured with errors no greater than 1%. The humidity of the room air shall at no time exceed 80%. Determine the mass of condensate for the steady-state test ($M_{C,SS}$) in pounds by subtracting the tare container weight from the total container and condensate weight measured at the end of the 30-minute condensate collection test period.

8.5 *Input to interrupted ignition device.* For burners equipped with an interrupted ignition device, record the nameplate electric power used by the ignition device, PE_{IG}, or record that PE_{IG} = 0.4 kW if no nameplate power input is provided. Record the nameplate ignition device on-time interval, t_{IG}, or, if the nameplate does not provide the ignition device on-time interval, measure the on-time interval with a stop watch at the beginning of the test, starting when the burner is turned on. Set t_{IG} = 0 and PE_{IG} = 0 if the device on-time interval is less than or equal to 5 seconds after the burner is on.

8.6 *Cool-down test for gas- and oil-fueled gravity and forced air central furnaces without stack dampers and without adjustable fan control.* Turn off the main burner after completing steady-state testing, and measure the flue gas temperature by means of the thermocouple grid described in section 7.6 of ASHRAE 103–2007 at 1.5 minutes ($T_{F,OFF}(t_3)$) and 9 minutes ($T_{F,OFF}(t_4)$) after the burner shuts off. When taking these temperature readings, the integral draft diverter shall remain blocked and insulated, and the stack restriction shall remain in place. On atmospheric systems with an integral draft diverter or draft hood and equipped with either an electromechanical inlet damper or an electromechanical flue damper that closes within 10 seconds after the burner shuts off to restrict the flow through the heat exchanger in the off-cycle, bypass or adjust the control for the electromechanical damper so that the damper remains open during the cool-down test. For furnaces that employ post-purge, measure the length of the post-purge period with a stopwatch. The time from burner ''OFF'' to combustion blower ''OFF'' (electrically de-energized) shall be recorded as t_P. If t_P is designated by the I&O manual to be greater than 180 seconds, stop the combustion blower at 180 seconds and use that value for t_P. Measure the flue gas temperature by means of the thermocouple grid described in section 7.6 of ASHRAE 103–2007 at the end of post-purge period, $t_P(T_{F,OFF}(t_P))$, and at the time (1.5 + t_P) minutes ($T_{F,OFF}(t_3)$) and (9.0 + t_P) minutes ($T_{F,OFF}(t_4)$) after the main burner shuts off. If the measured t_P is less than or equal to 30 seconds, set t_P at 0 and conduct the cool-down test as if there is no post-purge.

8.7 *Cool-down test for gas- and oil-fueled gravity and forced air central furnaces without stack dampers and with adjustable fan control.* For a furnace with adjustable fan control, the time delay, t_P, will be until the supply air temperature drops to a value of 40 °F above the inlet air temperature or 3 minutes for non-condensing furnaces and 1.5 minutes for condensing furnaces, whichever is longer. For a furnace with adjustable fan control with a range of adjustment that does not allow for the time delay specified above, the fan control shall be bypassed and the fan manually controlled to allow for the appropriate delay time, as specified in section 8.6 of this appendix (case equivalent to a central furnace without adjustable fan control). For a furnace that employs a single motor to drive both the power burner and the indoor air circulating blower, the power burner and indoor air circulating blower shall be turned off at the same time.

8.8 *Cool-down test for gas- and oil-fueled boilers without stack dampers.* After steady-state testing has been completed, turn the main burner(s) ''OFF'' and measure the flue gas temperature at 3.75 minutes (temperature designated as $T_{F,OFF}(t_3)$) and 22.5 minutes (temperature designated as $T_{F,OFF}(t_4)$) after the burner shut-off using the thermocouple grid described in section 7.6 of ASHRAE 103–2007.

a. During this off-period, for units that do not have pump delay after shut-off, no water shall be allowed to circulate through the hot water boilers.

b. For units that have pump delay on shut-off, except those having pump controls sensing water temperature, the pump shall be stopped by the unit control and the time between burner shut-off and pump shut-off (t^+) shall be measured and recorded to the nearest second.

c. For units having pump delay controls that sense water temperature, the pump shall be operated for 15 minutes and t^+ shall be recorded as 15 minutes. While the pump is operating, the inlet water temperature and flow rate shall be maintained at the same values as during the steady-state test, as specified in sections 9.1 and 8.4.2.3 of ASHRAE 103–2007.

d. For boilers that employ post-purge, measure the length of the post-purge period with a stopwatch. The time from burner ''OFF'' to combustion blower ''OFF'' (electrically de-energized) shall be recorded as t_P. If t_P is designated by the I & O manual to be greater than 180 seconds, stop the combustion blower at 180 seconds and use that value for t_P. Measure the flue gas temperature by means of the thermocouple grid described in section 7.6 of ASHRAE 103–2007 at the end of the post-purge period t_P ($T_{F,OFF}(t_P)$) and at (3.75 + t_P) minutes ($T_{F,OFF}(t_3)$) and (22.5 + t_P) minutes ($T_{F,OFF}(t_4)$) after the main burner shuts off. If the measured t_P is less than or equal to 30 seconds, record t_P as 0 and conduct the cool-down test as if there is no post-purge.

8.9 *Direct measurement of off-cycle losses testing method.* [Reserved.]

8.10 *Calculation options.* The rate of the flue gas mass flow through the furnace and the factors D_P, D_F, and D_S are calculated by the equations in sections 11.6.4, 11.7.1, and 11.7.2 of ASHRAE 103–2007. On units whose design is such that there is no measurable airflow through the combustion chamber and heat exchanger when the burner(s) is (are) off (as determined by the optional test procedure in section 7.10.1 of this appendix), D_F and D_P may be set equal to 0.05.

8.11 *Optional test procedures for condensing furnaces and boilers that have no off-period flue losses.* For units that have applied the test method in section 7.10 of this appendix to determine that no measurable airflow exists through the combustion chamber and heat exchanger during the burner off-period and having post-purge periods of less than 5 seconds, D_F and D_P may be set equal to 0.05. At the discretion of the one testing, the cool-down and heat-up tests specified in sections 9.5 and 9.6 of ASHRAE 103–2007 may be omitted on such units. In lieu of conducting the cool-down and heat-up tests, the tester may use the losses determined during the steady-state test described in section 9.1 of ASHRAE 103–2007 when calculating heating seasonal efficiency, $Effy_{HS}$.

8.12 *Measurement of electrical standby and off mode power.*

8.12.1 *Standby power measurement.* With all electrical auxiliaries of the furnace or boiler not activated, measure the standby power ($P_{W,SB}$) in accordance with the procedures in IEC 62301 (incorporated by reference, see § 430.3), except that section 8.5, *Room Ambient Temperature,* of ASHRAE 103–2007 (incorporated by reference, see § 430.3) and the voltage provision of section 8.2.1.4, *Electrical Supply,* of ASHRAE 103–2007 shall apply in lieu of the corresponding provisions of IEC 62301 at section 4.2, *Test room,* and the voltage specification of section 4.3, *Power supply.* Frequency shall be 60Hz. Measure the wattage so that all possible standby mode wattage for the entire appliance is recorded, not just the standby mode wattage of a single auxiliary. Round the recorded standby power ($P_{W,SB}$) to the second decimal place, except for loads greater than or equal to 10W, which must be recorded to at least three significant figures.

8.12.2 *Off mode power measurement.* If the unit is equipped with an off switch or there is an expected difference between off mode power and standby mode power, measure off mode power ($P_{W,OFF}$) in accordance with the standby power procedures in IEC 62301 (incorporated by reference, see § 430.3), except that section 8.5, *Room Ambient Temperature,* of ASHRAE 103–2007 (incorporated by reference, see § 430.3) and the voltage provision of section 8.2.1.4, *Electrical Supply,* of ASHRAE 103–2007 shall apply in lieu of the corresponding provisions of IEC 62301 at section 4.2, *Test room,* and the voltage specification of section 4.3, *Power supply.* Frequency shall be 60Hz. Measure the wattage so that all possible off mode wattage for the entire appliance is recorded, not just the off mode wattage of a single auxiliary. If there is no expected difference in off mode power and standby mode power, let $P_{W,OFF} = P_{W,SB}$, in which case no separate measurement of off mode power is necessary. Round the recorded off mode power ($P_{W,OFF}$) to the second decimal place, except for loads greater than or equal to 10W, which must be recorded to at least three significant figures.

9.0 *Nomenclature.* Nomenclature shall include the nomenclature specified in section 10 of ASHRAE Standard 103–2007 (incorporated by reference, see § 430.3) and the following additional variables:

Eff_{motor}= Efficiency of power burner motor

PE_{IG} = Electrical power to the interrupted ignition device, kW

$R_{T,a} = R_{T,F}$ if flue gas is measured
= $R_{T,S}$ if stack gas is measured

$R_{T,F}$ = Ratio of combustion air mass flow rate to stoichiometric air mass flow rate

$R_{T,S}$ = Ratio of the sum of combustion air and relief air mass flow rate to stoichiometric air mass flow rate
t_{IG} = Electrical interrupted ignition device on-time, min.
$T_{a,SS,X}$ = $T_{F,SS,X}$ if flue gas temperature is measured, °F
= $T_{S,SS,X}$ if stack gas temperature is measured, °F
y_{IG} = Ratio of electrical interrupted ignition device on-time to average burner on-time
y_P = Ratio of power burner combustion blower on-time to average burner on-time
BE_S = Secondary boiler pump electrical energy input rate at full-load steady-state operation, if present
E_O = Gas valve and controls combined electrical energy input rate at full-load steady-state operation, if present
E_{SO} = Average annual electric standby mode and off mode energy consumption, in kilowatt-hours
$P_{W,OFF}$ = Furnace or boiler off mode power, in watts
$P_{W,SB}$ = Furnace or boiler standby mode power, in watts

10.0 *Calculation of derived results from test measurements.* Calculations shall be as specified in section 11 of ASHRAE 103–2007 (incorporated by reference, see § 430.3), except for sections 11.5.11.1, 11.5.11.2, and appendices B and C; and as specified in sections 10.1 through 10.12 and Figure 1 of this appendix.

10.1 *Heating Seasonal Efficiency and AFUE for Electric Furnaces and Boilers.* The heating seasonal efficiency for various types of electric furnaces and boilers, $Effy_{HS-E}$, is determined as follows:

$Effy_{HS-E}$ = 100 (for indoor units)
$Effy_{HS-E}$ = 100–3.3L_J (for electric forced-air central furnaces intended for outdoor installation)
$Effy_{HS-E}$ = 100–1.7L_J (for electric forced-air central furnaces intended for installation in a location identical to isolated combustion system installation)
$Effy_{HS-E}$ = 100–4.7L_J (for electric boilers intended for outdoor installation)
$Effy_{HS-E}$ = 100–2.4L_J (for electric boilers intended for installation in a location identical to isolated combustion system installation)

Where

L_J = jacket loss as determined in section 8.6 of ASHRAE 103–2007, %
AFUE = $Effy_{HS-E}$

10.2 *Annual fuel utilization efficiency.* The annual fuel utilization efficiency (AFUE) is as defined in sections 11.2.12 (non-condensing systems), 11.3.12 (condensing systems), 11.4.12 (non-condensing modulating systems) and 11.5.12 (condensing modulating systems) of ASHRAE 103–2007, except for the definition for the term $Effy_{HS}$ in the defining equation for AFUE. $Effy_{HS}$ is defined as:

$Effy_{HS}$ = heating seasonal efficiency as defined in sections 11.2.11 (non-condensing systems), 11.3.11 (condensing systems), 11.4.11 (non-condensing modulating systems) and 11.5.11 (condensing modulating systems) of ASHRAE 103–2007, except that for condensing modulating systems sections 11.5.11.1 and 11.5.11.2 are replaced by sections 10.3 and 10.4 of this appendix. $Effy_{HS}$ is based on the assumptions that all weatherized warm air furnaces or boilers are located outdoors, that non-weatherized warm air furnaces are installed as isolated combustion systems, and that non-weatherized boilers are installed indoors.

10.3 *Part-Load Efficiency at Reduced Fuel Input Rate.* If the option in section 9.10 of ASHRAE 103–2007 is not employed, calculate the part-load efficiency at the reduced fuel input rate, $Effy_{U,R}$, for condensing furnaces and boilers equipped with either step-modulating or two-stage controls, expressed as a percent and defined as:

$$Effy_{U,R} = 100 - L_{L,A} + L_G - L_C - C_J L_J - \left[\frac{t_{ON}}{t_{ON} + \left(\frac{Q_P}{Q_{IN}}\right) t_{OFF}}\right] x \left(L_{S,ON} + L_{S,OFF} + L_{I,ON} + L_{I,OFF}\right)$$

If the option in section 9.10 of ASHRAE 103–2007 is employed, calculate $Effy_{U,R}$ *as follows:*

$$Effy_{U,R} = 100 - L_{L,A} + L_G - L_C - C_J L_J - \left[\frac{t_{ON}}{t_{ON} + \left(\frac{Q_P}{Q_{IN}}\right) t_{OFF}}\right] (C_S)(L_{S,SS})$$

Where:

$L_{L,A}$ = value as defined in section 11.2.7 of ASHRAE 103–2007,
L_G = value as defined in section 11.3.11.1 of ASHRAE 103–2007, at reduced input rate,
L_C = value as defined in section 11.3.11.2 of ASHRAE 103–2007 at reduced input rate,
L_J = value as defined in section 11.4.8.1.1 of ASHRAE 103–2007 at maximum input rate,
t_{ON} = value as defined in section 11.4.9.11 of ASHRAE 103–2007,
Q_P = pilot fuel input rate determined in accordance with section 9.2 of ASHRAE 103–2007 in Btu/h,
Q_{IN} = value as defined in section 11.4.8.1.1 of ASHRAE 103–2007,
t_{OFF} = value as defined in section 11.4.9.12 of ASHRAE 103–2007 at reduced input rate,
$L_{S,ON}$ = value as defined in section 11.4.10.5 of ASHRAE 103–2007 at reduced input rate,
$L_{S,OFF}$ = value as defined in section 11.4.10.6 of ASHRAE 103–2007 at reduced input rate,
$L_{I,ON}$ = value as defined in section 11.4.10.7 of ASHRAE 103–2007 at reduced input rate,
$L_{I,OFF}$ = value as defined in section 11.4.10.8 of ASHRAE 103–2007 at reduced input rate,
C_J = jacket loss factor and equal to:
= 0.0 for furnaces or boilers intended to be installed indoors
= 1.7 for furnaces intended to be installed as isolated combustion systems
= 2.4 for boilers (other than finned-tube boilers) intended to be installed as isolated combustion systems
= 3.3 for furnaces intended to be installed outdoors
= 4.7 for boilers (other than finned-tube boilers) intended to be installed outdoors
= 1.0 for finned-tube boilers intended to be installed outdoors
= 0.5 for finned-tube boilers intended to be installed in isolated combustion system applications

$L_{S,SS}$ = value as defined in section 11.5.6 of ASHRAE 103–2007 at reduced input rate,

C_S = value as defined in section 11.5.10.1 of ASHRAE 103–2007 at reduced input rate.

10.4 *Part-Load Efficiency at Maximum Fuel Input Rate.* If the option in section 9.10 of ASHRAE 103–2007 is not employed, calculate the part-load efficiency at maximum fuel input rate, $Effy_{U,H}$, for condensing furnaces and boilers equipped with two-stage controls, expressed as a percent and defined as:

$$Effy_{U,H} = 100 - L_{L,A} + L_G - L_C - C_J L_J - \left[\frac{t_{ON}}{t_{ON} + \left(\frac{Q_P}{Q_{IN}}\right) t_{OFF}}\right] x\ (L_{S,ON} + L_{S,OFF} + L_{I,ON} + L_{I,OFF})$$

If the option in section 9.10 of ASHRAE 103–2007 is employed, calculate $Effy_{U,H}$ as follows:

$$Effy_{U,H} = 100 - L_{L,A} + L_G - L_C - C_J L_J - \left[\frac{t_{ON}}{t_{ON} + \left(\frac{Q_P}{Q_{IN}}\right) t_{OFF}}\right] (C_S)(L_{S,SS})$$

Where:

$L_{L,A}$ = value as defined in section 11.2.7 of ASHRAE 103–2007,

L_G = value as defined in section 11.3.11.1 of ASHRAE 103–2007 at maximum input rate,

L_C = value as defined in section 11.3.11.2 of ASHRAE 103–2007 at maximum input rate,

L_J = value as defined in section 11.4.8.1.1 of ASHRAE 103–2007 at maximum input rate,

t_{ON} = value as defined in section 11.4.9.11 of ASHRAE 103–2007,

Q_P = pilot fuel input rate determined in accordance with section 9.2 of ASHRAE 103–2007 in Btu/h,

Q_{IN} = value as defined in section 11.4.8.1.1 of ASHRAE 103–2007,

t_{OFF} = value as defined in section 11.4.9.12 of ASHRAE 103–2007 at maximum input rate,

$L_{S,ON}$ = value as defined in section 11.4.10.5 of ASHRAE 103–2007 at maximum input rate,

$L_{S,OFF}$ = value as defined in section 11.4.10.6 of ASHRAE 103–2007 at maximum input rate,

$L_{I,ON}$ = value as defined in section 11.4.10.7 of ASHRAE 103–2007 at maximum input rate,

$L_{I,OFF}$ = value as defined in section 11.4.10.8 of ASHRAE 103–2007 at maximum input rate,

C_J = value as defined in section 10.3 of this appendix,

$L_{S,SS}$ = value as defined in section 11.5.6 of ASHRAE 103–2007 at maximum input rate,

C_S = value as defined in section 11.5.10.1 of ASHRAE 103–2007 at maximum input rate.

10.5 *National average burner operating hours, average annual fuel energy consumption, and average annual auxiliary electrical energy consumption for gas or oil furnaces and boilers.*

10.5.1 *National average number of burner operating hours.* For furnaces and boilers equipped with single-stage controls, the national average number of burner operating hours is defined as:

BOH_{SS} = 2,080 (0.77) (A) ($Q_{OUT}/(1 + \alpha)$) − 2,080 (B)

Where:

2,080 = national average heating load hours

0.77 = adjustment factor to adjust the calculated design heating requirement and heating load hours to the actual heating load experienced by the heating system

A = 100,000/[341,300(y_P PE + y_{IG} PE_{IG} + y BE) + (Q_{IN} − Q_P)$Effy_{HS}$], for forced draft unit, indoors
= 100,000/[341,300(y_P PE Eff_{motor} + y_{IG} PE_{IG} + y BE) + (Q_{IN} − Q_P) $Effy_{HS}$], for forced draft unit, ICS,
= 100,000/[341,300(y_P PE(1 − Eff_{motor}) + y_{IG} PE_{IG} + y BE) + (Q_{IN} − Q_P) $Effy_{HS}$], for induced draft unit, indoors, and
= 100,000/[341,300(y_{IG} PE_{IG} + y BE) + (Q_{IN} − Q_P) $Effy_{HS}$], for induced draft unit, ICS

B = 2 Q_P ($Effy_{HS}$)(A)/100,000

Where:

Eff_{motor} = Power burner motor efficiency provided by manufacturer,
= 0.50, an assumed default power burner efficiency if not provided by manufacturer.

100,000 = factor that accounts for percent and kBtu

PE = burner electrical power input at full-load steady-state operation, including electrical ignition device if energized, as defined in section 9.1.2.2 of ASHRAE 103–2007.

y_P = ratio of induced or forced draft blower on-time to average burner on-time, as follows:
1 for units without post-purge;
1 + (t_P/t_{ON}) for single-stage furnaces or boilers with post-purge;

PE_{IG} = electrical input rate to the interrupted ignition device on burner (if employed), as defined in section 8.5 of this appendix

y_{IG} = ratio of burner interrupted ignition device on-time to average burner on-time, as follows:
0 for burners not equipped with interrupted ignition device;
(t_{IG}/t_{ON}) for single-stage furnaces or boilers.

t_{IG} = on-time of the burner interrupted ignition device, as defined in section 8.5 of this appendix

t_P = post-purge time as defined in section 8.6 or 8.7 (furnace) or section 8.8 (boiler) of this appendix
= 0 if t_P is equal to or less than 30 second.

y = ratio of blower or pump on-time to average burner on-time, as follows:
1 for furnaces without fan delay or boilers without a pump delay;
1+($t^+ - t^-$)/t_{ON} for furnaces with fan delay or boilers with pump delay;

BE = circulating air fan or water pump electrical energy input rate at full-load steady-state operation, as defined in section 9.1.2.2 of ASHRAE 103–2007

Q_{IN} = as defined in section 11.2.8.1 of ASHRAE 103–2007

Q_P = as defined in section 11.2.11 of ASHRAE 103–2007

$Effy_{HS}$ = as defined in section 11.2.11 (non-condensing systems) or section 11.3.11.3 (condensing systems) of ASHRAE Standard 103–2007, percent, and calculated on the basis of:
isolated combustion system installation, for non-weatherized warm air furnaces;
indoor installation, for non-weatherized boilers; or

outdoor installation, for furnaces and boilers that are weatherized.
2 = ratio of the average length of the heating season in hours to the average heating load hours
t^+ = as defined in section 9.5.1.2 of ASHRAE 103–2007 or section 8.8 of this appendix
t^- = as defined in section 9.6.1 of ASHRAE 103–2007
t_{ON} = average burner on-time per cycle as defined in Table 7 of ASHRAE 103–2007
Q_{OUT} = as defined in section 11.2.8 of ASHRAE 103–2007
α = as defined in section 11.2.8.2 of ASHRAE 103–2007

10.5.1.1 For furnaces and boilers equipped with two-stage or step-modulating controls, the national average number of burner operating hours at the reduced operating mode is defined as:

$BOH_R = X_R\ (2{,}080)\ (0.77)\ (A_R)\ (Q_{OUT}/(1+\alpha)) - 2{,}080\ (B_R)$

Where:

$A_R = 100{,}000/[341{,}300(y_{P,R}\ PE_R + y_{IG,R}\ PE_{IG,R} + y_R BE_R) + (Q_{IN,R} - Q_P) Effy_{U,R}]$, for forced draft unit, indoors
$= 100{,}000/[341{,}300(y_{P,R}\ PE_R\ Eff_{motor} + y_{IG,R}\ PE_{IG,R} + y_R BE_R) + (Q_{IN,R} - Q_P)\ Effy_{U,R}]$, for forced draft unit, isolated combustion system,
$= 100{,}000/[341{,}300(y_{P,R}\ PE_R\ (1\text{-}Eff_{motor}) + y_{IG,R}\ PE_{IG,R} + y_R BE_R) + (Q_{IN,R} - Q_P)\ Effy_{U,R}]$, for induced draft unit, indoors, and
$= 100{,}000/[341{,}300(y_{IG,R}\ PE_{IG,R} + y_R BE_R) + (Q_{IN,R} - Q_P)\ Effy_{U,R}]$, for induced draft unit, isolated combustion system
$B_R = 2\ Q_P\ (Effy_{U,R})(A_R)/100{,}000$
X_R = as defined in section 11.4.8.6 of ASHRAE 103–2007
$Q_{IN,R}$ = as defined in section 11.4.8.1.2 of ASHRAE 103–2007
$Effy_{U,R}$ = average part load efficiency at the reduced fuel input rate as defined in section 11.4.11.1 of ASHRAE 103–2007
$PE_{IG,R}$ = electrical input rate to the interrupted ignition device on burner (if employed), as defined in section 8.5 of this appendix and measured at the reduced fuel input rate.
$y_{IG,R}$ = ratio of burner interrupted ignition device on-time to average burner on-time, as follows:
0 for burners not equipped with an interrupted ignition device; $(t_{IG}/t_{ON,R})$ otherwise;
t_{IG} = on-time of the burner interrupted ignition device, as defined in section 8.5 of this appendix
PE_R = value as defined in section 9.1.2.2 of ASHRAE 103–2007 and measured at the reduced fuel input rate.
$y_{P,R}$ = ratio of induced or forced draft blower on-time to average burner on-time, as follows:
1 for units without post-purge;
$1+(t_P/t_{ON,R})$ for furnaces or boilers with post-purge;
$t_{P,R}$ = post-purge time measured at the reduced fuel input rate as defined for t_P in sections 8.6 or 8.7 (furnace) or section 8.8 (boiler) of this appendix.
= 0 if $t_{P,R}$ is equal to or less than 30 second.
BE_R = value as defined in section 9.1.2.2 of ASHRAE 103–2007 and measured at the reduced fuel input rate.
y_R = ratio of blower or pump on-time to average burner on-time, determined as follows:
1 for furnaces without fan delay or boilers without a pump delay;
$1+(t_R^+ - t_R^-)/t_{ON,R}$ for furnaces with fan delay or oilers with pump delay.
t_R^+ = delay time between burner shutoff and the blower or pump shutoff measured at the reduced fuel input rate as defined for t^+ in section 9.5.1.2 of ASHRAE 103–2007 (furnace) or section 8.8 of this appendix (boiler).
t_R^- = as defined in section 9.6.1 of ASHRAE 103–2007 and measured at the reduced fuel input rate.
$t_{ON,R}$ = average burner on-time per cycle as defined in Table 7 of ASHRAE 103–2007 and measured at the reduced fuel input rate.
Q_{OUT} = as defined in section 11.2.8 of ASHRAE 103–2007
α = as defined in section 11.2.8.2 of ASHRAE 103–2007

10.5.1.2 For furnaces and boilers equipped with two-stage controls, the national average number of burner operating hours at the maximum operating mode is defined as:

$BOH_H = X_H\ (2{,}080)\ (0.77)\ (A_H)\ (Q_{OUT}/(1+\alpha)) - 2{,}080\ (B_H)$

Where:

$A_H = 100{,}000/[341{,}300(y_{P,H}\ PE_H + y_{IG,H}\ PE_{IG,H} + y_H BE_H) + (Q_{IN} - Q_P) Effy_{U,H}]$, for forced draft unit, indoors
$= 100{,}000/[341{,}300(y_{P,H}\ PE_H\ Eff_{motor} + y_{IG,H}\ PE_{IG,H} + y_H BE_H) + (Q_{IN} - Q_P)\ Effy_{U,H}]$, for forced draft unit, isolated combustion system,
$= 100{,}000/[341{,}300(y_{P,H}\ PE_H\ (1\text{-}Eff_{motor}) + y_{IG,H}\ PE_{IG,H} + y_H BE_H) + (Q_{IN} - Q_P)\ Effy_{U,H}]$, for induced draft unit, indoors, and
$= 100{,}000/[341{,}300(y_{IG,H}\ PE_{IG,H} + y_H BE_H) + (Q_{IN}\text{-}Q_P)\ Effy_{U,H}]$, for induced draft unit, isolated combustion system
$B_R = 2\ Q_P\ (Effy_{U,H})(A_H)/100{,}000$
X_H = as defined in section 11.4.8.5 of ASHRAE 103–2007
Q_{IN} = as defined in section 11.4.8.1.1 of ASHRAE 103–2007
$Effy_{U,H}$ = average part load efficiency at the maximum fuel input rate as defined in section 11.4.11.2 of ASHRAE 103–2007
$PE_{IG,H}$ = value as defined in section 8.5 of this appendix and measured at the maximum fuel input rate
$y_{IG,H}$ = ratio of burner interrupted ignition device on-time to average burner on-time, as follows:
0 for burners not equipped with interrupted ignition device; $(t_{IG}/t_{ON,H})$ otherwise
t_{IG} = on-time of the burner interrupted ignition device, as defined in section 8.5 of this appendix
PE_H = value as defined in section 9.1.2.2 of ASHRAE 103–2007 and measured at the maximum fuel input rate
$y_{P,H}$ = ratio of induced or forced draft blower on-time to average burner on-time, as follows:
1 for units without post-purge;
$1+(t_P/t_{ON,H})$ for furnaces or boilers with post-purge;
$t_{P,H}$ = post-purge time measured at the maximum fuel input rate as defined for t_P in sections 8.6 or 8.7 (furnace) or section 8.8 (boiler) of this appendix
= 0 if $t_{P,H}$ is equal to or less than 30 second
BE_H = value as defined in section 9.1.2.2 of ASHRAE 103–2007 and measured at the maximum fuel input rate
y_H = ratio of blower or pump on-time to average burner on-time, as follows:
1 for furnaces without fan delay or boilers without a pump delay;
$1+ (t_H^+ - t_H^-)/t_{ON,H}$ for furnaces with fan delay or boilers with pump delay
t_H^+ = delay time between burner shutoff and the blower or pump shutoff measured at the maximum fuel input rate as defined for t^+ in section 9.5.1.2 of ASHRAE 103–2007 (furnace) or section 8.8 of this appendix (boiler)
t_H^- = as defined in section 9.6.1 of ASHRAE 103–2007 and measured at the maximum fuel input rate
$t_{ON,H}$ = average burner on-time per cycle as defined in Table 7 of ASHRAE Standard 103–2007 and measured at the maximum fuel input rate
Q_{OUT} = as defined in section 11.2.8 of ASHRAE 103–2007
α = as defined in section 11.2.8.2 of ASHRAE 103–2007

10.5.1.3 For furnaces and boilers equipped with step-modulating controls, the national average number of burner operating hours at the modulating operating mode is defined as:

$BOH_M = X_M\ (2{,}080)\ (0.77)\ (A_M)\ (Q_{OUT}/(1 + \alpha)) - 2{,}080\ (B_M)$

Where:

$A_M = 100{,}000/[341{,}300(y_{P,H}\ PE_H + y_{IG,H}\ PE_{IG,H} + y_H BE_H) + (Q_{IN,M} - Q_P) Effy_{U,M}]$, for forced draft unit, indoors
$= 100{,}000/[341{,}300(y_{P,H}\ PE_H\ Eff_{motor} + y_{IG,H}\ PE_{IG,H} + y_H BE_H) + (Q_{IN,M} - Q_P)\ Effy_{U,M}]$, for forced draft unit, isolated combustion system,
$= 100{,}000/[341{,}300(y_{P,H}\ PE_H\ (1 - Eff_{motor}) + y_{IG,H}\ PE_{IG,H} + y_H BE_H) + (Q_{IN,M} - Q_P)\ Effy_{U,M}]$, for induced draft unit, indoors, and
$= 100{,}000/[341{,}300(y_{IG,H}\ PE_{IG,H} + y_H BE_H) + (Q_{IN,M} - Q_P)\ Effy_{U,M}]$, for induced draft unit, isolated combustion system
$B_R = 2\ Q_P\ (Effy_{U,M})(A_M)/100{,}000$
X_H = as defined in section 11.4.8.5 of ASHRAE 103–2007
$Q_{IN,M} = (100)(Q_{OUT,M}/Effy_{SS,M})$
$Q_{OUT,M}$ = as defined in section 11.4.8.10 of ASHRAE 103–2007
$Effy_{U,M}$ = average part-load efficiency at the modulating fuel input rate as defined in section 11.4.8.7 of ASHRAE 103–2007
$PE_{IG,H}$ = value as defined in section 8.5 of this appendix and measured at the modulating fuel input rate
$y_{IG,H}$ = ratio of burner interrupted ignition device on-time to average burner on-time, as follows:
0 for burners not equipped with an interrupted ignition device;
$(t_{IG}/t_{ON,H})$ otherwise
t_{IG} = on-time of the burner interrupted ignition device, as defined in section 8.5 of this appendix

PE_H = value as defined in section 9.1.2.2 of ASHRAE 103–2007 and measured at the maximum fuel input rate
$y_{P,H}$ = ratio of induced or forced draft blower on-time to average burner on-time, as follows:
1 for units without post-purge;
1 + ($t_P/t_{ON,H}$) for furnaces or boilers with post-purge;
$t_{P,H}$ = post-purge time measured at the maximum fuel input rate as defined for t_P in sections 8.6 or 8.7 (furnace) or section 8.8 (boiler) of this appendix
= 0 if $t_{P,H}$ is equal to or less than 30 second
BE_H = value as defined in section 9.1.2.2 of ASHRAE 103–2007 and measured at the maximum fuel input rate
y_H = ratio of blower or pump on-time to average burner on-time, as follows:
1 for furnaces without fan delay or boilers without a pump delay;
1 + ($t_H^+ - t_H^-$)/$t_{ON,H}$ for furnaces with fan delay or boilers with pump delay
t_H^+ = as defined in section 9.5.1.2 of ASHRAE 103–2007 or section 8.8 of this appendix and measured at the maximum fuel input rate
t_H^- = as defined in section 9.6.1 of ASHRAE 103–2007 and measured at the maximum fuel input rate
$t_{ON,H}$ = average burner on-time per cycle as defined in Table 7 of ASHRAE 103–2007 and measured at the maximum fuel input rate
Q_{OUT} = as defined in section 11.2.8 of ASHRAE 103–2007
α = as defined in section 11.2.8.2 of ASHRAE 103–2007

10.5.2 *Average annual fuel energy consumption for gas or oil fueled furnaces or boilers.* For furnaces or boilers equipped with single-stage controls, the average annual fuel energy consumption (E_F) is expressed in Btu per year and defined as:

$$E_F = BOH_{SS} (Q_{IN} - Q_P) + 8{,}760\ Q_P$$

Where:
BOH_{SS} = as defined in section 10.5.1 of this appendix
Q_{IN} = as defined in section 11.2.8.1 of ASHRAE 103–2007
Q_P = as defined in section 11.2.11 of ASHRAE 103–2007
8,760 = total number of hours per year

10.5.2.1 For furnaces or boilers equipped with two-stage controls, E_F is defined as:

$$E_F = BOH_H (Q_{IN}) + BOH_R (Q_{IN,R}) + (8{,}760 - BOH_H - BOH_R) Q_P$$

Where:
BOH_R = as defined in section 10.5.1.1 of this appendix
BOH_H = as defined in section 10.5.1.2 of this appendix
$Q_{IN,R}$ = as defined in section 11.4.8.1.2 of ASHRAE 103–2007
Q_{IN} = as defined in section 11.4.8.1.1 of ASHRAE 103–2007
8,760 = as specified in section 10.5.2 of this appendix
Q_P = as defined in section 11.2.11 of ASHRAE 103–2007

10.5.2.2 For furnaces or boilers equipped with step-modulating controls, E_F is defined as:

$$E_F = BOH_M (Q_{IN,M}) + BOH_R (Q_{IN,R}) + (8{,}760 - BOH_H - BOH_R) Q_P$$

Where:
BOH_R = as defined in section 10.5.1.1 of this appendix
BOH_M = as defined in section 10.5.1.3 of this appendix
$Q_{IN,R}$ = as defined in section 11.4.8.1.2 of ASHRAE 103–2007
$Q_{IN,M}$ = as defined in section 10.5.1.3 of this appendix
8,760 = as specified in section 10.5.2 of this appendix
Q_P =as defined in section 11.2.11 of ASHRAE 103–2007

10.5.3 *Average annual auxiliary electrical energy consumption for gas or oil-fueled furnaces or boilers.* For furnaces and boilers equipped with single-stage controls, the average annual auxiliary electrical consumption (E_{AE}) is expressed in kilowatt-hours and defined as:

$$E_{AE} = BOH_{SS} (y_P PE + y_{IG} PE_{IG} + yBE + y_S BE_S + y_O E_O) + E_{SO}$$

Where:
BOH_{SS} = as defined in section 10.5.1 of this appendix
y_P = as defined in section 10.5.1 of this appendix
PE = as defined in section 10.5.1 of this appendix
y_{IG} = as defined in section 10.5.1 of this appendix
PE_{IG} = as defined in section 10.5.1 of this appendix
y = as defined in section 10.5.1 of this appendix
BE = as defined in section 10.5.1 of this appendix
y_S = ratio of secondary boiler pump on-time to average burner on-time, as follows:
0 for furnaces;
1 for boilers;
BE_S = secondary boiler pump electrical energy input rate at full-load steady-state operation, if present
y_O = ratio of gas valve and controls combined on-time to average burner on-time, as follows:
1 for furnaces or boilers;
E_O = gas valve and controls combined electrical energy input rate at full-load steady-state operation, if present
E_{SO} = as defined in section 10.12 of this appendix

10.5.3.1 For furnaces or boilers equipped with two-stage controls, E_{AE} is defined as:

$$E_{AE} = BOH_R (y_{P,R} PE_R + y_{IG,R} PE_{IG,R} + y_R BE_R + y_{S,R} BE_{S,R} + y_{O,R} BE_{O,R}) + BOH_H (y_{P,H} PE_H + y_{IG,H} PE_{IG,H} + y_H BE_H + y_{S,H} BE_{S,H} + y_{O,H} BE_{O,H}) + E_{SO}$$

Where:
BOH_R = as defined in section 10.5.1.1 of this appendix
$y_{P,R}$ = as defined in section 10.5.1.1 of this appendix
PE_R = as defined in section 10.5.1.1 of this appendix
$y_{IG,R}$ = as defined in section 10.5.1.1 of this appendix
$PE_{IG,R}$ = as defined in section 10.5.1.1 of this appendix
y_R = as defined in section 10.5.1.1 of this appendix
BE_R = as defined in section 10.5.1.1 of this appendix
$y_{S,R}$ = ratio of secondary boiler pump on-time to average burner on-time, as follows:
0 for furnaces;
1 for boilers;
$BE_{S,R}$ = secondary boiler pump electrical energy input rate at reduced load steady-state operation, if present
$y_{O,R}$ = ratio of gas valve and controls combined on-time to average burner on-time, as follows:
1 for furnaces or boilers;
$E_{O,R}$ = gas valve and controls combined electrical energy input rate at reduced load steady-state operation, if present
BOH_H = as defined in section 10.5.1.2 of this appendix
$y_{P,H}$ = as defined in section 10.5.1.2 of this appendix
PE_H = as defined in section 10.5.1.2 of this appendix
$y_{IG,H}$ = as defined in section 10.5.1.2 of this appendix
$PE_{IG,H}$ = as defined in section 10.5.1.2 of this appendix
y_H = as defined in section 10.5.1.2 of this appendix
BE_H = as defined in section 10.5.1.2 of this appendix
$y_{S,H}$ = ratio of secondary boiler pump on-time to average burner on-time, as follows:
0 for furnaces;
1 for boilers;
$BE_{S,H}$ = secondary boiler pump electrical energy input rate at full-load steady-state operation, if present
$E_{O,H}$ = gas valve and controls combined electrical energy input rate at full-load steady-state operation, if present
E_{SO} = as defined in section 10.12 of this appendix

10.5.3.2 For furnaces or boilers equipped with step-modulating controls, E_{AE} is defined as:

$$E_{AE} = BOH_R (y_{P,R} PE_R + y_{IG,R} PE_{IG,R} + y_R BE_R + y_{S,R} BE_{S,R} + y_{O,R} BE_{O,R}) + BOH_M (y_{P,H} PE_H + y_{IG,H} PE_{IG,H} + y_H BE_H + y_{S,H} BE_{S,H} + y_{O,H} E_{O,H}) + E_{SO}$$

Where:
BOH_R = as defined in section 10.5.1.1 of this appendix
$y_{P,R}$ = as defined in section 10.5.1.1 of this appendix
PE_R = as defined in section 10.5.1.1 of this appendix
$y_{IG,R}$ = as defined in section 10.5.1.1 of this appendix
$PE_{IG,R}$ = as defined in section 10.5.1.1 of this appendix
y_R = as defined in section 10.5.1.1 of this appendix
BE_R = as defined in section 10.5.1.1 of this appendix
$y_{S,R}$ = as defined in section 10.5.3.1 of this appendix
$BE_{S,R}$ = as defined in section 10.5.3.1 of this appendix
$y_{O,R}$ = as defined in section 10.5.3.1 of this appendix
$E_{O,R}$ = as defined in section 10.5.3.1 of this appendix
BOH_M = as defined in section 10.5.1.3 of this appendix
$y_{P,H}$ = as defined in section 10.5.1.2 of this appendix
PE_H = as defined in section 10.5.1.2 of this appendix

$y_{IG,H}$ = as defined in section 10.5.1.2 of this appendix
$PE_{IG,H}$ = as defined in section 10.5.1.2 of this appendix
y_H = as defined in section 10.5.1.2 of this appendix
BE_H = as defined in section 10.5.1.2 of this appendix
$y_{S,H}$ = as defined in section 10.5.3.1 of this appendix
$BE_{S,H}$ = as defined in section 10.5.3.1 of this appendix
$y_{O,H}$ = as defined in section 10.5.3.1 of this appendix
$E_{O,H}$ = as defined in section 10.5.3.1 of this appendix
E_{SO} = as defined in section 10.12 of this appendix

10.6 *Average annual electric energy consumption for electric furnaces or boilers.*

$E_E = 100(2{,}080)(0.77)(Q_{OUT}/(1 + \alpha))/(3.412\ AFUE) + E_{SO}$

Where:

100 = to express a percent as a decimal
2,080 = as specified in section 10.5.1 of this appendix
0.77 = as specified in section 10.5.1 of this appendix
Q_{OUT} = as defined in section 10.5.1 of this appendix
α = as defined in section 10.5.1 of this appendix
3.412 = conversion to express energy in terms of watt-hours instead of Btu
AFUE = as defined in section 11.1 of ASHRAE 103–2007, in percent, and calculated on the basis of: isolated combustion system installation, for non-weatherized warm air furnaces; indoor installation, for non-weatherized boilers; or outdoor installation, for furnaces and boilers that are weatherized
E_{SO} = as defined in section 10.12 of this appendix

10.7 *Energy factor.*

10.7.1 *Energy factor for gas or oil furnaces and boilers.* Calculate the energy factor, EF, for gas or oil furnaces and boilers defined as, in percent:

$EF = (E_F - 4{,}600\ (Q_P))(Effy_{HS})/(E_F - 3{,}412\ (E_{AE}))$

Where:

E_F = average annual fuel consumption as defined in section 10.5.2 of this appendix
E_{AE} = as defined in section 10.5.3 of this appendix
$Effy_{HS}$ = Annual Fuel Utilization Efficiency as defined in sections 11.2.11, 11.3.11, 11.4.11 or 11.5.11 of ASHRAE 103–2007, in percent, and calculated on the basis of: isolated combustion system installation, for non-weatherized warm air furnaces;
indoor installation, for non-weatherized boilers; or outdoor installation, for furnaces and boilers that are weatherized.
3,412 = conversion factor from kilowatt to Btu/h

10.7.2 *Energy factor for electric furnaces and boilers.* The energy factor, EF, for electric furnaces and boilers is defined as:

EF = AFUE

Where:

AFUE = Annual Fuel Utilization Efficiency as defined in section 10.6 of this appendix, in percent

10.8 *Average annual energy consumption for furnaces and boilers located in a different geographic region of the United States and in buildings with different design heating requirements.*

10.8.1 *Average annual fuel energy consumption for gas or oil-fueled furnaces and boilers located in a different geographic region of the United States and in buildings with different design heating requirements.* For gas or oil-fueled furnaces and boilers, the average annual fuel energy consumption for a specific geographic region and a specific typical design heating requirement (E_{FR}) is expressed in Btu per year and defined as:

$E_{FR} = (E_F - 8{,}760\ Q_P)(HLH/2{,}080) + 8{,}760\ Q_P$

Where:

E_F = as defined in section 10.5.2 of this appendix
8,760 = as specified in section 10.5.2 of this appendix
Q_P = as defined in section 10.5.1 of this appendix
HLH = heating load hours for a specific geographic region determined from the heating load hour map in Figure 1 of this appendix
2,080 = as defined in section 10.5.1 of this appendix

10.8.2 *Average annual auxiliary electrical energy consumption for gas or oil-fueled furnaces and boilers located in a different geographic region of the United States and in buildings with different design heating requirements.* For gas or oil-fueled furnaces and boilers, the average annual auxiliary electrical energy consumption for a specific geographic region and a specific typical design heating requirement (E_{AER}) is expressed in kilowatt-hours and defined as:

$E_{AER} = (E_{AE} - E_{SO})\ (HLH/2080) + E_{SOR}$

Where:

E_{AE} = as defined in section 10.5.3 of this appendix
E_{SO} = as defined in section 10.12 of this appendix
HLH = as defined in section 10.8.1 of this appendix
2,080 = as specified in section 10.5.1 of this appendix
E_{SOR} = as specified in section 10.8.3 of this appendix

10.8.3 *Average annual electric energy consumption for electric furnaces and boilers located in a different geographic region of the United States and in buildings with different design heating requirements.* For electric furnaces and boilers, the average annual electric energy consumption for a specific geographic region and a specific typical design heating requirement (E_{ER}) is expressed in kilowatt-hours and defined as:

$E_{ER} = 100(0.77)(Q_{OUT}/(1 + \alpha))HLH/(3.412\ AFUE) + E_{SOR}$

Where:

100 = as specified in section 10.6 of this appendix
0.77 = as specified in section 10.5.1 of this appendix
Q_{OUT} = as defined in section 10.5.1 of this appendix
α = as defined in section 10.5.1 of this appendix
HLH = as defined in section 10.8.1 of this appendix
3.412 = as specified in section 10.6 of this appendix
AFUE = as defined in section 10.6 of this appendix
E_{SOR} = E_{SO} as defined in section 10.12 of this appendix, except that in the equation for E_{SO}, the term BOH is multiplied by the expression (HLH/2080) to get the appropriate regional accounting of standby mode and off mode loss

10.9 *Annual energy consumption for mobile home furnaces*.

10.9.1 *National average number of burner operating hours for mobile home furnaces (BOH_{SS}).* BOH_{SS} is the same as in section 10.5.1 of this appendix, except that the value of $Effy_{HS}$ in the calculation of the burner operating hours, BOH_{SS}, is calculated on the basis of a direct vent unit with system number 9 or 10.

10.9.2 *Average annual fuel energy for mobile home furnaces (E_F).* E_F is same as in section 10.5.2 of this appendix except that the burner operating hours, BOH_{SS}, is calculated as specified in section 10.9.1 of this appendix.

10.9.3 *Average annual auxiliary electrical energy consumption for mobile home furnaces (E_{AE}).* E_{AE} is the same as in section 10.5.3 of this appendix, except that the burner operating hours, BOH_{SS}, is calculated as specified in section 10.9.1 of this appendix.

10.10 *Calculation of sales weighted average annual energy consumption for mobile home furnaces.* In order to reflect the distribution of mobile homes to geographical regions with average HLH_{MHF} values different from 2,080, adjust the annual fossil fuel and auxiliary electrical energy consumption values for mobile home furnaces using the following adjustment calculations.

10.10.1 For mobile home furnaces, the sales weighted average annual fossil fuel energy consumption is expressed in Btu per year and defined as:

$E_{F,MHF} = (E_F - 8{,}760\ QP)HLH_{MHF}/2{,}080 + 8{,}760\ Q_P$

Where:

E_F = as defined in section 10.9.2 of this appendix
8,760 = as specified in section 10.5.2 of this appendix
Q_P = as defined in section 10.5.1 of this appendix
HLH_{MHF} = 1880, sales weighted average heating load hours for mobile home furnaces
2,080 = as specified in section 10.5.1 of this appendix

10.10.2 For mobile home furnaces, the sales-weighted-average annual auxiliary electrical energy consumption is expressed in kilowatt-hours and defined as:

$E_{AE,MHF} = E_{AE}\ HLH_{MHF}/2{,}080$

Where:

E_{AE} = as defined in section 10.9.3 of this appendix

HLH_{MHF} = as defined in section 10.10.1 of this appendix

2,080 = as specified in section 10.5.1 of this appendix

10.11 *Direct determination of off-cycle losses for furnaces and boilers equipped with thermal stack dampers.* [Reserved.]

10.12 *Average annual electrical standby mode and off mode energy consumption.* Calculate the annual electrical standby mode and off mode energy consumption (E_{SO}) in kilowatt-hours, defined as:

$$E_{SO} = ((P_{W,SB} * (4160 - BOH)) + (P_{W,OFF} * 4600)) * K$$

Where:

$P_{W,SB}$ = furnace or boiler standby mode power, in watts, as measured in section 8.12.1 of this appendix

4,160 = average heating season hours per year

$P_{W,OFF}$ = furnace or boiler off mode power, in watts, as measured in section 8.12.2 of this appendix

4,600 = average non-heating season hours per year

K = 0.001 kWh/Wh, conversion factor for watt-hours to kilowatt-hours

BOH = total burner operating hours as calculated in section 10.5 of this appendix for gas or oil-fueled furnaces or boilers. Where for gas or oil-fueled furnaces and boilers equipped with single-stage controls, BOH = BOH_{SS}; for gas or oil-fueled furnaces and boilers equipped with two-stage controls, BOH = $(BOH_R + BOH_H)$; and for gas or oil-fueled furnaces and boilers equipped with step-modulating controls, BOH = $(BOH_R + BOH_M)$. For electric furnaces and boilers,

$$BOH = 100(2080)(0.77)(Q_{OUT}/(1+\alpha))/(E_{in}\ 3.412(AFUE))$$

Where:

100 = to express a percent as a decimal

2,080 = as specified in section 10.5.1 of this appendix

0.77 = as specified in section 10.5.1 of this appendix

Q_{OUT} = as defined in section 10.5.1 of this appendix

α = as defined in section 10.5.1 of this appendix

3.412 = conversion to express energy in terms of kBtu instead of kilowatt-hours

AFUE = as defined in section 11.1 of ASHRAE 103—2007 in percent

E_{in} = Steady-state electric rated power, in kilowatts, from section 9.3 of ASHRAE 103–2007

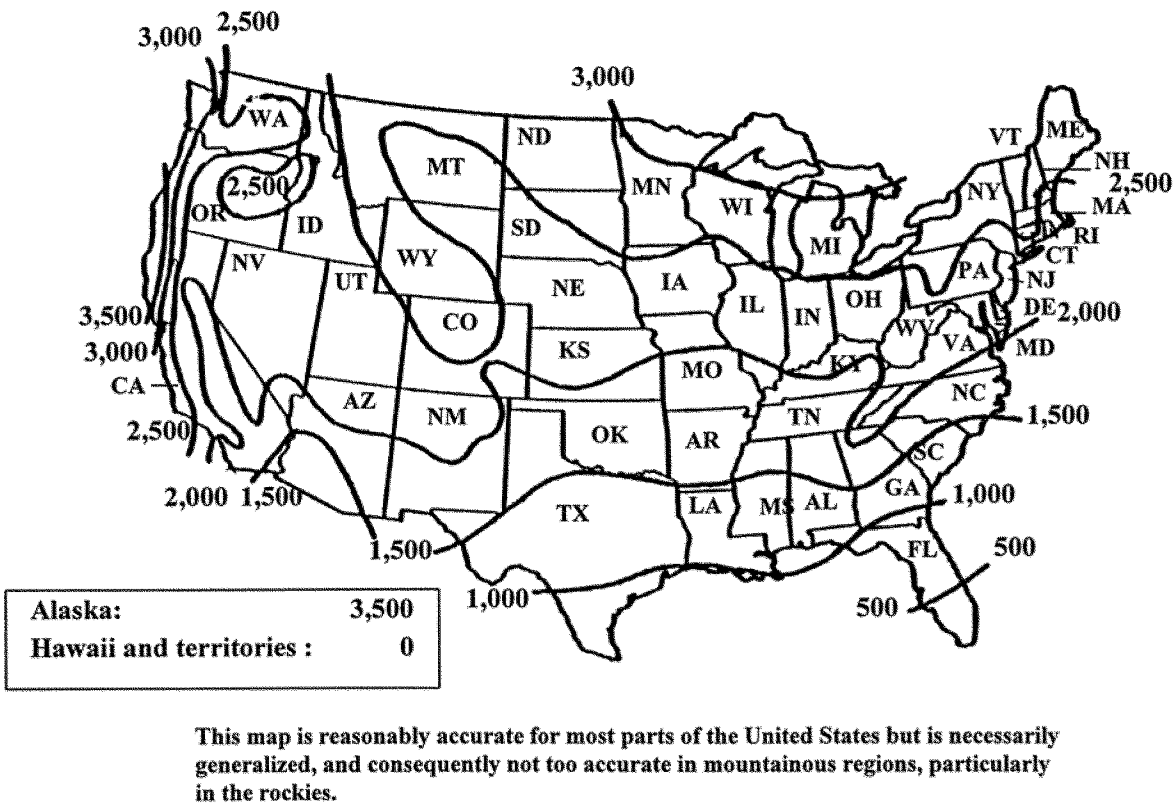

FIGURE 1- HEATING LOAD HOURS (HLH) FOR THE UNITED STATES

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