## DEPARTMENT OF ENERGY

### 10 CFR Parts 429 and 430

**[EERE–2019–BT–TP–0037]**

**RIN 1904–AE83**

## Energy Conservation Program: Test Procedure for Consumer Boilers

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

**ACTION:** Notice of proposed rulemaking and request for comment.

**SUMMARY:** The U.S. Department of Energy (''DOE'') proposes to amend the test procedures for consumer boilers to incorporate by reference the latest version of the industry standards currently referenced in the Federal test procedure. DOE proposes to relocate the test procedure in a new appendix separate from the residential furnace test procedure. DOE also proposes to remove an extraneous definition from its regulatory definitions. DOE is seeking comment from interested parties on the proposal.

**DATES:** DOE will accept comments, data, and information regarding this proposal no later than May 16, 2022. See section V, ''Public Participation,'' for details. DOE will hold a webinar on Thursday, April 7, 2022, from 1 p.m. to 4 p.m. See section V, ''Public Participation,'' for webinar registration information, participant instructions, and information about the capabilities available to webinar participants. If no participants register for the webinar, it will be cancelled.

**ADDRESSES:** Interested persons are encouraged to submit comments using the Federal eRulemaking Portal at *www.regulations.gov.* Follow the instructions for submitting comments. Alternatively, interested persons may submit comments, identified by docket number EERE–2019–BT–TP–0037 and/or RIN 1904–AE83, by any of the following methods:

1. *Federal eRulemaking Portal: www.regulations.gov.* Follow the instructions for submitting comments.

2. *Email: ConsumerBoilers2019TP0037@ee.doe.gov.* Include the docket number EERE–2019–BT–TP–0037 and/or RIN 1904–AE83 in the subject line of the message.

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.

Although DOE has routinely accepted public comment submissions through a variety of mechanisms, including postal mail and hand delivery/courier, the Department has found it necessary to make temporary modifications to the comment submission process in light of the ongoing coronavirus (''COVID–19'') pandemic. DOE is currently suspending receipt of public comments via postal mail and hand delivery/courier. If a commenter finds that this change poses an undue hardship, please contact Appliance Standards Program staff at (202) 586–1445 to discuss the need for alternative arrangements. Once the COVID–19 pandemic health emergency is resolved, DOE anticipates resuming all of its regular options for public comment submission, including postal mail and hand delivery/courier.

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

The docket web page can be found at *www.regulations.gov/docket/EERE-2019-BT-TP-0037.* The docket web page contains instructions on how to access all documents, including public comments, in the docket. See section V for information on how to submit comments through *www.regulations.gov.*

**FOR FURTHER INFORMATION CONTACT:**

Ms. Julia Hegarty, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Office, EE–2J, 1000 Independence Avenue SW, Washington, DC 20585–0121. Telephone: (240) 597–6737. Email *ApplianceStandardsQuestions@ee.doe.gov.*

Ms. Amelia Whiting, U.S. Department of Energy, Office of the General Counsel, GC–33, 1000 Independence Avenue SW, Washington, DC 20585–0121. Telephone: (202) 586–2588. Email: *Amelia.Whiting@hq.doe.gov.*

For further information on how to submit a comment, review other public comments and the docket, or participate in a public meeting (if one is held), contact the Appliance and Equipment Standards Program staff at (202) 287–1445 or by email: *ApplianceStandardsQuestions@ee.doe.gov.*

**SUPPLEMENTARY INFORMATION:** DOE proposes to maintain and amend a previously approved incorporation by reference and to newly incorporate by reference the following industry standards into the Code of Federal Regulations (''CFR'') at 10 CFR part 430:

American National Standards Institute (''ANSI'')/American Society of Heating, Refrigerating and Air-Conditioning Engineers (''ASHRAE'') Standard 103–2017 (ANSI/ASHRAE 103–2017), ''Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers,'' approved July 3, 2017.

ANSI/ASHRAE Standard 41.6–2014 (ANSI/ASHRAE 41.6–2014), ''Standard Method for Humidity Measurement,'' approved July 3, 2014. Copies of ANSI/ASHRAE 103–2017 and ANSI/ASHRAE 41.6–2014 can be obtained from the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 180 Technology Parkway NW, Peachtree Corners, GA 30092, (800) 527–4723 or (404) 636–8400, or online at: *www.ashrae.org.*

ASTM, International (''ASTM'') Standard D2156–09 (Reapproved 2018) (ASTM D2156–09 (R2018)), ''Standard Test Method for Smoke Density in Flue Gases from Burning Distillate Fuels,'' reapproved October 1, 2018.

Copies of ASTM D2156–09 (R2018) can be obtained from the ASTM, International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428–2959 or online at: *www.astm.org.*

International Electrotechnical Commission (''IEC'') 62301 (IEC 62301), ''Household electrical appliances-Measurement of standby power,'' (Edition 2.0 2011–01).

Copies of IEC 62301 can be obtained from the American National Standards Institute, 25 W 43rd Street, 4th Floor, New York, NY 10036, (212) 642–4900, or online at: *webstore.ansi.org.*

See section IV.M of this document for a further discussion of these standards.

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## I. Authority and Background

Furnaces, which includes consumer boilers, are included in the list of ''covered products'' for which DOE is authorized to establish and amend energy conservation standards and test procedures. (42 U.S.C. 6291(23); 42 U.S.C. 6292(a)(5)) DOE's energy conservation standards and test procedures for consumer boilers are currently prescribed at title 10 CFR 430.32(e)(2), and 10 CFR part 430, subpart B, appendix N, *Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers* (''appendix N''). The following sections discuss DOE's authority to establish test procedures for consumer boilers and relevant background information regarding DOE's consideration of test procedures for this product.

### *A. Authority*

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

The energy conservation program under EPCA consists essentially of four parts: (1) Testing, (2) labeling, (3) Federal energy conservation standards, and (4) certification and enforcement procedures. Relevant provisions of EPCA specifically include definitions (42 U.S.C. 6291), test procedures (42 U.S.C. 6293), labeling provisions (42 U.S.C. 6294), energy conservation standards (42 U.S.C. 6295), and the authority to require information and reports from manufacturers (42 U.S.C. 6296).

The Federal 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 (42 U.S.C. 6295(s)), and (2) making representations about the efficiency of those consumer products (42 U.S.C. 6293(c)). Similarly, DOE must use these test procedures to determine whether the products comply with relevant standards promulgated under EPCA. (42 U.S.C. 6295(s))

Federal energy efficiency requirements for covered products established under EPCA generally supersede State laws and regulations concerning energy conservation testing, labeling, and standards. (42 U.S.C. 6297) DOE may, however, grant waivers of Federal preemption in limited circumstances for particular State laws or regulations, in accordance with the procedures and other provisions of EPCA. (42 U.S.C. 6297(d))

Under 42 U.S.C. 6293, the statute sets forth the criteria and procedures DOE must follow when prescribing or amending test procedures for covered products. EPCA requires that any test procedures prescribed or amended under this section must 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 not be unduly burdensome to conduct. (42 U.S.C. 6293(b)(3))

EPCA also requires that, at least once every 7 years, DOE evaluate test procedures for each type of covered product, including the consumer boilers that are the subject of this document, to determine whether amended test procedures would more accurately or fully comply with the requirements for the test procedures to not be unduly burdensome to conduct and be reasonably designed to produce test results that reflect energy efficiency, energy use, and estimated operating costs during a representative average use cycle or period of use. (42 U.S.C. 6293(b)(1)(A))

If the Secretary determines, on his own behalf or in response to a petition by any interested person, that a test procedure should be prescribed or amended, the Secretary shall promptly publish in the **Federal Register** proposed test procedures and afford interested persons an opportunity to present oral and written data, views, and arguments with respect to such procedures. The comment period on a proposed rule to amend a test procedure shall be at least 60 days but may not exceed 270 days. In prescribing or amending a test procedure, the Secretary shall take into account such information as the Secretary determines relevant to such procedure, including technological developments relating to energy use or energy efficiency of the type (or class) of covered products involved. (42 U.S.C. 6293(b)(2)) If DOE determines that test procedure revisions are not appropriate, DOE must publish its determination not to amend the test procedures. DOE is publishing this notice of proposed rulemaking (NOPR) in satisfaction of the 7-year lookback review requirement specified in EPCA. (42 U.S.C. 6293(b)(1)(A))

### *B. Background*

As stated, DOE's existing test procedure for consumer boilers appears at Title 10 of the CFR part 430, subpart B, appendix N (''Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers'') and is used to determine the annual fuel utilization efficiency (''AFUE''), which is the regulatory metric for consumer boilers.

DOE most recently updated its test procedure for consumer boilers in a final rule published in the **Federal Register** on January 15, 2016 (''January 2016 final rule''). 81 FR 2628. The January 2016 final rule amended the existing DOE test procedure for

[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 Infrastructure Investment and JobsEnergy Act of 2020, Public Law 117–58 (Nov. 15, 2021116–260 (Dec. 27, 2020).

consumer boilers to improve the consistency and accuracy of test results generated using the DOE test procedure and to reduce test burden. In particular, the modifications relevant to consumer boilers included: (1) Clarifying the definition of the electrical power term, ''PE''; (2) adopting a smoke stick test for determining whether minimum default draft factors can be applied; (3) allowing for optional measurement of condensate during establishment of steady-state conditions; (4) updating references to the applicable installation and operation (''I&O'') manual and providing clarifications for when the I&O manual does not specify test set-up; and (5) revising the AFUE reporting precision. DOE also revised the definitions of several terms in the test procedure and added an enforcement provision to provide a method of test for DOE to determine compliance with the automatic means design requirement mandated by the Energy Independence and Security Act of 2007, Public Law 110–140 (Dec. 19, 2007). 81 FR 2628, 2629–2630.

On May 15, 2020, DOE published in the **Federal Register** a request for information (''May 2020 RFI'') seeking comments on the existing DOE test procedure for consumer boilers, which incorporates by reference ANSI/ASHRAE Standard 103–1993. 85 FR 29352. ANSI/ASHRAE 103–1993 provides test procedures for determining the AFUE of residential central furnaces and boilers. In the May 2020 RFI, DOE requested comments, information, and data about a number of issues, including: (1) The test procedure's scope and definitions; (2) updates to industry standards; (3) ambient test conditions; (4) provisions for testing boilers with manually adjustable combustion airflow; (5) calculation of steady-state heat loss for condensing, modulating boilers; and (6) provisions for testing step modulating boilers. *Id.* at 85 FR 29354–29357. DOE also sought comment generally on whether the current test procedures are reasonably designed to produce results that measure energy efficiency during a representative average use cycle or period of use, whether any potential amendments would make the test procedure unduly burdensome to conduct, whether existing test procedures limit a manufacturer's ability to provide additional features, on the impact of any potential amendments on manufacturers including small businesses, on whether there are any potential issues related to emerging smart technologies, and generally on any other aspect of the test procedure for consumer boilers. *Id.* at 85 FR 23957.

DOE received comments in response to the May 2020 RFI from the interested parties listed in Table I.1.

TABLE I.1—WRITTEN COMMENTS RECEIVED IN RESPONSE TO THE MAY 2020 RFI

| Commenter(s) | Reference in this NOPR | Commenter type |
|---|---|---|
| Air-Conditioning, Heating and Refrigeration Institute | AHRI | Trade Association. |
| Pacific Gas and Electric Company, San Diego Gas and Electric, Southern California Edison (collectively referred to as the California Investor Owned Utilities). | CA IOUs | Utilities. |
| Northwest Energy Efficiency Alliance | NEEA | Efficiency Organization. |
| Weil-McLain | Weil-McLain | Manufacturer. |
| Bradford White Corporation | BWC | Manufacturer. |
| Rheem Manufacturing Company | Rheem | Manufacturer. |
| Burnham Holdings, Inc | BHI | Manufacturer. |
| Energy Kinetics, Inc | Energy Kinetics | Manufacturer. |
| Lochinvar | Lochinvar | Manufacturer. |

*C. Deviation From Appendix A*

In accordance with section 3(a) of 10 CFR part 430, subpart C, appendix A (''appendix A''), DOE notes that it is deviating from the provision in appendix A regarding the pre-NOPR stages for a test procedure rulemaking. Section 8(b) of appendix A states if DOE determines that it is appropriate to continue the test procedure rulemaking after the early assessment process, it will provide further opportunities for early public input through **Federal Register** documents, including notices of data availability and/or requests for information. DOE is opting to deviate from this provision due to the substantial feedback and information supplied by commenters in response to the May 2020 RFI. As discussed in section I.B of this NOPR, the May 2020 RFI requested submission of comments, data, and information pertinent to test procedures for consumer boilers. In response to the May 2020 RFI, stakeholders provided substantial comments and information, which DOE has found sufficient to identify the need to modify the test procedures for consumer boilers.

## II. Synopsis of the Notice of Proposed Rulemaking

In this NOPR, DOE proposes to update appendix N to remove the provisions applicable only to consumer boilers and to rename the current appendix as ''Uniform Test Method for Measuring the Energy Consumption of Furnaces.'' Correspondingly, DOE proposes to create a new test procedure at 10 CFR 430 subpart B, appendix EE, ''Uniform Test Method for Measuring the Energy Consumption of Boilers'' (''appendix EE''). In the new appendix EE, DOE proposes to include all provisions currently included in appendix N relevant to consumer boilers, with the following modifications:

(1) Incorporate by reference the current revision to the applicable industry standard, ANSI/ASHRAE 103–2017, ''Methods of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers.''

(2) Incorporate by reference the current revision of ASTM Standard D2156–09 (Reapproved 2018), ''Standard Test Method for Smoke Density in Flue Gases from Burning Distillate Fuels.''

(3) Incorporate by reference ANSI/ASHRAE 41.6–2014, ''Standard Method for Humidity Measurement.''

(4) Update the definitions to reflect the changes in ANSI/ASHRAE 103–2017 as compared to ANSI/ASHRAE 103–1993.

DOE also proposes in this NOPR to remove the definition of outdoor furnace or boiler from 10 CFR 430.2.

DOE's proposed actions are summarized in Table II.1 compared to the current test procedure as well as the reason for the proposed change.

TABLE II.1—SUMMARY OF CHANGES IN PROPOSED TEST PROCEDURE RELATIVE TO CURRENT TEST PROCEDURE

| Current DOE test procedure | Proposed test procedure | Attribution |
|---|---|---|
| Test procedure requirements based on industry standard ANSI/ASHRAE 103–1993. | Test procedure requirements based on ANSI/ASHRAE 103–2017. | Industry standard update to ANSI/ASHRAE 103–2017. |
| Procedure for adjusting oil-fired burner references industry standard ASTM D2156–09 (Reapproved 2013). | Procedure for adjusting oil-fired burner references industry standard ASTM D2156–09 (Reapproved 2018). | Industry standard update to ASTM D2156–09 (Reapproved 2018). |
| Limits the maximum relative humidity during certain tests, but does not provide specific instructions for how to measure relative humidity. | References ANSI/ASHRAE 41.6 for instructions for measuring relative humidity of the test room. | Referenced by industry standard ANSI/ASHRAE 103–2017, which is being proposed in this NOPR. |
| Includes a definition for ''outdoor furnace or boiler'' at 10 CFR 430.2. | Removes the definition for ''outdoor furnace or boiler''. | Remove an unused definition. |

DOE tentatively determines that the proposed amendments described in section III of this document could minimally impact the measured efficiency of certain consumer boilers, but that if such impacts are realized, re-testing and re-rating would not be required. DOE also tentatively determines that the proposed test procedures improve the representativeness of the test method and would not be unduly burdensome to conduct. Discussion of DOE's proposed actions are addressed in detail in section III of this document.

## III. Discussion

### *A. Scope of Applicability*

As discussed, in the context of ''covered products,'' EPCA includes boilers in the definition of ''furnace.'' (42 U.S.C. 6291(23)) EPCA defines the term ''furnace'' to mean 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 British thermal units (''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. *Id.* DOE has codified this definition in its regulations at 10 CFR 430.2.

DOE defines ''electric boiler'' as 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 square inch gauge (''psig'') steam pressure; a hot water boiler operates at or below 160 psig water pressure and 250 degrees Fahrenheit (°F) water temperature. 10 CFR 430.2.

DOE defines ''low pressure steam or hot water boiler'' as an electric, gas or oil burning furnace designed to supply low pressure steam or hot water for space heating application. 10 CFR 430.2. As with an electric boiler, 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. *Id.*

The scope of the test procedure for consumer boilers is specified in section 1.0 of appendix N, which references section 2 of ANSI/ASHRAE 103–1993. In relevant part, section 2 of ANSI/ASHRAE 103–1993 states that the industry test standard applies to boilers [3] with inputs less than 300,000 Btu per hour (''Btu/h''); having gas, oil, or electric input; and intended for use in residential applications. Further, ANSI/ASHRAE 103–1993 applies to equipment that utilizes single-phase electric current or low-voltage DC current.

In the May 2020 RFI, DOE requested comment on whether any consumer boilers are available on the market that are covered by the scope provision of ANSI/ASHRAE 103–1993, but that are not covered by the definition of ''furnace'' as codified by DOE at 10 CFR 430.2. 85 FR 29352, 29354. DOE also requested comment on whether any consumer boilers on the market are covered by DOE's definition of ''furnace'' that are not covered by the scope provision of ANSI/ASHRAE 103–1993. *Id.*

AHRI, Rheem, and Weil-McLain stated that air-to-water and water-to-water heat pumps fall under the definition of ''furnace'' in the CFR, but are not covered by the current test procedures. (AHRI, No. 6 at p. 1; Rheem, No. 9 at p. 2; Weil-McLain, No. 5 at p. 3) [4] BHI commented that if DOE were to regulate hydronic heat pumps, such products should be classified as heat pumps and the boiler definition in 10 CFR 430.2 should be modified to explicitly exclude them. BHI also stated that ASHRAE 103 is not intended to evaluate such products. (BHI, No. 11 at p. 1)

NEEA recommended that DOE add a definition for combination space and domestic hot water boilers as the current DOE definitions are ambiguous when it comes to the developing product category as these products fit both the definition of consumer boiler and water heater. NEEA also suggested that DOE adopt a test procedure referencing industry standards ASHRAE 124 and Canadian Standards Association (CSA) P.9, as appropriate, once the ongoing revision to ASHRAE 124 is finalized. (NEEA, No. 10 at pp. 3–4) Rheem also recommended that DOE consider adopting a test procedure for combination boilers. (Rheem, No. 9 at p. 2)

DOE tentatively agrees with commenters that air-to-water and water-to-water heat pumps meet the definitional criteria to be classified as a consumer boiler. These products utilize only single-phase electric current, are designed to be the principal heating source for the living space of a residence, are not contained within the

[3] ASHRAE 103–1993 defines a ''boiler'' as: A self-contained fuel-burning or electrically heated appliance for supplying low-pressure steam or hot water for space heating application. This definition covers electric boilers and low-pressure steam or hot water boilers as those terms are defined by DOE at 10 CFR 430.2.

[4] This and subsequent parentheticals parenthetical provide a reference for information located in the docket of DOE's rulemaking to develop test procedures for consumer boilers. (Docket No. EERE–2019–BT–TP–0037, which is maintained at *www.regulations.gov/docket?D=EERE-2019-BT-TP-0037*). Parenthetical references are arranged as follows: (commenter name, comment docket ID number, page of that document).

same cabinet with a central air conditioner whose rated cooling capacity is above 65,000 Btu per hour, meet the definition of an electric boiler,[5] and have a heat input rate of less than 300,000 Btu per hour (*i.e.,* the requirement for electric boilers). As such they meet the criteria of ''furnace'' as defined in 10 CFR 430.2. DOE also tentatively agrees with commenters that the current test procedure in appendix N does not address such products and would not provide a rated value that is representative of the performance of these products. In particular, the AFUE metric for electric boilers in ANSI/ASHRAE 103–1993 is calculated as 100 percent minus jacket loss.[6] This metric provides a representative measure of efficiency for electric boilers using electric resistance technology, for which an efficiency value of 100 percent (the ratio of heat output to energy input) is the maximum upper limit that technically could be achieved. The AFUE metric does not allow for ratings greater than 100 percent for electric boilers. However, this metric would not provide a representative or meaningful measure of efficiency for a boiler with a heat pump supplying the heat input, because heat pump efficiency (in terms of heat output to energy input) typically exceeds 100 percent.

Based on a review of the market, hydronic air-to-water and water-to-water heat pumps offered in the United States are often advertised as competing products for consumer boilers, but typically provide representations of energy efficiency using a Coefficient of Performance (''COP'') metric. They are often marketed for low-temperature radiator, floor heating, and domestic hot water applications, but also can be marketed for use in high-temperature radiator applications.

DOE tentatively proposes to determine that hydronic air-to-water and water-to-water heat pumps are consumer boilers under EPCA, but that due to the lack of a Federal test procedure, such products are not subject to the current performance standards at 10 CFR 430.32(e). DOE identified AHRI 550/590, 2020, ''Standard for Performance Rating of Water-Chilling and Heat Pump Water-Heating Packages Using the Vapor Compression Cycle'' (''AHRI 550/590''), as an industry test method that some manufacturers use for evaluating the heating efficiency of hydronic air-to-water and water-to-water heat pumps in terms of heating coefficient of performance ($COP_H$).[7] DOE was not able to identify any industry method for determining AFUE of such products. DOE further notes that AFUE is defined as the efficiency descriptor for boilers in EPCA. (*See* 42 U.S.C. 6291(20).)

DOE seeks comment on whether any other industry test methods exist for determining the heating efficiency of air-to-water or water-to-water heat pumps. DOE seeks comment specifically on AHRI 550/590, and whether it would be appropriate for adoption as a Federal test procedure for such products, and if so, whether modifications could be made to result in an AFUE rating.

Regarding NEEA's comment on combination space and domestic hot water boilers, DOE is aware that the industry standard for testing these products (ASHRAE 124, ''Methods of Testing for Rating Combination Space-Heating and Water-Heating Appliances'') is currently under revision. DOE plans to further evaluate the industry test method once it is finalized and available. DOE is not proposing a specific definition for combination space and water heating boilers at this time. DOE notes, however, that to the extent that a combination space and water heating product meets the definition of electric boiler or low pressure steam or hot water boiler, it is subject to the test procedure at appendix N and energy conservation standards for consumer boilers at 10 CFR 430.32(e)(2), and must be tested and rated accordingly. DOE is unaware of any design characteristics of combination space and water heating products that would prevent their testing according to appendix N.

*B. Definitions*

In addition to the overarching definition for a furnace (which includes boilers) and the associated definitions for ''electric boiler'' and ''low pressure steam or hot water boiler'' presented in section III.A of this document, DOE also has defined ''outdoor boilers'' and ''weatherized warm air boilers'' at 10 CFR 430.2 as follows:

- *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).
- *Weatherized warm air furnace or boiler* means a furnace or boiler designed for installation outdoors, approved for resistance to wind, rain, and snow, and supplied with its own venting system.

In the May 2020 RFI, DOE requested comment on the definitions currently applicable to consumer boilers and whether any of these definitions need to be revised, and if so, how. 85 FR 29352, 29355.

BWC stated that the definition for ''outdoor boiler''[8] should be made more similar to ''weatherized warm air furnace or boiler'' by adding the weather-resistant conditions, asserting that the only difference between these two products is that a weatherized warm air furnace or boiler requires that venting be supplied. BWC also commented that ANSI Z21.13, ''Gas-Fired Low Pressure Steam and Hot Water Boilers,'' does not differentiate between outdoor and weatherized boilers. (BWC, No. 4 at p. 1)

Lochinvar and CA IOUs commented that changes to the definitions are not needed. (Lochinvar, No. 8 at p. 1; CA IOUs, No. 7 at p. 4) CA IOUs also recommended that DOE avoid any modifications to existing definitions that would reduce the ability of the test procedure to compare performance across products that use different technologies to provide similar consumer utility. (CA IOUs, No. 7 at p. 4)

Regarding the definition of ''outdoor furnace or boiler,'' the energy conservation standards for boilers at 10 CFR 430.32(e)(2)(iii) do not distinguish between outdoor or weatherized boilers. With regard to the test procedure, different jacket loss factors are applied based on whether a boiler is intended to be installed indoors, outdoors, or as an isolated combustion system. The heating seasonal efficiency ($Effy_{HS}$) calculation, which is an element of AFUE, is based on the assumption that all weatherized boilers are located outdoors (see section 10.1 of appendix N). Appendix N does not specify a separate jacket loss assumption for ''outdoor furnaces or boilers.'' As such, DOE has initially determined that the definition for ''outdoor furnace or boiler'' is extraneous in that the boiler testing method is described based on whether the boiler is weatherized (and thus required to be tested under the assumption that it is intended for

[5] As discussed in section III.B of this document, ''electric boiler'' means 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 psig steam pressure; a hot water boiler operates at or below 160 psig water pressure and 250 °F water temperature. 10 CFR 430.2.

[6] The term ''jacket loss'' is used by industry to mean the transfer of heat from the outer surface (*i.e.,* jacket) of a boiler to the ambient air surrounding the boiler.

[7] AHRI 550/590 is available at: *www.ahrinet.org/App_Content/ahri/files/STANDARDS/AHRI/AHRI_Standard_550-590_I-P_2015_with_Errata.pdf.*

[8] DOE interprets BWC's comment as referring to the definition of ''outdoor furnace or boiler'' at 10 CFR 430.2.

installation outdoors), not whether it meets the definition of an ''outdoor boiler.'' For analogous reasons, the definition appears to be extraneous with regard to consumer furnaces. Further, the definition of ''outdoor boiler'' is not used elsewhere in the test method or energy conservation standards. For these reasons, DOE does not propose to modify the definition for outdoor furnace or boiler and instead proposes to remove this definition from its regulations.

DOE seeks comment on its proposal to remove the definition of ''outdoor furnace or boiler'' from its regulations. DOE seeks comment on whether removing the definition for ''outdoor furnace or boiler'' would impact the application of the test procedure or energy conservation standards for any such products.

In addition to the definitions included in 10 CFR 430.2, section 2.0 of appendix N incorporates by reference the definitions in Section 3 of ANSI/ASHRAE 103–1993, with modifications and additions as specified in section 2.0 of appendix N. Sections 2.1 through 2.13 of appendix N provide additional definitions relevant to the consumer boilers test procedure.

DOE requested comment on whether the definitions for consumer boilers in section 2.0 through section 2.13 of appendix N, including those from ANSI/ASHRAE 103–1993 that are incorporated by reference, are still appropriate or whether amendments are needed. 85 FR 29352, 29355.

Lochinvar and Weil McLain stated that the definitions in ASHRAE 103–1993 and the CFR are still adequate and/or do not require changes. (Lochinvar, No. 8 at p. 2; Weil McLain, No. 5 at p. 3) BWC stated that the definition listed in 10 CFR 430.2 and ANSI/ASHRAE 103–2017 definitions as being appropriate. (BWC, No. 4 at p. 2) The CA IOUs recommended that DOE make no changes to the current definitions for consumer boilers in the code and that the current definitions adequately cover these products for the purpose of performing the DOE test procedure. (CA IOUs, No. 7 at p. 4)

As discussed in section III.C of this document, DOE is proposing to incorporate by reference the most recent version of ASHRAE 103: ANSI/ASHRAE 103–2017. DOE is proposing minor modifications to the definitions in appendix N to account for the inclusion of several definitions in ANSI/ASHRAE 103–2017 that were not included ANSI/ASHRAE 103–1993. Specifically, ANSI/ASHRAE 103–2017 includes definitions for ''air intake terminal,'' ''control,'' and ''isolated combustion system'' that are not in ANSI/ASHRAE 103–1993. The definitions for ''control'' and ''isolated combustion system'' in ANSI/ASHRAE 103–2017 are almost identical as currently defined in sections 2.3 and 2.7 of appendix N, respectively. Therefore, DOE proposes to remove those two definitions from the consumer boiler test procedure in the CFR, as they would be redundant with the definitions incorporated by reference through ANSI/ASHRAE 103–2017.

DOE seeks comment on its proposal to incorporate by reference the definitions in ANSI/ASHRAE 103–2017 and to remove the definitions for ''control'' and ''isolated combustions system'' from the consumer boiler test procedure at appendix N accordingly.

As discussed further in section III.D of this document, DOE is proposing to move the consumer boiler testing provisions from appendix N to a proposed new appendix EE and maintain the consumer furnace test provisions in appendix N. The proposed changes to definitions, if made final, would be applicable only to the test procedure for consumer boilers in proposed new appendix EE.

*C. Metric*

As discussed, the energy conservation standards for consumer boilers rely on the AFUE metric. 10 CFR 430.32(e)(2). For gas-fired and oil-fired boilers, AFUE accounts for fossil fuel consumption in active, standby, and off modes, but does not include electrical energy consumption. For electric boilers, AFUE accounts for electrical energy consumption in active mode. EPCA defines the term ''annual fuel utilization efficiency,'' in part, as meaning the efficiency descriptor for furnaces and boilers. (42 U.S.C. 6291(20)). In addition, separate metrics for power consumption during standby mode and off mode ($P_{W,SB}$ and $P_{W,OFF}$, respectively) are used to regulate standby mode and off mode energy consumption. 10 CFR 430.32(e)(2)(iii)(B).

AFUE is defined by ASHRAE 103 (both the 1993 and 2017 version) as the ratio of annual output energy to annual input energy, which includes any non-heating-season pilot input loss, but, for gas- or oil-fired furnaces or boilers, does not include electric energy. For gas- and oil-fired boilers, the AFUE test generally consists of steady-state, cool down, and heat up tests, during which various measurements are taken (*e.g.,* flue gas temperature, concentration of $CO_2$ in the flue gas). (*See* Sections 9.1, 9.5, and 9.6, respectively, of both ANSI/ASHRAE 103–1993 and ANSI/ASHRAE 103–2017.) For condensing boilers, condensate collection tests during steady state and cyclic operation are also specified. (*See* Sections 9.2 and 9.8 of both ANSI/ASHRAE 103–1993 and ANSI/ASHRAE 103–2017.) The test measurements are used in conjunction with certain assumptions, to calculate the AFUE. (*See* Section 11 of both ANSI/ASHRAE 103–1993 and ANSI/ASHRAE 103–2017.)

Energy Kinetics provided comments pertaining to the AFUE metric, including suggestions of how it could be made more representative of field performance. Energy Kinetics asserted that oversizing is not accurately reflected in AFUE; specifically, that the 0.7 oversize factor in the AFUE test method is too low, and that a more representative oversize factor would be a value of 3 to 4.[9] Energy Kinetics further asserted that AFUE does not appropriately account for idle losses and provided an example of a boiler with an AFUE of 83.5 percent and idle loss of 4.87 percent that the commenter argued would consume 63 percent more fuel than a boiler with an AFUE of 87.5 percent and an idle loss of 0.15 percent. (Energy Kinetics, No. 3 at p. 1)

Energy Kinetics suggested that DOE change from the AFUE metric to a combination of a thermal efficiency metric and an idle loss metric. The commenter argued that both AFUE and thermal efficiency are closely aligned to steady-state efficiency, but thermal efficiency is a faster and easier test to perform and is currently used in commercial boiler testing. Energy Kinetics suggested that idle loss could either be measured or a prescribed value to foster innovation and recognize better performing systems, while also simultaneously reducing test burden. (Energy Kinetics, No. 3 at p. 2)

Energy Kinetics stated that AFUE does not account for the impact of energy savings controls, which prevents comparisons of the performance of various types of boilers and controls. Energy Kinetics stated that AFUE assumes that the boiler is in the conditioned space and that any heat lost from the boiler is gained in the conditioned space; and asserted that in practice this heat is wasted in basements, up chimneys, and out draft hoods and draft regulators. Energy

[9] The oversize factor is applied to account for the typical practice of sizing a boiler such that the heating capacity exceeds the heating load. In ASHRAE 103–1993, for non-modulating boilers the oversize factor is assigned as a national average value of 0.7, and for modulating boilers the oversize factor is calculated based on the ratio of the heating capacity to the average design heating requirement. In ASHRAE 103–2017, the oversize factor at the maximum input rate is assigned as 0.7 for both modulating and non-modulating models.

Kinetics also argued that for combined heat and hot water boilers in the conditioned space, heat lost in summer while heating domestic water should have an impact on air conditioning cooling loads. Energy Kinetics asserted that AFUE does not apply to boilers that provide both space heating and domestic hot water. The commenter also asserted that use of AFUE for both boilers and furnaces creates the false implication that the products can be compared, but that they cannot be compared due to differences in distribution losses. (Energy Kinetics, No. 3 at p. 2)

As noted previously, EPCA defines AFUE as the efficiency descriptor for boilers. (42 U.S.C. 6291(20)) Therefore, DOE must use AFUE as the efficiency metric for boilers and cannot change to thermal efficiency and idle loss as suggested by Energy Kinetics. Further, EPCA prescribes a design requirement that hot water boilers must include an automatic means for adjusting water temperature, which will limit idle losses and reduce the potential for energy savings from further accounting for such losses as a separate metric or within the AFUE metric. (42 U.S.C. 6295(f)(3)(A)–(B)) Idle loss could be further addressed in the context of AFUE as opposed to evaluating a separate metric. At present time, DOE does not have sufficient data to propose prescribed values that would address idle loss. DOE seeks further comment from interested parties regarding whether idle losses could be better reflected in the test method. For the reasons discussed, DOE is not proposing to adopt an idle loss or thermal efficiency metric, or to incorporate a specific test for idle loss in the AFUE test method at this time.

Regarding the other issues identified with the AFUE metric, DOE notes that certain control systems, such as modulating burner control systems, are accounted for in the test procedure with specific instructions regarding how such units should be tested. (*See,* for example, sections 7.4 and 10.1 of appendix N, which provide specific instructions for testing and calculating AFUE of modulating boilers.) As discussed in the preceding paragraph, other control systems, such as an automatic means for adjusting water temperature, are required by prescriptive standard. (42 U.S.C. 6295(f)(3)(A)–(B)); 10 CFR 430.32(e)(2)(iii)(A). Energy Kinetics did not provide specific comments or recommendations regarding what additional control systems should be accounted for. DOE is not proposing additional changes related to controls.

Regarding the assumption that boilers are installed indoors, DOE notes that EPCA states that AFUE for boilers that are not weatherized is determined based on the assumption that they are located within the heated space. (*See* 42 U.S.C. 6291(20)(C).) Regarding boilers that provide both space heating and domestic hot water, DOE notes that such products can be tested separately for AFUE for space heating and for their water heating performance under the DOE test methods for water heaters. As discussed in section III.A of this document, an industry test method for combined heating and domestic hot water boiler systems (ASHRAE 124) is currently under revision, and DOE plans to evaluate the industry test method further once it is finalized and available. Lastly, regarding both boilers and furnaces using AFUE, DOE notes that EPCA prescribes AFUE as the metric for both furnaces and boilers. (*See* 42 U.S.C. 6291(20)).

*D. Updates to Industry Standards*

As discussed, ANSI/ASHRAE 103–1993 is referenced throughout appendix N for various testing requirements pertaining to determination of the AFUE of consumer boilers. Appendix N also references certain sections of IEC 62301 (Second Edition) for determining the electrical standby mode and off mode energy consumption, and ASTM D2156–09 (Reapproved 2013) for adjusting oil burners. DOE noted in the May 2020 RFI that in the case of IEC 62301, the version of the standard that is currently incorporated by reference is still the most recent version; and in the case of ASTM D2156–09, the most recent iteration of the standard is a version reapproved in 2018 that did not contain any changes from the 2009 version. 85 FR 29352, 29355. DOE did not receive any comments pertaining to its incorporation by reference of IEC 62301 or ASTM D2156–09 and continues to view these as the appropriate standards to reference. DOE proposes to maintain the current reference to IEC 62301, and to update the reference to ASTM D2156–09 to reflect the version that was reapproved in 2018.

As discussed, ANSI/ASHRAE 103–1993 provides procedures for determining the AFUE of consumer boilers (and furnaces). As mentioned previously, ANSI/ASHRAE 103–1993 has been updated multiple times since 1993. In the rulemaking that culminated in the January 2016 final rule, DOE initially proposed to incorporate by reference the most recent version of ANSI/ASHRAE 103 available at the time (*i.e.,* ANSI/ASHRAE 103–2007), but ultimately declined to adopt the proposal in the final rule based on concerns about the impact that changing to ANSI/ASHRAE 103–2007 would have on AFUE ratings of products distributed in commerce at that time. 81 FR 2628, 2632–2633 (Jan. 15, 2016). DOE stated that further evaluation was needed to determine the potential impacts of ANSI/ASHRAE 103–2007 on the measured AFUE of boilers. *Id.* DOE theorized that ANSI/ASHRAE 103–2007 might better account for the operation of two-stage and modulating products and stated that the Department may further investigate adopting it or a successor test procedure in the future. *Id.*

After the January 2016 final rule, ANSI/ASHRAE 103 was again updated to the current version (*i.e.,* ANSI/ASHRAE 103–2017). In the May 2020 RFI, DOE identified several substantive differences between ANSI/ASHRAE 103–1993 and ANSI/ASHRAE 103–2017 that pertain to consumer boilers and requested further comment on the differences between ANSI/ASHRAE 103–1993 and ANSI/ASHRAE 103–2017. 85 FR 29352, 29355. These differences included that:

1. ASHRAE 103–2017 includes calculations for determining the average on-time and off-time per cycle for two-stage and modulating boilers, rather than assigning fixed values as in ASHRAE 103–1993;

2. ASHRAE 103–2017 includes calculations for the part-load at maximum and reduced fuel input rates of condensing two-stage and modulating boilers when the heat up and cool down tests are omitted as per section 9.10, while ASHRAE 103–1993 does not include these calculations; [10]

3. ASHRAE 103–2017 increases post-purge time from less than 5 seconds in ASHRAE 103–1993 to less than or equal to 30 seconds for determining whether section 9.10, ''Optional Test Procedures for Conducting Furnaces and Boilers that have no OFF-Period Flue Loss,'' is applicable for units with no measurable airflow through the combustion chamber during the burner off-period, and it also makes the application for the default draft factor values in section 9.10 a requirement rather than optional;

4. ASHRAE 103–2017 changes the method for determining national average burner operating hours (BOH), average annual fuel energy consumption (EF), and average annual auxiliary electrical energy consumption (EAE), especially for two-stage and modulating products, based on a 2002 study from NIST.

*Id.*

[10] DOE published a final rule in the **Federal Register** on July 10, 2013, that added equations to appendix N to calculate the part-load efficiencies at the maximum input rate and reduced input rates for two-stage and modulating condensing furnaces and boilers when the manufacturer chooses to omit the heat-up and cool-down tests under the test procedure. 78 FR 41265. The equations in ASHRAE 103–2017 are identical to those in appendix N.

DOE requested information on whether any differences not identified by DOE in the May 2020 RFI would impact the consumer boiler test procedure. *Id.*

BWC stated that the only difference between ANSI/ASHRAE 103–1993 and ANSI/ASHRAE 103–2017 is for the indoor air temperature requirements and noted that the 1993 version of the standard specifies a temperature of 70 °F, while the 2017 version simply references the actual indoor air temperature. (BWC, No. 4 at p. 2) BWC further stated that it believes this difference accounts for only slight changes in calculation with little to no added burden in the test procedure. (BWC, No. 4 at p. 2) Lochinvar identified a change that was not discussed in the RFI, which is that the oversize factor for non-condensing, modulating boilers has been changed from being calculated based on the design heating requirement (''DHR'') to a constant oversize factor of 0.7. Lochinvar also explained that the constant oversize factor removes variations based on where the boiler outputs fall in the ADHR ranges and is more representative and provides more consistent AFUE results across the range of boiler output capacities. (Lochinvar, No. 8, at p. 2)

While DOE acknowledges the change discussed by BWC, in that the equations in ANSI/ASHRAE 103–2017 refer to the indoor air temperature as the variable ''$T_{IA}$,'' rather than defined as ''70,'' DOE notes that Section 11.2.10.1 of ANSI/ASHRAE 103–2017 defines $T_{IA}$ as 70 °F, the ''assumed average indoor air temperature.'' Therefore, the use of $T_{IA}$ in place of ''70'' in subsequent sections of ANSI/ASHRAE 103–2017 is equivalent to the use of ''70'' in each analogous equation in ANSI/ASHRAE 103–1993.

DOE also acknowledges the change identified by Lochinvar, and notes that this change resolves in part an issue with the calculations for modulating, condensing models in ANSI/ASHRAE 103–1993. In the May 2020 RFI, DOE discussed that the calculations in ANSI/ASHRAE 103–1993 either rely on certain values calculated for non-condensing, non-modulating boilers to determine the AFUE of condensing, modulating boilers, or result in a circular reference. 85 FR 29352, 29357. Changing the oversize factor to a constant 0.7 for condensing, modulating boilers, rather than basing it on an equation, appears to partially, but not fully, resolve the potential circular reference in ANSI/ASHRAE 103–2017. In further reviewing the calculations in ANSI/ASHRAE 103–2017, DOE interprets them to rely on certain values calculated for non-condensing, non-modulating boilers to determine the AFUE of condensing, modulating boilers to avoid a circular reference.

Specifically, the issue arises within the calculation of steady state efficiencies at maximum and minimum input rate, which depends in part on the steady-state heat loss due to condensate going down the drain at the maximum and reduced input rates. (*See* Section 11.5.7.3 of ANSI/ASHRAE 103–2017, which refers to Section 11.3.7.3.) The steady-state heat loss due to condensate going down the drain at the maximum and minimum input rates is calculated in part based on the national average outdoor air temperature at the maximum and minimum input rates. (*See* Section 11.5.7.2 of ANSI/ASHRAE 103–2017, which refers to Section 11.3.7.2.) The national average outdoor air temperatures at the maximum and minimum input rates are both a function of the balance point temperature. (*See* Section 11.5.8.3 of ANSI/ASHRAE 103–2017, which refers to Section 11.4.8.3.) The balance point temperature is calculated based on the oversize factor at maximum input rate (which is, as discussed previously, a constant value in ANSI/ASHRAE 103–2017) and the ratio of the heating capacity at the minimum input rate to the heating capacity at the maximum input rate. (*See* Section 11.5.8.4 of ANSI/ASHRAE 103–2017, which references Section 11.4.8.4.) The heating capacities at the minimum and maximum input rates are calculated based in part on the steady-state efficiencies at minimum and maximum input rates, respectively. (*See* Section 11.5.8.1 of ANSI/ASHRAE 103–2017, which references Section 11.4.8.1.) If the calculations were interpreted to refer back to the steady-state efficiencies at minimum and maximum input rates for a modulating, condensing model, as determined by Section 11.5.7.2 of ANSI/ASHRAE 103–2017, a circular reference would result. However, since there is no specific instruction to use the values as calculated by Section 11.5.7.2, DOE interprets ANSI/ASHRAE 103–2017 to instead instruct that the steady-state efficiency at maximum and reduced input rates be determined as specified in Section 11.4.8.1, which refers to Section 11.4.7, which in turn refers to Section 11.2.7 for the calculation of steady-state efficiency for non-condensing, non-modulating boilers. The steady-state efficiencies at maximum and minimum input calculated using Section 11.2.7 can then be used to obtain values for output capacities at the maximum and reduced input, which are needed to calculate the balance point temperature, the average outdoor air temperature at maximum and minimum input, and finally the heat loss due to condensate going down the drain at maximum and minimum input rates. DOE proposes to add provisions to clarify the approach for calculating steady-state efficiencies at maximum and minimum input rates for condensing, modulating boilers using ANSI/ASHRAE 103–2017.

DOE seeks comment on its proposal to clarify the calculation of steady-state efficiencies at maximum and minimum input rates for condensing, modulating boilers using ANSI/ASHRAE 103–2017.

DOE also considered the impact of the change in oversize factor from a calculated value to a constant value. DOE analysis suggests that changing the oversize factor from being determined by an equation to being specified as a constant value of 0.7 is unlikely to have a substantive impact on AFUE ratings, as DOE calculations indicate the AFUE value is not particularly sensitive to changes in the oversize factor value. For example, DOE reviewed test data for three modulating, condensing boilers and found that the change in oversize factor from a calculated value, as specified in ANSI/ASHRAE 103–1993, to 0.7 changed the AFUE rating by 0.01 AFUE percentage points or less for all 3 models. DOE also examined more extreme scenarios for these boilers, in which DOE assigned oversize factors from a minimum of 0 to a maximum of 1.31 and found that the resulting AFUE values differed by only up to 0.07 AFUE percentage points as compared to the AFUE with the assigned 0.7 oversize factor, and only up to 0.13 AFUE percentage points when comparing the AFUE result at the upper and lower bounds. These minimum and maximum oversize factors correspond to the minimum and maximum values that would result from calculation based on the procedure for determining these values in ANSI/ASHRAE 103–1993 (*i.e.,* heating capacity divided by design heating requirement minus one; *see* Section 11.4.8.2 of ANSI/ASHRAE 103–1993).

As such, DOE is proposing to adopt the constant 0.7 oversize factor through incorporation by reference of ANSI/ASHRAE 103–2017. Accordingly, DOE is also proposing to remove calculation requirements corresponding to multiple degrees of oversizing.

DOE also requested information on whether the differences between ANSI/ASHRAE 103–1993 and ANSI/ASHRAE 103–2017 identified in the May 2020 RFI would impact the measured AFUE,

and if so, DOE requested test data demonstrating the degree of such impact. DOE also requested comment on whether the updates to ANSI/ASHRAE 103 are appropriate for adoption in the Federal test procedure for consumer boilers, whether the changes would allow for more representative energy efficiency ratings, and whether the changes would increase test burden. 85 FR 29352, 29355–29356.

AHRI, Rheem, BWC, Lochinvar, CA IOUs, and NEEA supported updating the test procedure to incorporate by reference ANSI/ASHRAE 103–2017. (AHRI, No. 6 at p. 3; Rheem, No. 9 at p. 3; BWC, No. 4 at p. 2; Lochinvar, No. 8 at p. 2; CA IOUs, No. 7 at p. 5; NEEA, No. 10 at p. 1) AHRI, Rheem, and Lochinvar encouraged DOE to gather data on whether the differences between the 1993 and 2017 versions of ANSI/ASHRAE 103–1993 would impact measured AFUE. (AHRI, No. 6 at p. 3 ; Rheem, No. 9 at p. 3; Lochinvar, No. 8 at p. 2)

AHRI stated that it does not believe that adopting the 2017 edition of ANSI/ASHRAE 103 would significantly affect the efficiency ratings or change the test burden. AHRI commented that members did not have sufficient time to reliably assess the impact on measure efficiency and encouraged DOE to generate data to determine if adopting ASHRAE 103–2017 would have any effect on the appliance efficiency rating. (AHRI, No. 6 at p. 3) Similarly, Rheem stated that it does not believe that adopting the 2017 edition of the ANSI/ASHRAE 103 would significantly affect the efficiency ratings, although retesting existing models to the new edition would temporarily increase the test burden. (Rheem, No. 9 at p. 3) The CA IOUs also stated that it believed that ASHRAE 103–2017 is more representative of typical operation for two-stage, modulating, and condensing boiler technologies and that updating to this standard should not create significant additional burden, as the majority of changes are reflected in the calculation methodology rather than the test procedure. (CA IOUs, No. 7 at p. 5)

Lochinvar asserted that the testing methods in ANSI/ASHRAE 103–2017 represent a significant improvement as compared to those referenced by DOE in ANSI/ASHRAE 103–1993 for residential boilers, and cited the use of calculated values rather than referencing graphs, more realistic on- and off-cycle times, and the uniform oversize factor regardless of output rate as providing a more representative average use cycle and more repeatable results. (Lochinvar, No. 8 at p. 2) Lochinvar stated that updating to the 2017 version may result in variations of up to 0.5 percent AFUE in either direction for any given model. (*Id.*) Lochinvar also stated that it does not believe that referencing ANSI/ASHRAE 103–2017 would change the measured efficiency enough to result in substantially different efficiency ratings as compared to those currently certified, and, therefore, does not believe that retesting would be necessary if the referenced industry standard were updated. (*Id.* at pp. 2–3)

BHI tentatively supported updating to ANSI/ASHRAE 103–2017, with the caveat that it has not fully studied the impacts of the potential changes. BHI also requested that DOE provide industry with a set of sample calculations for each type of boiler covered by the standard, if DOE adopts ASHRAE 103–2017, to ensure that everyone is operating from identical methods of calculating AFUE or provide industry with a vetted software tool. (BHI, No. 11 at p. 2)

NEEA stated that an update to ANSI/ASHRAE 103–2017 would better capture the performance of two stage and modulating units. (NEEA, No. 10 at pp. 1–2) NEEA explained that while the update my affect AFUE ratings, the revised ratings will better reflect annual energy performance leading to a more accurate representation of boiler energy use. *Id.*

Weil McLain recommended against updating to ANSI/ASHRAE 103–2017, arguing that the 1993 version of ASHRAE 103 is still appropriate and that the resulting increases in accuracy and resolution of the test method would not increase the accuracy of the test procedure due to the reporting of AFUE to the tenth of a percent, nor would be worth the burden of changing the test procedure. (Weil McLain, No. 5 at p. 3)

In this rulemaking, DOE evaluated whether the differences between the 1993 and 2017 editions of ASHRAE 103 would result in differences in the measured AFUE.

DOE's preliminary review of prior test data has indicated a potential for difference in AFUE for certain units, specifically two-stage or modulating models, due to the changes to the cycle times between the two editions. In the development of the January 2016 final rule, DOE conducted preliminary testing to examine the impacts of the changes in cycle times between the 1993 and 2007 editions of ASHRAE 103, which are comparable to the changes between the 1993 and 2017 editions of ASHRAE 103. 81 FR 2628, 2633. Data collected for the January 2016 final rule for three models of condensing, modulating boilers showed that the changes in on-cycle and off-cycle times resulted in changes in AFUE of 0.11, −0.50, and 0.22 percent, respectively. For two models of non-condensing, modulating boilers, calculating the AFUE based on the on-cycle and off-cycle times in ANSI/ASHRAE 103–2007 changed the AFUE by 0.11 and −0.14 percent, respectively.[11]

In addition, AHRI submitted data for testing it had conducted in response to the changes proposed in a test procedure NOPR for consumer furnaces and boilers that was published by DOE on March 11, 2015 (80 FR 12876). The data from AHRI, in relevant part, examined the change in AFUE resulting from using ANSI/ASHRAE 103–2007 as compared to ANSI/ASHRAE 103–1993 for three units. The data showed changes in AFUE of −0.05 percent for a non-condensing, modulating unit, and −0.03 and 0.23 percent for two condensing, modulating units. (*See* EERE–2012–BT–TP–0024–0036 at p. 10)

In reviewing ANSI/ASHRAE 103–2017 as compared to ANSI/ASHRAE 103–1993, DOE tentatively concludes that the improvements included in ANSI/ASHRAE 103–2017 provide a more representative average use cycle for consumer boilers, and in particular, for two-stage and modulating boilers. Specifically, DOE expects that the use of calculated values rather than referencing graphs, the specification of more representative on- and off-cycle times, and the specification of a constant oversize factor regardless of output rate would improve the results obtained from ANSI/ASHRAE 103–2017 as compared to ANSI/ASHRAE 103–1993.

Therefore, DOE proposes to update the reference to ANSI/ASHRAE 103 in the test procedure for consumer boilers to the 2017 edition. DOE tentatively concludes that a change from ANSI/ASHRAE 103–1993 to ANSI/ASHRAE 103–2017 would not materially alter the burden or cost of conducting an AFUE test. Additional details on DOE's assessment of the burden associated with this proposed change are in section III.G.1 of this document. DOE is proposing changes only with respect to consumer boilers, and not for consumer furnaces. DOE is not proposing to amend the reference to ANSI/ASHRAE 103–1993 for the provisions applicable to consumer furnaces. As discussed, to implement this change for boilers only, DOE proposes to move the test provisions for consumer boilers to a new appendix, appendix EE, ''Uniform

[11] These data were presented at a public meeting for the March 11, 2015 NOPR pertaining to test procedures for furnaces and boilers and can be found at: *www.regulations.gov/document/EERE-2012-BT-TP-0024-0021.*

Test Method for Measuring the Energy Consumption of Boilers.''

Corresponding to the updated industry standard, DOE proposes to make several modifications in the proposed new appendix EE as compared to the current test method in appendix N. As discussed in section III.B of this document, DOE proposes to remove from new appendix EE definitions for ''control'' and ''isolated combustion system,'' as these definitions are included in ANSI/ASHRAE 103–2017. DOE also proposes to remove the sections for calculating part-load efficiency at reduced and maximum fuel input rates (currently sections 10.2 and 10.3 in appendix N) from proposed new appendix EE. These sections were initially adopted by DOE because ANSI/ASHRAE 103–1993 did not provide calculations for the scenario allowed under section 9.10 of ASHRAE 103 (which is included in both the 1993 and 2017 versions), in which the heat up and cool down tests can be optionally skipped provided that certain criteria are met. ANSI/ASHRAE 103–2017 added equations to address that scenario that are identical to those previously adopted by DOE, rendering those sections duplicative. DOE is also proposing minor changes to the test method for models with post-purge times longer than 3 minutes, consistent with the updates included in ANSI/ASHRAE 103–2017. DOE is also proposing changes to the calculations in section 10, consistent with changes in ANSI/ASHRAE 103–2017. DOE notes that appendix N includes certain clarifications to ANSI/ASHRAE 103–1993 (*e.g.,* to specify a reference to a manufacturer's I&O manual rather than a manufacturer recommendation), and DOE proposes to maintain those clarifications in new appendix EE to the extent they apply to ANSI/ASHRAE 103–2017.

As discussed earlier in this section, test data indicate that the update to the 2017 edition of ASHRAE 103 could result in changes to the measured AFUE of two-stage and modulating boilers ranging from −0.50 percent to 0.23 percent, with no discernable trend in the direction or magnitude of change. DOE also notes that several commenters indicated that incorporating ANSI/ASHRAE 103–2017 would likely not significantly impact rated values.

DOE seeks further comment on its proposal to update the incorporation by reference of ASHRAE 103 to the most recent version (*i.e.,* ANSI/ASHRAE 103–2017) and in particular the potential impact on ratings and whether retesting would be required.

*E. Test Procedure Requirements*

1. Ambient Conditions

The current consumer boilers test procedure specifies that the ambient air temperature during testing must be between 65 °F and 100 °F for non-condensing boilers, and between 65 °F and 85 °F for condensing boilers. *See* section 7.0 of appendix N and Section 8.5.2 of ANSI/ASHRAE 103–1993. In addition, the relative humidity cannot exceed 80 percent during condensate measurement. Section 8.0 of appendix N and 9.2 of ANSI/ASHRAE 103–1993.

In the May 2020 RFI, DOE requested comment and data on the effects of ambient temperature and relative humidity on AFUE results, whether the current ranges of allowable conditions adversely impact the representativeness of AFUE values or repeatability of AFUE testing, and whether a narrower range of allowable ambient conditions would increase testing burden. 85 FR 29352, 29356.

AHRI and Rheem encouraged DOE to defer to the ambient conditions specified in ANSI/ASHRAE 103–2017, and stated that any changes would mainly impact condensing models. (AHRI, No. 6, at p. 4; Rheem, No. 9 at p. 3) Lochinvar stated that the prior record and DOE conclusions pertaining to ambient temperature ranges and relative humidity limits remain valid and that further revisions are not necessary. (Lochinvar, No. 8 at p. 3) Lochinvar also asserted that tightening ambient condition tolerances could disproportionately impact small businesses, as they are less likely to be able to absorb the costs of equipment to maintain such ambient conditions. (Lochinvar, No. 8 at p. 6) Weil McLain and BHI also supported the use of industry consensus test procedures and recommended maintaining the range of operating conditions established in industry standards. (Weil McLain, No. 5 at p. 4; BHI, No. 11 at p. 2)

CA IOUs recommended that DOE narrow the range of allowable ambient temperature to between 55 °F and 75 °F during the test, with a tolerance of ±2 °F, to better represent field conditions. (CA IOUs, No. 7 at p. 4) NEEA also recommended that DOE update ambient and combustion air temperatures to better reflect real world conditions that exist in basements, garages, or semi-conditioned spaces and operate during winter months when temperatures are colder. (NEEA, No. 10 at p. 2) Specifically, NEEA suggested limiting the range of ambient air temperatures to be reflective of temperatures in spaces where consumer boilers are likely to be installed; limiting the range of combustion air temperatures to reflect the likely conditioners boilers will see (*i.e.* reflective of the outside air temperature for condensing products; and limit the range of allowable conditions overall to reduce the opportunities for gaming the test procedure and ensure consistency of ratings across multiple tested products. (NEEA, No. 10 at p. 2) NEEA explained that the ambient air temperature and the combustion air temperature are likely to affect the boiler's performance and will affect radiation and convection losses and combustion efficiency, respectively. (NEEA, No. 10 at p. 2)

In the January 2016 final rule, DOE investigated concerns regarding the ambient air temperature and humidity ranges allowed by the test method. 81 FR 2628, 2638. In that rulemaking, some commenters raised concerns that the wide range of allowable ambient conditions could impact test results, and that the ranges were initially developed based on laboratory conditions that are now outdated, (*i.e.,* more closely controlled conditions may now be achievable). *Id.* DOE had tested one non-condensing boiler at several ambient conditions and found that the effects on AFUE were not statistically significant. DOE also conducted a series of eight AFUE tests on a condensing, modulating unit and found that the variations in AFUE could not be definitively attributed to changes in ambient conditions based on the data. 80 FR 12875, 12890 (Mar. 11, 2015) Therefore, DOE did not propose to update the ambient conditions in the NOPR that preceded the January 2016 final rule and stated in the January 2016 final rule that the impact of ambient conditions on AFUE values warranted further study, but that DOE did not have adequate data to justify changing the test procedure to narrow the ambient temperature or humidity ranges. *Id.*

In response to that NOPR, and again in response to the May 2020 RFI, BHI provided test data for a single condensing boiler which showed a change in AFUE of 1.3 percent when the relative humidity was changed from approximately 30 percent to 70 percent. BHI did not support changing the ambient temperature or humidity limitations in ANSI/ASHRAE 103–2017, stating in response to the May 2020 RFI that minimal changes should be made to industry standards. (BHI, No. 11 at pp. 2, 11 [12])

After considering these comments and test data, DOE tentatively concludes that it lacks sufficient evidence to determine

[12] See also Docket No. EERE–2012–BT–TP–0024–0035 at p. 7.

that ambient conditions affect AFUE to the extent that a model tested under different ambient conditions within the current allowable bounds of the test method could have significantly different AFUE ratings. Although BHI provided test data for a single unit showing a difference, DOE notes that DOE's previous test data, obtained from multiple units, did not indicate conclusively that ambient test conditions within the current bounds cause substantive differences in AFUE. Therefore, DOE is not proposing to change the ambient test condition requirements.

2. Combustion Airflow Settings

In the course of the rulemaking for the January 2016 final rule, to provide for greater consistency in burner airflow settings during testing, DOE proposed specifying that the excess air ratio, flue oxygen (''$O_2$'') percentage, or flue carbon dioxide (''$CO_2$'') percentage be within the middle 30th percentile of the acceptable range specified in the I&O manual. 80 FR 12876, 12883, 12906 (Mar. 11, 2015). In absence of a specified range in the I&O manual, DOE proposed requiring the combustion airflow to be adjusted 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 carbon monoxide (''CO'') ratio below 400 parts per million (''ppm'') during the steady-state test described in Section 9.1 of ANSI/ASHRAE 103–2007, whichever is higher. 80 FR 12876, 12906. However, after considering comments regarding the representativeness of the proposal and the potential impact on rated AFUE, DOE determined that further study was needed to determine how such changes would impact AFUE ratings. 81 FR 2628, 2636.

In the May 2020 RFI, DOE requested comment on whether more specific instructions for setting the excess air ratio, flue $O_2$ percentage, and/or flue $CO_2$ percentage should be provided in the consumer boilers test procedure, and if so, what those instructions should entail. 85 FR 29352, 29356. DOE was particularly interested in understanding whether such a change would improve the representativeness of the test method, and whether it would impact test burden.

AHRI suggested that for boilers with manually adjustable airflows, the $CO_2$ level be set to within 0.1 percent of the $CO_2$ level, if specified, or within 0.2 percent of the maximum if a range is given. In addition, the commenters recommended that flue CO levels be maintained below 400 ppm and, for oil boilers, that the smoke level not exceed smoke spot number 1 as measured by ASTM D–2156.[13] The commenters suggested that if those conditions are not met at the $CO_2$ levels described above, then the highest possible $CO_2$ level that meets the CO and smoke criteria (as applicable) should be used. (AHRI, No. 6 at p. 4) Rheem explained that more specific instructions for setting the excess air ratio, the flue $O_2$ level, and/or the flue $CO_2$ level should be added to the test procedure. Rheem further stated its support for the proposed language included with AHRI's comments. (Rheem, No. 9 at p. 3)

BWC stated that the AHRI residential boiler certification program operations manual sufficiently addresses setup and adjustment of $O_2$ and $CO_2$ and urged DOE to harmonize the Federal test procedure with these instructions in the AHRI operations manual. BWC explained that it would be more representative of how boilers will be setup and operate in the field. BWC stated that, for premix boilers, when $O_2$ and $CO_2$ values are not listed in the setup instructions the current test procedure requires conducting the tests at the CO air-free (COAF) limit, which is unrepresentative of manufacturer-recommended field setup, and could lead to inaccurate AFUE ratings. BWC stated that it believes capturing the original $CO_2$ level the unit was set at during its initial certification would provide greater consistency to test results. (BWC, No. 4 at p. 2)

Lochinvar suggested that, for boilers with adjustable combustion airflow, the $CO_2$ should be set to either the I&O manual specification or, if a range is specified, to the upper limit of the range. If no $CO_2$ setting is specified, Lochinvar suggested testing in the as-found condition. (Lochinvar, No. 8 at p. 3) Lochinvar also recommended the following requirements be added to the test method: (1) For oil or power gas burner units with natural or induced draft, the draft in the firebox be as specified in the manufacturer's I&O instructions; (2) on forced draft or pressure-fired boilers, the pressure at the vent connection be as specified in the manufacturer's I&O instructions, or when a range of pressure is provided combustion shall be set to the recommended pressure that results in the highest $CO_2$; (3) when tests are required at reduced input rates and I&O instructions include instruction for adjusting the air/fuel ratio, firebox pressure, or vent pressure at the minimum firing rate, the adjustments shall be made as specified in the previous paragraphs but to the values provided for the minimum firing rate, or otherwise, no adjustments to the air/fuel ratio, firebox pressure or vent pressure at the minimum firing rate shall be made; and (4) no firebox or vent pressure adjustments shall be made to outdoor boilers. (Lochinvar No. 8 at pp. 3–4)

CA IOUs requested that DOE add explicit guidelines for flue $O_2$, $CO_2$, or excess air ratios, but did not provide specific suggestions. (CA IOUs, No. 7 at p. 5) BHI expressed concern that the addition of $CO_2$ adjustment requirements would create significant burden in the form of requiring existing boilers to be retested, and that this change would result in significant reductions in AFUE ratings across the market. BHI recommended that if DOE elects to make this change, conditions similar to those recommended by AHRI should be adopted. (BHI, No. 11 at p. 3)

Weil McLain also expressed concern with the adoption of a requirement for $CO_2$ during testing for boilers with manually adjustable airflow, asserting that it could introduce an advantage or disadvantage to this product type relative to others that serve the same market (*i.e.,* including more combustion property requirements on one category of regulated product and not all gas-fired categories of regulated products), and may limit technologies and future enhancements in the field of combustion science. Weil-McLain stated that if the DOE pursues this topic, it recommended that DOE take a combustion technology neutral position by recognizing that: (A) Increasing the combustion $CO_2$ is ultimately constrained by a corresponding increase in the percentage of CO in the flue products and (B) there are gas-fired appliances for which the $CO_2$ is designed into the combustion system and require physically changing or modifying components to change the $CO_2$. Weil-McLain instead recommended establishing a limit of 400 ppm of CO on an air-free basis without additional constraints on combustion products for gas-fired appliances with the ability to adjust the $CO_2$. (Weil McLain, No. 5 at pp. 4–5)

[13] Section 3.1.1 of ASTM D2156–09 (R2018) defines ''smoke spot number, n'' as the number of the spot on the standard scale most closely matching the color (or shade) of the test spot. In section 4, ASTM D2156–09 (R2018) summarizes the test method for determining the smoke spot number as follows: A test smoke spot is obtained by pulling a fixed volume of flue gas through a fixed area of standard filter paper. The color (or shade) of the spot thus produced is visually matched with a standard scale, and the smoke density is expressed as a ''smoke spot number.''

After considering these comments, DOE tentatively concludes that it lacks sufficient data and information to indicate that establishing a requirement for setting the excess air ratio, flue $O_2$ percentage, and/or flue $CO_2$ percentage would provide ratings that are more representative than the ratings provided under the current approach. Therefore, DOE has tentatively determined to maintain the current test procedure and is not proposing to establish a requirement for setting the excess air ratio, flue $O_2$ percentage, and/or flue $CO_2$ percentage.

3. Input Rates for Step Modulating Boilers

Appendix N includes a number of specific provisions for consumer boilers with step modulating controls. Boilers with step modulating controls are capable of operating at reduced input rates (*i.e.,* less than that maximum nameplate input rate) and gradually or incrementally increasing or decreasing the input rate as needed to meet the heating load. The test procedure currently requires step modulating boilers to be tested at the maximum rate and a minimum (*i.e.,* ''reduced'') input rate for the steady-state test (referencing Section 9.1 of ASRHAE 103–1993), the reduced input rate for the cool-down test (referencing Section 9.5.2.4 of ASRHAE 103–1993), and the reduced input rate for the heat-up test (referencing Section 9.6.2.1 of ASRHAE 103–1993). In addition, both the optional tracer gas test and the measurement of condensate under cyclic conditions, when conducted, are performed at the reduced input rate (referencing Sections 9.7.5 and 9.8 of ANSI/ASHRAE 103–1993, respectively). ANSI/ASHRAE 103–2017 contains the same input rate requirements for modulating boilers as ANSI/ASHRAE 103–1993.

In the May 2020 RFI, DOE requested comment on whether the existing provisions for testing step modulating boilers appropriately reflect the performance of such boilers. If not, DOE sought specific recommendations on the changes that would be necessary to make the test procedure more representative for such products. 85 FR 29352, 29357.

AHRI, Rheem, BWC, and Weil McLain commented that the current federal test procedure for modulating units is representative and appropriate. (AHRI No. 6 at p. 5; Rheem, No. 9 at p. 4; BWC, No. 4 at p. 2; Weil McLain, No. 5 at p. 5)

Based on the comments received and absent information to the contrary, DOE is not proposing changes for step modulating units to account for operation at any additional input rates beyond those already specified by the test procedure.

4. Return Water Temperature

The test procedure at appendix N currently requires a nominal return water temperature of 120 °F to 124 °F for non-condensing boilers and 120 °F ± 2 °F for condensing boilers. (*See* section 7.0 of appendix N and Sections 8.4.2.3 and 8.4.2.3.2 of ANSI/ASHRAE 103–1993.)

CA IOUs recommended that DOE adopt multiple entering water temperatures for condensing and non-condensing boilers, respectively, consistent with the methodology developed by the ASHRAE 155P Committee for testing and rating commercial boilers. (CA IOUs, No. 7 at p. 2)

On January 15, 2016, DOE published a final rule amending the energy conservation standards for consumer furnaces (the ''January 2016 ECS final rule''). 81 FR 2320. For its analysis for the January 2016 ECS final rule, DOE investigated the relationship between return water temperature and field performance, and developed adjustment factors to modify the AFUE based on expected return water temperatures. DOE developed adjustment factors for low, medium, and high return water temperature scenarios and estimated that, on average, AFUE would vary from the rated value by −2.66 percent to +3.15 percent depending on the model characteristics and return water temperature.[14] While DOE developed three return water temperature scenarios, there is a wide range of potential return water temperatures in the field. 81 FR 2320, 2354.

EPCA requires DOE to establish test procedures that are reasonably designed to produce test results which measure energy efficiency of a consumer boilers during a representative average use cycle or period of use, as determined by the Secretary, and shall not be unduly burdensome to conduct. (42 U.S.C. 6293(b)(3)) DOE tentatively concludes that given the wide potential range of operating conditions, the single return water temperature specified in ANSI/ASHRAE 103–2017 provides an average value that allows for a comparison of performance at comparable rating conditions and is reasonably representative.

DOE seeks additional comment on whether the return water temperature in the current test method and ANSI/ASHRAE 103–2017 are representative and appropriate, and whether any specific changes to the required conditions could improve representativeness. DOE is also interested in receiving comment on the test burden that would result from changing the return water temperature(s) specified in the test procedure.

5. Active Mode Electrical Energy Consumption

As noted in section III.C of this document, for gas-fired and oil-fired boilers, AFUE accounts for fossil fuel consumption in active, standby, and off modes, but does not include electrical energy consumption.

In response to the May 2020 RFI, CA IOUs recommended that all of the active mode energy use should be accounted for; however, information on the active mode electrical energy use be reported separately, as is done for off mode and standby mode, to enable product differentiation and to identify best performing boilers regarding electrical energy consumption. (CA IOUs, No. 7 at p. 4)

As stated, AFUE does not include active mode or standby mode and off mode electrical consumption for gas-fired and oil-fired boilers. As such, active mode and standby mode and off mode electrical energy consumption is not a factor in determining whether a gas-fired or oil-fired boiler complies with the applicable energy conservation standard, and is therefore not required to be reported. The DOE test procedure includes provisions for determining the average annual auxiliary electrical energy consumption for gas-fired and oil-fired boilers ($E_{AE}$), as a separate metric from AFUE, that accounts for active mode, standby mode, and off mode electrical consumption. (*See* appendix N, section 10.4.3.) $E_{AE}$ is referenced by the calculations at 10 CFR 430.23(n)(1) for determining the estimated annual operating cost for furnaces. However, the provisions at 10 CFR 430.23(n) include several incorrect references to sections in appendix N. DOE is proposing to correct the incorrect section references as part of this NOPR, but does not view this as a substantive change to the requirements of 10 CFR 430.23(n). Specifically, DOE proposes to change references to sections 10.2, 10.3, 10.4, and 10.5 of appendix N to reference sections 10.4, 10.5, 10.6, and 10.7 of appendix N, respectively.

[14] See chapter 7 of the January 2016 ECS Final Rule technical support document (Document No. 70 in Docket No. EERE–2012–BT–STD–0047), found online at *www.regulations.gov/document/EERE-2012-BT-STD-0047-0070.*

Although not required to be reported separately to DOE, to the extent that a manufacturer voluntarily chooses to make representations as to the active mode and standby mode and off mode electrical consumption of a gas-fired or oil-fired boiler, such representations must fairly disclose the results of testing according to the DOE test procedure. (42 U.S.C. 6293(c)(1))

6. Standby Mode and Off Mode

As discussed in section III.C of this document, separate metrics for power consumption during standby mode and off mode ($P_{W,SB}$ and $P_{W,OFF}$, respectively) are used to regulate standby mode and off mode energy consumption. These values are measured in accordance with the procedures in IEC 62301, with certain exceptions specified regarding test conditions, instrumentation requirements, and rounding requirements. (*See* appendix N, section 8.11.)

AHRI recommended that DOE consider streamlining the standby and off mode power consumption test procedure. (AHRI, No. 6 at p. 6) AHRI stated that it will investigate means to streamline the process and will submit a proposal, but AHRI did not have sufficient time to develop a proposal for this comment deadline. (AHRI, No. 6 at p. 6) DOE has not received further input or detail from AHRI on this issue prior to the issuance of this NOPR.

Lochinvar suggested that the standby mode and off mode test procedure be simplified by allowing a measurement of standby and off mode energy consumption using a calibrated power meter. (Lochinvar, No. 8 at p. 5)

EPCA requires that DOE amend test procedures to include standby mode and off mode energy consumption, ''taking into consideration the most current versions of Standards 62301 and 62087 of the International Electrotechnical Commission.'' (42 U.S.C. 6295(gg)(2)(A)) The DOE test method currently references IEC 62301, which provides instructions for measuring standby mode and off mode energy consumption. IEC 62301 provides several options for measuring the standby mode and off mode power consumption using either the ''sampling method,'' ''average reading method,'' or ''direct meter reading method.'' Although these methods vary, if the standby or off mode consumption is stable, each method can be completed in under 1 hour, and the sampling method can be completed in as little as 15 minutes. DOE has determined that the provisions in IEC 62301 provide an appropriate representation of standby mode and off mode energy consumption and are not unduly burdensome. *See generally* 77 FR 76831 (Dec. 31, 2012). The commenters did not present data to show that a simplified method could produce results equivalent to IEC 62301. For these reasons, DOE is not proposing to amend the test method for standby mode and off mode energy consumption.

DOE seeks further comment on whether a simplified approach for measuring standby mode and off mode electrical energy consumption is appropriate and would provide accurate, representative results that are comparable to those obtained with IEC 62301.

7. Full Fuel Cycle

Energy Kinetics stated that Full Fuel Cycle (''FFC'') efficiency and source efficiency analysis should be incorporated into the test procedure to allow for comparisons between direct fired heat and hot water systems and electric grid-based systems. Energy Kinetics argued that low electric power generation efficiency and high transmission and distribution losses create a false sense of high efficiency for vapor compression cycle heating equipment when compared to direct fired heating equipment. (Energy Kinetics, No. 3 at p. 3)

The FFC accounts for the energy consumed in extracting, processing, and transporting fuels. Generally, DOE uses the National Energy Modeling System (''NEMS'') as the basis for deriving the energy and emission multipliers used to conduct FFC analyses in support of energy conservation standards rulemakings. 77 FR 49701 (Aug. 17, 2012). DOE also uses NEMS to derive factors to convert site electrical energy 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 *Annual Energy Outlook.* The energy and emission multipliers used to conduct FFC analyses are subject to change each year.

DOE has previously considered a FFC metric in the January 2016 final rule. In that final rule, DOE concluded that a mathematical adjustment to the test procedure to account for FFC is not appropriate, because the mathematical adjustment to the site-based energy descriptor relies on information that is updated annually, which would require annual updating of the test method. 81 FR 2628, 2639. DOE maintains that position for this NOPR, as the circumstances are the same as when DOE last considered this issue for the January 2016 final rule, and accordingly is not proposing to amend the test procedure to reflect FFC.

8. Conversion Factor for British Thermal Units

Upon its review of the current appendix N test procedure, DOE observed inconsistencies in the existing formulas with respect to the values used to convert energy in watts (W) or kilowatts (kW) to Btu/h. For example, section 10.5 of the current appendix N indicates that the conversion factor from watt-hours to Btu (*i.e.,* watts to Btu/h) is 3.412. Simultaneously, section 10.4 of the current appendix N includes equations which include 341,300 as the conversion factor between Watts and Btu/h expressed for percentage points (essentially identifying the conversion factor from watt-hours to Btu as 3.413 instead of 3.412).

ANSI/ASHRAE 103–1993 also has these inconsistencies. (See, for example, section 4 of ANSI/ASHRAE 103–1993 and Appendix B of ANSI/ASHRAE 103–1993, which use 3.412 W/(Btu/h) and 3.413 W/(Btu/h), respectively). ANSI/ASHRAE 103–2017 strictly uses the 3.413 W/(Btu/h) conversion factor, however.

DOE notes that the conversion factor between watts and Btu/h is generally accepted to be 1 watt = 3.412142 Btu/h (or 1 Btu/h = 0.2930711 watts), as published in the ASHRAE Fundamentals Handbook.[15] This value is more appropriately rounded to 3.412 W/(Btu/h); therefore, DOE is making a correction to the proposed appendix N and appendix EE test procedures to use 3.412 W/(Btu/h) in all calculations. This correction is not expected to affect AFUE ratings.

*F. Alternative Efficiency Determination Methods*

At 10 CFR 429.70, DOE includes provisions for alternative efficiency determination methods (''AEDMs''), which are computer modeling or mathematical tools that predict the performance of non-tested basic models. They are derived from mathematical models and engineering principles that govern the energy efficiency and energy consumption characteristics of a type of covered equipment. These computer modeling and mathematical tools, when properly developed, can provide a relatively straight-forward and reasonably accurate means to predict the energy usage or efficiency characteristics of a basic model of a

[15] *2021 ASHRAE Handbook: Fundamentals (I–P Edition).* Peachtree Corners, GA: American Society of Heating, Refrigeration and Air-Conditioning Engineers, 2021.

given covered product or equipment and reduce the burden and cost associated with testing. 78 FR 79579, 79580 (Dec. 31, 2013; the ''December 2013 AEDM Final Rule'').

Where authorized by regulation, AEDMs enable manufacturers to rate and certify their basic models by using the projected energy use or energy efficiency results derived from these simulation models in lieu of testing. *Id* at 78 FR 79580. DOE has authorized the use of AEDMs for certain covered products and equipment that are difficult or expensive to test in an effort to reduce the testing burden faced by manufacturers of expensive or highly customized basic models. *Id.* DOE's regulations currently permit manufacturers of certain products and equipment to use AEDMs to rate their non-tested basic models (and combinations, where applicable) provided they meet the Department's regulations governing such use.

Weil-McLain encouraged DOE to allow use of AEDMs for consumer boilers similar to DOE's existing approach to allow AEDMs for commercial equipment (which DOE understands to refer to commercial package boilers) in order to reduce testing burden and speed the new product development process while maintaining the intent of EPCA. (Weil-McLain, No. 5 at pp. 1–2)

Currently, manufacturers of consumer boilers (or furnaces more generally) are not authorized to use an AEDM to determine ratings for these products. However, as discussed in section III.G.1 of this NOPR, manufacturers of cast iron boilers may determine AFUE for models at a capacity other than the highest or lowest of the group of basic models having identical intermediate sections and combustion chambers through linear interpolation of data obtained for the smallest and largest capacity units of the family. See 10 CFR 429.18(a)(2)(iv)(A). These provisions already provide manufacturers with an alternative method of rating consumer boilers without testing every model, and this alternative method reduces manufacturer test burden. Further, DOE explained in the December 2013 AEDM Final Rule that the AEDM provisions extend to those products or equipment which ''have expensive or highly-customized basic models.'' 78 FR 79579, 79580. The current AEDM provisions for commercial HVAC equipment (including commercial package boilers, for example) were in part the result of a negotiated rulemaking effort by the Appliance Standards and Rulemaking Federal Advisory Committee (ASRAC) in 2013. *Id.* Boilers designed for residential applications were not considered at the time.[16] 78 FR 79579. Hence, at this time, DOE does not have sufficient information to propose AEDM regulations for consumer boilers.

DOE requests further comment on whether AEDM provisions similar to those in place for commercial equipment would be necessary and appropriate for consumer boilers.

*G. Certification Requirements*

1. Linear Interpolation

Certification requirements for consumer boilers are provided at 10 CFR 429.18. These requirements, in part, allow for manufacturers to make representations of efficiency for basic models of sectional cast-iron boilers having identical intermediate sections and combustion chambers using linear interpolation of data obtained for the smallest and largest capacity units of the family. 10 CFR 429.18(a)(2)(iv)(A). AHRI and Lochinvar recommended that DOE extend the applicability of the existing linear interpolation provisions to boilers with any type of heat exchanger material. Specifically, AHRI and Lochinvar suggested that DOE include an additional section to the linear interpolation provisions stating, ''for each basic model or input capacity of boilers having similar geometric construction other than the higher or lowest input capacity in the group of basic models and is not a sectional cast-iron boiler.'' Both commenters proposed language which reflects these potential changes and also includes editorial updates. (AHRI No. 6 at p. 2; Lochinvar, No. 8, at p. 5)

DOE adopted the linear interpolation provision applicable to cast-iron boilers in a final rule published on April 13, 1979 (''April 1979 Final Rule''). 44 FR 22410. In the April 1979 Final Rule, DOE discussed the effects of sectional design of cast-iron boilers. Data submitted showed that the annual fuel utilization efficiency, energy consumption and estimated annual operating cost of sectional cast iron boilers (*i.e.,* cast iron boilers consisting of an assembly of two end sections and a variable number of identical intermediate sections, the number of intermediate sections depending on the desired heating capacity) can be accurately predicted by a linear interpolation based on data obtained from units having the smallest and largest number of intermediate sections. *Id.* 44 FR 22415. Therefore, little or no new information would result from any requirement for actual testing of middle-sized units. *Id.* In particular, data was submitted that showed the efficiencies measured according to DOE test procedures of 15 groups of sectional cast-iron boilers, with each group comprising boilers identical except for the number of intermediate sections. *Id.* An analysis of the data showed that linear interpolation for the middle-sized units resulted in errors in the measured efficiency of less than 2 percent compared to actual test results. *Id.* DOE concluded that since the tolerance of all measures of energy consumption had been established as 5 percent (applicable to the test procedures at that time), the reliability of measured energy consumption for the middle-sized units would not be significantly diminished by a linear interpolation based on data obtained from testing units having the smallest and largest number of intermediate sections and the same combustion chamber. *Id.* As discussed, the analysis of this issue in the April 1979 Final Rule was limited to cast-iron boilers, for which a robust sample of test data was provided to justify the use of a linear interpolation approach. Commenters have not provided any data or other information to demonstrate that using a linear interpolation method with other types of heat exchanger materials would produce representative test results. Lacking such data or information that would justify extending the approach to other materials, DOE is not proposing to extend the linear interpolation approach to boilers with other heat exchanger materials. If presented with such data or other information, DOE could consider such a change.

DOE seeks comment on data or other information that demonstrates that using a linear interpolation method for heat exchanger materials other than cast iron would produce representative test results.

2. Supplemental Test Instructions

For commercial boilers, DOE provides that a certification report may include supplemental testing instructions, if such information is necessary to run a valid test. Specifically, supplemental information must include any additional testing and testing set up instructions (*e.g.,* specific operational or control codes or settings), which would be necessary to operate the basic model under the required conditions specified by the relevant test procedure. 10 CFR 429.60(b)(4).

BHI suggested the creation of a repository for test instructions, similar to that currently in place for commercial boilers, instead of requiring a waiver to

[16] Working group meeting transcripts can be found at *www.regulations.gov* under Docket No. EERE–2013–BT–NOC–0023.

allow for use of specific test instructions not included in the I&O manual or the DOE test procedure. BHI stated that control systems are increasingly complex, which it asserted makes it impractical to run the test without special tools or codes in many cases. Further, BHI stated there are safety and reliability concerns with putting testing-specific instructions in the I&O manual. BHI also asserted that the use of the waiver process for these test instruction issues is burdensome, unnecessary, and is unjustifiably inconsistent with the test procedure rule for commercial boilers. (BHI, No. 11 at pp. 3–4)

BHI did not provide specific examples of test instructions that could not be included in the I&O manual due to concerns about safety or reliability, and that would thus need to be presented in a waiver. In addition, DOE has not received any petitions for waiver for any basic models of consumer boilers, indicating that there is not a problem with testing absent such additional information. Therefore, DOE is not proposing to establish a repository for test instructions for consumer boilers. Should testing of a consumer boiler necessitate controls or instructions other than those included in the I&O manual, manufacturers may petition for a waiver under the process established at 10 CFR 430.27.

DOE seeks further comment on whether supplemental test instructions are necessary for testing consumer boilers.

3. Standby Mode and Off Mode Certification

Lochinvar suggested that standby mode and off mode power consumption determined for a single basic model be permitted to be used for a product line. Lochinvar stated that the variation in standby and off mode power consumption between products of the same basic model are small enough to utilize the basic model's rating for the entire product line. (Lochinvar, No. 8 at p. 5)

DOE defines ''basic model'' in relevant part as meaning all units of a given type of covered product (or class thereof) manufactured by one manufacturer; having the same primary energy source; and which have essentially identical electrical, physical, and functional (or hydraulic) characteristics that affect energy consumption, energy efficiency, water consumption, or water efficiency. 10 CFR 430.2. If consumer boiler models are sufficiently similar that they can be grouped as a single basic model consistent with the definition above, it would be expected that these individual models would have nearly identical standby mode and off mode power consumption. In such an instance, standby mode and off mode power consumption determined for an individual model could be used for all individual models within the same basic model.

*H. Test Procedure Costs and Harmonization*

1. Test Procedure Costs and Impact

In response to the May 2020 RFI, Weil-McLain encouraged DOE to evaluate the cumulative burden upon industry based upon the average number of regulated product categories and active regulations for manufacturers during future product efficiency rulemakings. (Weil-McLain, No. 5 at p. 2)

EPCA requires that any amended test procedures prescribed must 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 not be unduly burdensome to conduct. (42 U.S.C. 6293(b)(3)) In proposing amendments to the test procedure for consumer boilers, DOE considers the burden to industry. In this NOPR, DOE proposes to amend the existing test procedure for consumer boilers by updating the references to industry standards to reference the most recent versions, *i.e.,* to reference ANSI/ASHRAE 103–2017 and ASTM D2156–09 (R2018). DOE has tentatively determined that these proposed amendments would not impact testing costs or increase burden, as discussed in the following paragraphs.

a. ASTM D2156–09 (R2018)

DOE proposes to incorporate by reference the most recent version of ASTM D2156–09, which was reaffirmed in 2018. Because the relevant provisions of ASTM D2156–09 (R2018) are unchanged from the version of ASTM D2156–09 currently incorporated by reference, this proposed change would not result in any change to how the test procedure is conducted, would not impact the measured AFUE ratings, and would not result in any change to the burden associated with the test procedure.

b. ANSI/ASHRAE 103–2017

DOE proposes to incorporate by reference the most recent version of ANSI/ASHRAE 103, ANSI/ASHRAE 103–2017. DOE has tentatively concluded that the test procedure referencing ANSI/ASHRAE 103–2017 would not impact the test procedure burden as compared to the current test procedure. As discussed in section III.D of this document, based on a review of test data and comments from stakeholders, DOE has tentatively determined that while the proposed amendment could result in differences in the measured values, such differences would be minimal and would not require re-testing or re-rating of any consumer boilers.

Based on this initial determination, manufacturers would be able to rely on data generated under the current test procedure, should the proposed amendments be finalized. As such, it would be unlikely that retesting of consumer boilers would be required solely as a result of DOE's adoption of the proposed amendments to the test procedure. However, if a manufacturer were to re-test a model using the proposed procedure, DOE estimates that the cost of performing the proposed AFUE test at a third-party laboratory would be $3,000.

DOE requests comment on DOE's tentative determination as to the impact and associated costs of the proposed incorporation by reference of ANSI/ASHRAE 103–2017.

c. ANSI/ASHRAE 41.6–2014

DOE proposes to incorporate by reference the most recent version of ANSI/ASHRAE 41.6, ANSI/ASHRAE 41.6–2014. ANSI/ASHRAE 41.6–2014 is referenced in ANSI/ASHRAE 103–2017 for determining the relative humidity of the room air during testing of condensing boilers. (*See* Section 8.5.1 of ANSI/ASHRAE 103–2017.) The previous version of ANSI/ASHRAE 103, ANSI/ASHRAE 103–1993, includes limitations on the relative humidity of the test room during testing of condensing boilers (*see* Sections 9.2 and 9.8.1 of ANSI/ASHRAE 103–1993), but does not provide instructions on how the measurements must be obtained. The reference to ASHRAE 41.6–2014 in ANSI/ASHRAE 103–2017 will ensure a consistent approach to determining the relative humidity for the purpose of meeting the test conditions. Because the DOE test method and ANSI/ASHRAE 103–1993 currently limit relative humidity allowed during testing, DOE reasons that relative humidity already must be measured under the current procedure. DOE has thus tentatively concluded that the incorporation by reference of ANSI/ASHRAE 41.6–2014 would not impact the test procedure burden as compared to the current test procedure, as the method would likely be similar to current practices.

DOE requests comment on DOE's tentative determination the proposed incorporation by reference of ASHRAE 41.6–2014 will not increase test burden.

2. Harmonization With Industry Standards

DOE's established practice is to adopt relevant industry standards as DOE test procedures unless such methodology would be unduly burdensome to conduct or would not produce test results that reflect the energy efficiency, energy use, water use (as specified in EPCA) or estimated operating costs of that product during a representative average use cycle or period of use. Section 8(c) of appendix A of 10 CFR part 430 subpart C. In cases where the industry standard does not meet this EPCA statutory criteria for test procedures, DOE will make modifications as part of the rulemaking process.

Appendix N incorporates by reference ANSI/ASHRAE Standard 103 for scope, definitions, classifications, requirements, instruments, apparatus, testing conditions, testing procedure, nomenclature, and calculations for determining AFUE. Appendix N also incorporates by reference IEC 62301 for measuring standby mode and off mode power consumption, and ASTM D2156–09 (Reapproved 2013) for adjusting oil burners. The industry standards DOE proposes to incorporate by reference via amendments described in this NOPR are discussed in further detail in section IV.M of this document. DOE notes that DOE has previously established certain modifications to ANSI/ASHRAE 103–1993 to improve representativeness and repeatability, provide additional direction, and reduce burden. Similarly, DOE has established modifications to IEC 62301 to substitute conditions for room ambient temperature and electrical supply from ANSI/ASHRAE 103–1993 to reduce burden. In general, DOE has determined that those modifications remain relevant to the updated editions of the referenced industry test standards and is not proposing to amend or delete those previously established modifications.

DOE requests comments on the benefits and burdens of the proposed updates and additions to industry standards referenced in the test procedure for consumer boilers.

*I. Compliance Date*

EPCA prescribes that, if DOE amends a test procedure, all representations of energy efficiency and energy use, including those made on marketing materials and product labels, must be made in accordance with that amended test procedure, beginning 180 days after publication of such a test procedure final rule in the **Federal Register**. (42 U.S.C. 6293(c)(2))

If DOE were to publish an amended test procedure, EPCA provides an allowance for individual manufacturers to petition DOE for an extension of the 180-day period if the manufacturer may experience undue hardship in meeting the deadline. (42 U.S.C. 6293(c)(3)) To receive such an extension, petitions must be filed with DOE no later than 60 days before the end of the 180-day period and must detail how the manufacturer will experience undue hardship. (*Id.*)

## IV. Procedural Issues and Regulatory Review

*A. Review Under Executive Order 12866*

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

*B. Review Under the Regulatory Flexibility Act*

The Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*) requires preparation of an initial regulatory flexibility analysis (''IRFA'') for any rule that by law must be proposed for public comment, unless the agency certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. As required by Executive Order 13272, ''Proper Consideration of Small Entities in Agency Rulemaking,'' 67 FR 53461 (Aug. 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 website: *energy.gov/gc/office-general-counsel.*

DOE reviewed this proposed rule under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003. DOE certifies that the proposed rule, if adopted, would not have significant economic impact on a substantial number of small entities. The factual basis of this certification is set forth in the following paragraphs.

Under 42 U.S.C. 6293, the statute sets forth the criteria and procedures DOE must follow when prescribing or amending test procedures for covered products. EPCA requires that any test procedures prescribed or amended under this section must 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 not be unduly burdensome to conduct. (42 U.S.C. 6293(b)(3))

In this NOPR, DOE proposes to update 10 CFR part 430 subpart B, appendix N, ''Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers,'' to remove the provisions applicable only to consumer boilers and rename the appendix ''Uniform Test Method for Measuring the Energy Consumption of Furnaces.'' Correspondingly, DOE proposes to create a new appendix EE, ''Uniform Test Method for Measuring the Energy Consumption of Boilers.'' In the proposed new appendix EE, DOE proposes to include all provisions currently included in appendix N for consumer boilers, with the following modifications:

(1) Incorporate by reference the current revision to the applicable industry standard, ANSI/ASHRAE 103–2017, ''Methods of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers''

(2) Incorporate by reference the current revision of ASTM Standard D2156–09 (Reapproved 2018), ''Standard Test Method for Smoke Density in Flue Gases from Burning Distillate Fuels'' (ASTM D2156–09)

(3) Incorporate by reference ASHRAE 41.6–2014, ''Standard Method for Humidity Measurement''

(4) Update the definitions to reflect the changes in ANSI/ASHRAE 103–2017 as compared to ANSI/ASHRAE 103–1993. Also remove definition of outdoor furnace or boiler from 10 CFR 430.2

For manufacturers of consumer boilers, the Small Business Administration (''SBA'') has set a size threshold, which defines those entities classified as ''small businesses'' for the purposes of the statute. DOE used the SBA's small business size standards to determine whether any small entities would be subject to the requirements of the rule. *See* 13 CFR part 121. The equipment covered by this rule is classified under North American Industry Classification System

(''NAICS'') code 333414,[17] ''Heating Equipment (except Warm Air Furnaces) Manufacturing.'' In 13 CFR 121.201, the SBA sets a threshold of 500 employees or fewer for an entity to be considered as a small business for this category. DOE identified manufacturers using DOE's Compliance Certification Database (''CCD''),[18] the AHRI database,[19] the California Energy Commission's Modernized Appliance Efficiency Database System (''MAEDbS''),[20] the ENERGY STAR Product Finder database,[21] and the prior consumer boiler energy conservation standards rulemaking. DOE used the publicly available information and subscription-based market research tools (*e.g.,* reports from Dun & Bradstreet [22]) to identify 28 original equipment manufacturers (''OEMs'') of the covered equipment. Of the 28 OEMs, DOE identified seven domestic manufacturers of consumer boilers that met the SBA definition of a ''small business.''

As stated earlier, in this NOPR, DOE proposes to amend the existing test procedure for consumer boilers by updating the references to industry standards to reference the most recent versions. Based on a review of test data and stakeholder comments, DOE has initially determined that the proposed amendments to reference ANSI/ASHRAE 103–2017 in the test procedure would not require retesting or re-rating. DOE conducted testing to compare the results from testing in accordance with ANSI/ASHRAE 103–1993 (the 1993 version is currently incorporated by reference in the DOE test procedure) with results using the more recent editions of ANSI/ASHRAE 103 to reach this tentative determination, which is further supported by a majority of comments from industry stakeholders indicating no expected impact of updating this test standard reference. ASTM Standard D2156–09, which is currently incorporated by reference, was reapproved in 2018 with no substantial differences. Therefore, DOE's proposal to incorporate the version of ASTM D2156–09 reapproved in 2018 would not result in any impact on results or test burden. DOE also proposes to incorporate by reference ANSI/ASHRAE 41.6–2014, a test method for determination of relative humidity. ANSI/ASHRAE 103–1993 (and by extension, the current DOE test procedure) includes limitations on the relative humidity of the test room during certain testing, but it does not provide instructions on how the measurements must be obtained. ASHRAE 41.6–2014 is referenced in ANSI/ASHRAE 103–2017 as the required approach to determining the relative humidity for the purpose of meeting the test conditions. The test method in ASHARE 41.6–2014 is understood to be similar to current industry practices and is thus not expected to introduce any new test burden for manufacturers.

As such, the test procedure amendments would not result in any change in burden associated the DOE test procedure for consumer boilers.

Therefore, DOE initially concludes that the test procedure amendments proposed in this NOPR would not have a ''significant economic impact on a substantial number of small entities,'' and that the preparation of an IRFA is not warranted. DOE will transmit the certification and supporting statement of factual basis to the Chief Counsel for Advocacy of the Small Business Administration for review under 5 U.S.C. 605(b).

DOE welcomes comment on the Regulatory Flexibility certification conclusion.

### *C. Review Under the Paperwork Reduction Act of 1995*

Manufacturers of consumer boilers must certify to DOE that their products comply with any applicable energy conservation standards. To certify compliance, manufacturers must first obtain test data for their products according to the DOE test procedures, including any amendments adopted for those test procedures. DOE has established regulations for the certification and recordkeeping requirements for all covered consumer products and commercial equipment, including consumer boilers. (*See generally* 10 CFR part 429.) The collection-of-information requirement for the 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 35 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.

In this NOPR, DOE is proposing to update references to industry test standards to reference the most current versions. DOE is also proposing to reorganize the test procedures so that boilers are addressed in an appendix separate from furnaces generally. The proposed amendments would not establish new or amended reporting requirements.

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 NOPR, DOE proposes test procedure amendments that it expects will be used to develop and implement future energy conservation standards for consumer 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, DOE has determined that adopting test procedures for measuring energy efficiency of consumer products and industrial equipment is consistent with activities identified in 10 CFR part 1021, appendix A to subpart D, A5 and A6. 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 (Aug. 4, 1999) imposes certain requirements on 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

[17] The size standards are listed by NAICS code and industry description and are available at: *www.sba.gov/document/support--table-size-standards* (Last accessed on September 22, 2021).

[18] DOE's Compliance Certification Database is available at: *www.regulations.doe.gov/ccms* (last accessed July 12, 2021).

[19] The AHRI Database is available at: *www.ahridirectory.org* (last accessed March 3, 2021).

[20] California Energy Commission's MAEDbS is available at *cacertappliances.energy.ca.gov/Pages/ApplianceSearch.aspx* (last accessed September 22, 2021).

[21] The ENERGY STAR Product Finder database is available at *energystar.gov/productfinder/* (last accessed September 22, 2021).

[22] *app.dnbhoovers.com.*

published a statement of policy describing the intergovernmental consultation process it will follow in the development of such regulations. 65 FR 13735. DOE has examined this proposed rule and has 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 proposed rule. 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. 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 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 proposed 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 proposed ''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 small governments. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR 12820; also available at *http://energy.gov/gc/office-general-counsel.* DOE examined this proposed rule according to UMRA and its statement of policy and determined that the rule contains neither an intergovernmental mandate, nor a mandate that may result in the expenditure of $100 million or more in any year, so these requirements do not apply.

*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 proposed 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*

DOE has determined, under Executive Order 12630, ''Governmental Actions and Interference with Constitutionally Protected Property Rights'' 53 FR 8859 (March 18, 1988), that this proposed regulation 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 agencies to review most disseminations of information to the public under 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 this 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 OMB, a Statement of Energy Effects for any proposed 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.

The proposed regulatory action to amend the test procedure for measuring the energy efficiency of consumer boilers is not a significant regulatory action under Executive Order 12866. 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.

*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), DOE must comply with section 32 of the Federal Energy

Administration Act of 1974, as amended by the Federal Energy Administration Authorization Act of 1977. (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.

The proposed modifications to the test procedure for consumer boilers would reference testing methods contained in certain sections of the following commercial standards: ANSI/ASHRAE Standard 103 (ANSI/ASHRAE 103–2017), ASTM D2156–09 (R2018), and ANSI/ASHRAE Standard 41.6–2014 (ANSI/ASHRAE 41.6–2014). DOE has evaluated these standards and is unable to conclude whether they fully comply with the requirements of section 32(b) of the FEAA (*i.e.,* whether they were developed in a manner that fully provides for public participation, comment, and review.) DOE will consult with both the Attorney General and the Chairman 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*

In this NOPR, DOE proposes to incorporate by reference the test standard published by ANSI/ASHRAE, titled ''Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers,'' ANSI/ASHRAE 103–2017. The purpose of ANSI/ASHRAE 103–2017 is to provide procedures for determining the annual fuel utilization efficiency of consumer furnaces and boilers. Relevant to the DOE test procedure, the standard includes test methods for cyclic and part-load performance and calculation procedures for establishing seasonal performance. The standard provides information on definitions, classifications, requirements, instruments, methods of testing, testing procedures, nomenclature, and calculations for determining the AFUE of consumer boilers.

ANSI/ASHRAE 103–2017 includes a reference to ANSI/ASHRAE 41.6–2014, ''Standard Method for Humidity Measurement,'' which DOE also proposes to incorporate by reference. ANSI/ASHRAE 41.6–2014 includes instructions for measuring the relative humidity of the test room air.

Copies of ANSI/ASHRAE 103–2017 and ANSI/ASHRAE 41.6–2014 can be obtained from the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., Publication Sales, 180 Technology Parkway NW, Peachtree Corners, GA 30092, (800) 527–4723 or (404) 636–8400, or online at: *www.ashrae.org.*

In this NOPR, DOE also proposes 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 (R2018)). ASTM D2156–09 (R2018) includes instructions for determining the amount of smoke produced by an oil burner to ensure the burner is adjusted properly.

Copies of ASTM D2156–09 (R2018) can be obtained from the ASTM International,100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428–2959 or online at: *www.astm.org.*

In this NOPR, DOE also proposes to incorporate by reference the test standard published by IEC, titled ''Household electrical appliances—Measurement of standby power,'' Edition 2.0 2011–01 (IEC 62301). IEC 62301 includes instructions for determining the electrical power consumption during standby mode.

Copies of IEC 62301 can be obtained from the American National Standards Institute, 25 W 43rd Street, 4th Floor, New York, NY 10036, (212) 642–4900, or online at: *webstore.ansi.org.*

## V. Public Participation

### *A. Participation in the Webinar*

The time and date for the webinar are listed in the **DATES** section at the beginning of this document. If no participants register for the webinar, it will be cancelled. Webinar registration information, participant instructions, and information about the capabilities available to webinar participants will be published on DOE's website: *www1.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=45&action=viewcurrent.* Participants are responsible for ensuring their systems are compatible with the webinar software.

### *B. Procedure for Submitting Prepared General Statements for Distribution*

Any person who has an interest in the topics addressed in this document, 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 webinar. Such persons may submit to *ApplianceStandardsQuestions@ee.doe.gov.* Persons who wish to speak should include with their request a computer file 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.

Persons requesting to speak should briefly describe the nature of their interest in this rulemaking and provide a telephone number for contact. DOE requests persons selected to make an oral presentation to submit an advance copy of their statements at least two weeks before the webinar. At its discretion, 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 Office. As necessary, requests to give an oral presentation should ask for such alternative arrangements.

### *C. Conduct of the Webinar*

DOE will designate a DOE official to preside at the webinar/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 webinar. 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 webinar/public meeting and until the end of the comment period, interested parties may submit further comments on the proceedings and any aspect of the rulemaking.

The webinar will be conducted in an informal, conference style. DOE will 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 permit, 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. 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 webinar/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 webinar/public meeting.

A transcript of the webinar/public meeting will be included in the docket, which can be viewed as described in the Docket section at the beginning of this document. In addition, any person may buy a copy of the transcript from the transcribing reporter.

*D. Submission of Comments*

DOE will accept comments, data, and information regarding this proposed rule no later than the date provided in the **DATES** section at the beginning of this proposed rule. Interested parties may submit comments using any of the methods described in the **ADDRESSES** section at the beginning of this document.

*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 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. 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 website 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.* Comments and documents submitted via email 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 on 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. No faxes will be accepted.

Comments, data, and other information submitted to DOE electronically should be provided in PDF (preferred), Microsoft Word or Excel, or text (ASCII) file format. Provide documents that are not secured, written in English and 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, 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. DOE will make its own determination about the confidential status of the information and treat it according to its determination.

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 from interested parties concerning the following issues:

(1) DOE seeks comment on whether any other industry test methods exist for determining the heating efficiency of air-to-water or water-to-water heat pumps. DOE seeks comment specifically on AHRI 550/590, and whether it would be appropriate for adoption as a Federal test procedure for such products, and if so, whether modifications could be made to result in an AFUE rating.

(2) DOE seeks comment on its proposal to remove the definition of ''outdoor furnace or boiler'' from its regulations. DOE seeks comment on whether removing the definition for ''outdoor furnace or boiler'' would impact the application of the test procedure or energy conservation standards for any such products.

(3) DOE seeks comment on its proposal to incorporate by reference the definitions in ANSI/ASHRAE 103–2017 and to remove the definitions for ''control'' and ''isolated combustions system'' from the consumer boiler test procedure at appendix N accordingly.

(4) DOE seeks comment on its proposal to clarify the calculation of steady-state efficiencies at maximum and minimum input rates for condensing, modulating boilers using ANSI/ASHRAE 103–2017.

(5) DOE seeks further comment on its proposal to update the incorporation by reference of ASHRAE 103 to the most recent version (*i.e.,* ANSI/ASHRAE 103–2017) and in particular the potential impact on ratings and whether retesting would be required.

(6) DOE seeks additional comment on whether the return water temperature in the current test method and ANSI/ASHRAE 103–2017 are representative and appropriate, and whether any specific changes to the required conditions could improve

representativeness. DOE is also interested in receiving comment on the test burden that would result from changing the return water temperature(s) specified in the test procedure.

(7) DOE seeks further comment on whether a simplified approach for measuring standby mode and off mode electrical energy consumption is appropriate and would provide accurate, representative results that are comparable to those obtained with IEC 62301.

(8) DOE requests further comment on whether AEDM provisions similar to those in place for commercial equipment would be necessary and appropriate for consumer boilers.

(9) DOE seeks comment on data or other information that demonstrates that using a linear interpolation method for heat exchanger materials other than cast iron would produce representative test results.

(10) DOE seeks further comment on whether supplemental test instructions are necessary for testing consumer boilers.

(11) DOE requests comment on DOE's tentative determination as to the impact and associated costs of the proposed incorporation by reference of ANSI/ASHRAE 103–2017.

(12) DOE requests comment on DOE's tentative determination the proposed incorporation by reference of ASHRAE 41.6–2014 will not increase test burden.

(13) DOE requests comments on the benefits and burdens of the proposed updates and additions to industry standards referenced in the test procedure for consumer boilers.

(14) DOE welcomes comment on the Regulatory Flexibility certification conclusion.

## VI. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this notice of proposed rulemaking and request for comment.

### List of Subjects

*10 CFR Part 429*

Administrative practice and procedure, Confidential business information, Energy conservation, Household appliances, 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.

### Signing Authority

This document of the Department of Energy was signed on February 17, 2022, by Kelly J. Speakes-Backman, Principal Deputy Assistant Secretary for Energy Efficiency and Renewable Energy, pursuant to delegated authority from the Secretary of Energy. That document with the original signature and date is maintained by DOE. For administrative purposes only, and in compliance with requirements of the Office of the Federal Register, the undersigned DOE Federal Register Liaison Officer has been authorized to sign and submit the document in electronic format for publication, as an official document of the Department of Energy. This administrative process in no way alters the legal effect of this document upon publication in the **Federal Register**.

Signed in Washington, DC, on February 22, 2022.

**Treena V. Garrett,**

*Federal Register Liaison Officer, U.S. Department of Energy.*

For the reasons stated in the preamble, DOE is proposing to amend parts 429 and 430 of chapter II 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; 28 U.S.C. 2461 note.

■ 2. Section 429.134 is amended by revising paragraphs (h) introductory text, (h)(1)(i)(A), and (h)(2)(i)(A) to read as follows:

### § 429.134 Product-specific enforcement provisions.

* * * * *

(h) *Residential boilers—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 EE to subpart B of part 430 of this chapter apply for the purposes of this paragraph (h).

(1) * * *

(i) * * *

(A) *Boiler installation.* Boiler installation in the test room shall be in accordance with the setup and apparatus requirements of section 6.0 of appendix EE to subpart B of part 430 of this chapter.

* * * * *

(2) * * *

(i) * * *

(A) *Boiler installation.* Boiler installation in the test room shall be in accordance with the setup and apparatus requirements by section 6.0 of appendix EE to subpart B of part 430 of this chapter.

* * * * *

## 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.

### § 430.2 [Amended]

■ 4. Section 430.2 is amended by removing the definition of ''outdoor furnace or boiler''.

■ 5. Section 430.3 is amended by:

■ a. Revising paragraph (a);

■ b. Revising paragraphs (g) introductory text and (g)(11);

■ c. Redesignating paragraphs (g)(17) and (18) as paragraphs (g)(18) and (19), respectively, and adding new paragraph (g)(17); and

■ d. Revising paragraph (j) introductory text;

■ e. Adding paragraph (j)(3); and

■ f. Revising paragraph (o)(6).

The revisions and additions read as follows:

### § 430.3 Materials incorporated by reference.

(a) Certain material is incorporated by reference into this [chapter/subchapter/part/subpart] with the approval of the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. To enforce any edition other than that specified in this section, the U.S. Department of Energy (DOE) must publish a document in the **Federal Register** and the material must be available to the public. All approved material is available for inspection at DOE and at the National Archives and Records Administration (NARA). Contact DOE at: U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, Sixth Floor, 950 L'Enfant Plaza SW, Washington, DC 20024, (202) 586–2945, *https://www.energy.gov/eere/buildings/*

*appliance-and-equipment-standards-program.* For information on the availability of this material at NARA, email: *fr.inspection@nara.gov,* or go to: *www.archives.gov/federal-register/cfr/ibr-locations.html.* The material may be obtained from the sources in the following paragraphs of this section.

* * * * *

(g) *ASHRAE.* American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., Publication Sales, 180 Technology Parkway NW, Peachtree Corners, GA 30092, 800–527–4723 or 404–636–8400, or go to *www.ashrae.org.*

* * * * *

(11) ANSI/ASHRAE Standard 41.6–2014, (''ASHRAE 41.6–2014''), Standard Method for Humidity Measurement, ANSI approved July 3, 2014, IBR approved for appendices F and EE to subpart B of this part.

* * * * *

(17) ANSI/ASHRAE Standard 103–2017, (''ANSI/ASHRAE 103–2017''), Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers, ANSI approved July 3, 2017, IBR approved for § 430.23 and appendix EE to subpart B of this part.

* * * * *

(j) ASTM International, 100 Barr Harbor Drive, Post Office Box C700, West Conshohocken, PA 19428–2959, telephone (877) 909–2786, website: *www.astm.org;*

* * * * *

(3) ASTM D2156–09 (Reapproved 2018) (''ASTM D2156–09 (R2018)''), Standard Test Method for Smoke Density in Flue Gases from Burning Distillate Fuels, approved October 1, 2018, IBR approved for appendix EE to subpart B of this part.

* * * * *

(o) * * *

(6) IEC 62301 (''IEC 62301''), Household electrical appliances—Measurement of standby power, (Edition 2.0, 2011–01), IBR approved for appendices C1, D1, D2, F, G, H, I, J2, N, O, P, Q, X, X1, Y, Z, BB, CC, and EE to subpart B of this part.

* * * * *

■ 6. Section 430.23 is amended by revising paragraph (n) to read as follows:

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

* * * * *

(n) *Furnaces.* (1) The estimated annual operating cost for furnaces is the sum of:

(i) Product of the average annual fuel energy consumption, in Btu's per year for gas or oil furnaces or in kilowatt-hours per year for electric furnaces, determined according to section 10.2.2 or 10.3 of appendix N (furnaces, excluding low pressure steam or hot water boilers and electric boilers) or appendix EE (low pressure steam or hot water boilers and electric boilers) of this subpart, as applicable, and the representative average unit cost in dollars per Btu for gas or oil, or dollars per kilowatt-hour for electric, as appropriate, as provided pursuant to section 323(b)(2) of the Act; plus

(ii) The product of the average annual auxiliary electric energy consumption in kilowatt-hours per year determined according to section 10.2.3 of appendix N (furnaces, excluding low pressure steam or hot water boilers and electric boilers) or appendix EE (low pressure steam or hot water boilers and electric boilers) of this subpart, as applicable, and the representative average unit cost in dollars per kilowatt-hour as provided pursuant to section 323(b)(2) of the Act.

(iii) Round the resulting sum to the nearest dollar per year.

(2) The annual fuel utilization efficiency (AFUE) 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.

(i) For gas and oil furnaces, determine AFUE according to section 10.1 of appendix N (furnaces, excluding low pressure steam or hot water boilers and electric boilers) or appendix EE (low pressure steam or hot water boilers and electric boilers) of this subpart, as applicable.

(ii) For electric furnaces, excluding electric boilers, determine AFUE in accordance with Section 11.1 of ANSI/ASHRAE) 103–1993 (incorporated by reference, see § 430.3); for electric boilers, determine AFUE in accordance with ANSI/ASHRAE 103–2017.

(iii) Round the annual fuel utilization efficiency to one-tenth of a percentage point.

(3) The estimated regional annual operating cost for furnaces must be rounded off to the nearest dollar per year and is defined as follows:

(i) When using appendix N for furnaces excluding low pressure steam or hot water boilers and electric boilers (see the note at the beginning of appendix N),

(A) For gas or oil-fueled furnaces,

$(E_{FR} \times C_{BTU}) = (E_{AER} \times C_{KWH})$

Where:

$E_{FR}$ = the regional annual fuel energy consumption in Btu per year, determined according to section 10.7.1 of appendix N;

$C_{BTU}$ = the representative average unit cost in dollars per Btu of gas or oil, as provided pursuant to section 323(b)(2) of the Act;

$E_{AER}$ = the regional annual auxiliary electrical energy consumption in kilowatt-hours per year, determined according to section 10.7.2 of appendix N; and

$C_{KWH}$ = the representative average unit cost in dollars per kilowatt-hour of electricity, as provided pursuant to section 323(b)(2) of the Act.

(B) For electric furnaces,

$(E_{ER} \times C_{KWH})$

Where:

$E_{ER}$ = the regional annual fuel energy consumption in kilowatt-hours per year, determined according to section 10.7.3 of appendix N; and

$C_{KWH}$ is as defined in paragraph (n)(3)(i)(A) of this section.

(ii) When using appendix EE for low pressure steam or hot water boilers and electric boilers (see the note at the beginning of appendix EE),

(A) For gas or oil-fueled boilers,

$(E_{FR} \times C_{BTU}) + (E_{AER} \times C_{KWH})$

Where:

$E_{FR}$ = the regional annual fuel energy consumption in Btu per year, determined according to section 10.5.1 of appendix EE;

$C_{BTU}$ and $C_{KWH}$ are as defined in paragraph (n)(3)(i)(A) of this section; and

$E_{AER}$ = the regional annual auxiliary electrical energy consumption in kilowatt-hours per year, determined according to section 10.5.2 of appendix EE.

(B) For electric boilers,

$(E_{ER} \times C_{KWH})$

Where:

$E_{ER}$ = the regional annual fuel energy consumption in kilowatt hours per year, determined according to section 10.5.3 of appendix EE; and

$C_{KWH}$ is as defined in paragraph (n)(3)(i)(A) of this section.

(4) The energy factor for furnaces, expressed in percent, is the ratio of annual fuel output of useful energy delivered to the heated space to the total annual energy input to the furnace determined according to either section 10.6 of appendix N (furnaces, excluding low pressure steam or hot water boilers and electric boilers) or section 10.4 of appendix EE (low pressure steam or hot water boilers and electric boilers) of this subpart, as applicable.

(5) The average standby mode and off mode electrical power consumption for furnaces shall be determined according to section 8.10 of appendix N (furnaces, excluding low pressure steam or hot water boilers and electric boilers) or section 8.9 of appendix EE (low

pressure steam or hot water boilers and electric boilers) of this subpart, as applicable. Round the average standby mode and off mode electrical power consumption to the nearest tenth of a watt.

(6) Other useful measures of energy consumption for furnaces shall be those measures of energy consumption which the Secretary determines are likely to assist consumers in making purchasing decisions and which are derived from the application of appendix N (furnaces, excluding low pressure steam or hot water boilers and electric boilers) or appendix EE (low pressure steam or hot water boilers and electric boilers) of this subpart.

* * * * *

■ 7. Appendix N to subpart B of part 430 is revised to read as follows:

## Appendix N to Subpart B of Part 430—Uniform Test Method for Measuring the Energy Consumption of Consumer Furnaces Other Than Boilers

0. *Incorporation by reference.*

DOE incorporated by reference in § 430.3, the entire standards for ASHRAE Standard 103–1993, ASTM D2156–09 (R2018), and IEC 62301. In cases where there is a conflict, the language of the test procedure in this appendix takes precedence over the incorporated standards. However, only the following enumerated provisions of ASHRAE 103–1993 apply to this appendix:

(1) ASHRAE 103–1993

(i) section 2 ''Scope'' as referenced in section 1.0 of this appendix;

(ii) section 3 ''Definitions'' as referenced in section 2.0 of this appendix;

(iii) section 4 ''Classifications'' as referenced in section 3.0 of this appendix;

(iv) section 5 ''Requirements'' as referenced in section 4.0 of this appendix;

(v) section 6 ''Instruments'' as referenced in section 5.0 of this appendix;

(vi) section 7 ''Apparatus'' (except for sections 7.1, 7.2.2.2, 7.2.2.5, 7.2.3.1, and 7.8) as referenced in section 6.0 of this appendix;

(vii) section 8 ''Methods of Testing'' (except for sections 8.2.1.3, 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) as referenced in section 7.0 of this appendix;

(viii) section 9 ''Test Procedure'' (except for sections 9.1.2.2.1, 9.1.2.2.2, 9.5.1.1, 9.5.1.2.1, 9.5.1.2.2,, 9.7.4, and 9.10) as referenced in section 8.0 of this appendix;

(ix) section 10 ''Nomenclature'' as referenced in section 9.0 of this appendix; and

(x) section 11 ''Calculations'' (except for sections 11.5.11.1, 11.5.11.2) as referenced in section 10.0 of this appendix.

1.0 *Scope.* The scope of this appendix is as specified in Section 2 of ASHRAE 103–1993 as it pertains to furnaces other than low pressure steam or hot water boilers or to electric boilers. Low pressure steam or hot water boilers and electric boilers are addressed in appendix EE of this subpart.

2.0 *Definitions.* Definitions include those specified in Section 3 of ASHRAE 103–1993 and the following additional and modified definitions.

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

*Control* means a device used to regulate the operation of a piece of equipment and the supply of fuel, electricity, air, or water.

*Draft inducer* means a fan incorporated in the furnace that either draws or forces air into the combustion chamber.

*Gas valve* means an automatic or semi-automatic device consisting essentially of a valve and operator that controls the gas supply to the burner(s) during normal operation of an appliance. The operator may be actuated by application of gas pressure on a flexible diaphragm, by electrical means, by mechanical means or by other means.

*Installation and operation (I&O) manual* means instructions for installing, commissioning, and operating the furnace, which are supplied with the product when shipped by the manufacturer.

*Isolated combustion system* means a system where a unit is installed within the structure, but isolated from the heated space. A portion of the jacket heat from the unit is lost, and air for ventilation, combustion and draft control comes from outside the heated space.

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

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

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

*Oil control valve* means an automatically or manually operated device consisting of an oil valve for controlling the fuel supply to a burner to regulate burner input.

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

a. Activation of other modes (including activation or deactivation of active mode) by remote switch (including thermostat or remote control), internal or external sensors, and/or timer; and

b. Continuous functions, including information or status displays or sensor-based functions.

*Thermal stack damper* means a type of stack damper that relies exclusively upon the changes in temperature in the stack gases to open or close the damper.

3.0 *Classifications.* Classifications are as specified in Section 4 of ASHRAE 103–1993 for furnaces.

4.0 *Requirements.* Requirements are as specified in Section 5 of ASHRAE 103–1993 for furnaces.

5.0 *Instruments.* Instruments must be as specified in Section 6 of ASHRAE 103–1993.

6.0 *Apparatus.* The apparatus used in conjunction with the furnace during the testing must be as specified in Section 7 of ASHRAE 103–1993 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 in the test room in accordance with the I&O manual, as defined in section 2.6 of this appendix, except that if provisions within this appendix are specified, then the provisions herein drafted and prescribed by DOE govern. If the I&O manual and any additional provisions of this appendix are not sufficient for testing a furnace, 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 103–1993 is not required.

c. Test multi-position furnaces in the least efficient configuration. Testing of multi-position furnaces in other configurations is permitted if energy use or efficiency is represented pursuant to the requirements in 10 CFR part 429.

d. The apparatuses described in section 6 of this appendix are used in conjunction with the furnace during testing. Each piece of apparatus shall conform to material and construction specifications listed in this appendix and in ASHRAE 103–1993, and the reference standards cited in this appendix and in ASHRAE 103–1993.

e. Test rooms containing equipment must have suitable facilities for providing the utilities (including but not limited to environmental controls, 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 in section 6 of this appendix.

6.2 *Forced-air central furnaces (direct vent and direct exhaust).*

a. Units not equipped with a draft hood or draft diverter must 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 provided in the I&O manual (*see* Figure 4 of ASHRAE 103–1993). 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 103–1993 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 103–1993, respectively. However, do not apply the insulation for the jacket loss test (if conducted) described in

Section 8.6 of ASHRAE 103–1993 or the steady-state test described in Section 9.1 of ASHRAE 103–1993.

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, respectively, of ASHRAE 103–1993. Do not apply the insulation for the jacket loss test (if conducted) described in Section 8.6 of ASHRAE 103–1993 or the steady-state test described in Section 9.1 of ASHRAE 103–1993. 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 103–1993 or the steady-state test described in Section 9.1 of ASHRAE 103–1993. 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 103–1993. 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–E of ASHRAE 103–1993.)

6.4 *Units with draft hoods or draft diverters.* Install the stack damper in accordance with the I&O manual. Install 5 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 in Section 6.4.c before the cool-down and heat-up tests described in Sections 9.5 and 9.6, respectively, of ASHRAE 103–1993. Do not apply the insulation for the jacket loss test (if conducted) described in Section 8.6 of ASHRAE 103–1993 or the steady-state test described in Section 9.1 of ASHRAE 103–1993.

6.5 *Condensate collection.* Attach condensate drain lines to the unit as specified in the I&O manual. Maintain a continuous downward slope of drain lines from the unit. 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) must 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 must have a vent opening to the atmosphere.

7.0 *Testing conditions.* The testing conditions must be as specified in Section 8 of ASHRAE 103–1993, except for Sections 8.2.1.3, 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 7.9 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 103–1993 shall be used. Maintain the gas supply, ahead of all controls for a furnace, at a test pressure between the normal and increased values shown in Table 1 of ASHRAE 103–1993. Maintain the regulator outlet pressure at a level approximating that recommended in the I&O manual, as defined in section 2.6 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 of ASHRAE 103–1993 and with a higher heating value within ±5% of the higher heating value shown in Table 1 of ASHRAE 103–1993. Determine the actual higher heating value in Btu per standard cubic foot for the gas to be used in the test within an error no greater than 1%.

7.2 *Gas burner.* Adjust the burners of gas-fired furnaces to their maximum Btu input ratings at the normal test pressure specified by section 7.1 of this appendix. 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 down to within ±2 percent of the hourly Btu nameplate input rating specified by the manufacturer as measured during the steady-state performance test in section 8 of this appendix. Set the primary air shutters in accordance with the I&O manual to give a good flame at this condition. If, however, the setting results in the deposit of carbon on the burners during any test specified herein, the tester shall adjust the shutters and burners until no more carbon is deposited and shall perform the tests again with the new settings (*see* Figure 9 of ASHRAE 103–1993). 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 103–1993. If a vent-limiting means is provided on a gas pressure regulator, keep it in place during all tests.

7.3 *Modulating gas burner adjustment at reduced input rate.* For gas-fired furnaces 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 by turning the safety control valve to the ''ON'' position.

7.4 *Oil burner.* Adjust the burners of oil-fired furnaces to give a $CO_2$ reading specified in the I&O manual and an hourly Btu input during the steady-state performance test described in section 8 of this appendix. Ensure the hourly BTU input is within ±2% of the normal hourly Btu input rating as specified in the I&O manual. Smoke in the flue may not exceed a No. 1 smoke during the steady-state performance test as measured by the procedure in ASTM D2156R13). Maintain the average draft over the fire and in the flue during the steady-state performance test at the value specified in the I&O manual. 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 103–1993.

7.5 Adjust air throughputs to achieve a temperature rise that is the higher of a and b, below, unless c applies. A tolerance of ±2 °F is permitted.

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 must be tested at the midpoint of the rise range.

7.6 Establish the temperature rise specified in section 7.5 of this appendix by adjusting the circulating airflow. This adjustment must 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 103–1993. 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 103–1993. The airflow restrictions shall then remain unchanged. If static pressure must be varied to prevent unstable blower operation, then increase the static pressure until blower operation is stabilized, except that the static pressure must 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.

7.7 *Measurement of jacket surface temperature.* Divide the jacket of the furnace into 6-inch squares when practical, and otherwise into 36-square-inch regions comprising 4-inch by 9-inch or 3-inch by 12-inch sections, and determine the surface temperature at the center of each square or section with a surface thermocouple. Record the surface temperature of the 36-square-inch areas in groups where the temperature differential of the 36-square-inch areas is less than 10 °F for temperature up to 100 °F above room temperature, and less than 20 °F for temperatures 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 103–1993).

7.8 *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 with the minimum vent length as specified in the I&O manual, or a 5-ft. flue pipe if there are no recommendations in the I&O manual. Do not connect a furnace employing a direct vent system to a chimney or induced-draft source. Vent combustion products solely by using the venting incorporated in the furnace and the vent or air intake system supplied by the manufacturer. For units that are not designed to significantly preheat the incoming air, *see* section 7.4 of this appendix and Figure 4a or 4b of ASHRAE 103–1993. For units that do significantly preheat the incoming air, *see* Figure 4c or 4d of ASHRAE 103–1993.

7.9 *Additional optional method of testing for determining $D_P$ and $D_F$ for furnaces.* 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 7.9.1 of this appendix, $D_F$ and $D_P$ may be set equal to 0.05.

7.9.1 *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. The minimum default draft factor (as allowed per Sections 8.8.3 and 9.10 of ASHRAE 103–1993) may be used only for units determined pursuant to this protocol to have no airflow through the combustion chamber and heat exchanger.

7.9.1.1 *Test apparatus.* Use a smoke stick that produces smoke that is easily visible and has a density less than or approximately equal to air. Use a smoke stick that produces smoke that is non-toxic to the test personnel and produces gas that is unreactive with the environment in the test chamber.

7.9.1.2 *Test conditions.* Minimize all air currents and drafts in the test chamber, including turning off ventilation if the test chamber is mechanically ventilated. Wait at least two minutes following the termination of the furnace on-cycle before beginning the optional test method for indicating the absence of flow through the heat exchanger.

7.9.1.3 *Location of the test apparatus.* After all air currents and drafts in the test chamber have been eliminated or minimized, position the smoke stick 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).

7.9.1.4 *Duration of test.* Establish the presence of smoke from the smoke stick and then monitor the direction of the smoke flow for no less than 30 seconds.

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

(a) If absolutely no smoke is drawn into the combustion air intake, the furnace 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 103–1993.

(b) If there is any smoke drawn into the intake, proceed with the methods of testing as prescribed in Section 8.8 of ASHRAE 103–1993.

8.0 *Test procedure.* Conduct testing and measurements as specified in Section 9 of ASHRAE 103–1993 except for Sections 9.1.2.2.1, 9.1.2.2.2, 9.5.1.1, 9.5.1.2.1, 9.5.1.2.2, 9.7.4, and 9.10; and as specified in sections 8.1 through 8.10 of this appendix. Section 8.4 of this appendix may be used in lieu of Section 9.2 of ASHRAE 103–1993.

8.1 *Fuel input.* For gas units, measure and record the steady-state gas input rate in Btu/hr, 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. For oil units, measure and record the steady-state fuel input rate.

8.2 *Electrical input.* During the steady-state test, perform a single measurement of all of the electrical power involved in burner operation (PE), including energizing the ignition system, controls, gas valve or oil control valve, and draft inducer, if applicable.

During the steady-state test, perform a single measurement of the electrical power to the circulating air blower (BE).

8.3 *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 stopwatch 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.

8.4 *Optional test procedures for condensing furnaces, measurement of condensate during the establishment of steady-state conditions.* For units with step-modulating or two-stage controls, conduct the test at both the maximum and reduced inputs. In lieu of collecting the condensate immediately after the steady state conditions have been reached as required by Section 9.2 of ASHRAE 103–1993, condensate may be collected during the establishment of steady state conditions as defined by Section 9.1.2.1 of ASHRAE 103–1993. Perform condensate collection for at least 30 minutes. Measure condensate mass immediately at the end of the collection period to prevent evaporation loss from the sample. Record fuel input for the 30-minute condensate collection test period. Observe and record fuel higher heating value (HHV), temperature, and pressures necessary for determining fuel energy input ($Q_{c,ss}$). Measure the fuel quantity and HHV with errors no greater than 1%. The humidity for the room air shall at no time exceed 80%. Determine the mass of condensate for the establishment of steady state conditions ($M_{c,ss}$) 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 *Cool-down test for gas- and oil-fueled gravity and forced-air central furnaces without stack dampers.* 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 103–1993 at 1.5 minutes ($T_{F,OFF}(t_3)$) and 9 minutes ($T_{F,OFF}(t_4)$) after shutting off the burner. When taking these temperature readings, the integral draft diverter must remain blocked and insulated, and the stack restriction must 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. Record the time from burner ''OFF'' to combustion blower ''OFF'' (electrically de-energized) as $t_P$. 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. If $t_P$ is prescribed by the I&O manual or measured 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 103–1993 at the end of the 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.

8.6 *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, measure the time delay between burner shutdown and blower shutdown, $t^+$. This time delay, $t^+$, will be 3.0 minutes for non-condensing furnaces or 1.5 minutes for condensing furnaces or until the supply air temperature drops to a value of 40 °F above the inlet air temperature, whichever results in the longest fan on-time. For a furnace without adjustable fan control or with the type of adjustable fan control whose range of adjustment does not allow for the time delay, $t^+$, specified above, bypass the fan control and manually control the fan to allow for the appropriate delay time as specified in Section 9.5.1.2 of ASHRAE 103–1993. 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 must be stopped at the same time.

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

8.8 *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 11.6.1, 11.6.2, 11.6.3, 11.6.4, 11.7.1, and 11.7.2 of ASHRAE 103–1993. 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 7.9 of this appendix), $D_F$ and $D_P$ may be set equal to 0.05.

8.10 *Optional test procedures for condensing furnaces that have no off-period flue losses.* For units that have applied the test method in section 7.9 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, the cool-down and heat-up tests specified in Sections 9.5 and 9.6 of ASHRAE 103–1993 may be omitted. 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 103–1993 when calculating heating seasonal efficiency, $Effy_{HS}$.

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

8.10.1 *Standby power measurement.* With all electrical auxiliaries of the furnace not activated, measure the standby power ($P_{W,SB}$) in accordance with the procedures in IEC 62301, except that Section 8.5, *Room Ambient Temperature,* of ASHRAE 103–1993 and the voltage provision of Section 8.2.1.4, *Electrical Supply,* of ASHRAE 103–1993 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. Clarifying further, IEC 62301 Section 4.4, *Power measurement instruments,* and Section 5, *Measurements,* apply in lieu of ASHRAE 103–1993 Section 6.10, *Energy Flow Rate.* 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.

8.10.2 *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, except that Section 8.5, *Room Ambient Temperature,* of ASHRAE 103–1993 and the voltage provision of Section 8.2.1.4, *Electrical Supply,* of ASHRAE 103–1993 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. Clarifying further, IEC 62301 Section 4.4, *Power measurement instruments,* and Section 5, *Measurements,* apply for this measurement in lieu of ASHRAE 103–1993 Section 6.10, *Energy Flow Rate.* 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, in which case round the recorded value to at least three significant figures.

9.0 *Nomenclature.* Nomenclature includes the nomenclature specified in Section 10 of ASHRAE 103–1993 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

$E_{SO}$ = Average annual electric standby mode and off mode energy consumption, in kilowatt-hours

$P_{W,OFF}$ = Furnace off mode power, in watts

$P_{W,SB}$ = Furnace standby mode power, in watts

10.0 *Calculation of derived results from test measurements.* Perform calculations as specified in Section 11 of ASHRAE 103–1993, except for Sections 11.5.11.1, 11.5.11.2, and appendices B and C; and as specified in Sections 10.1 through 10.11 and Figure 1 of this appendix.

10.1 *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 103–1993, 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 103–1993, except that for condensing modulating systems Sections 11.5.11.1 and 11.5.11.2 are replaced by Sections 10.2 and 10.3 of this appendix. $Effy_{HS}$ is based on the assumptions that all weatherized warm air furnaces are located outdoors and that non-weatherized warm air furnaces are installed as isolated combustion systems.

10.2 *Part-load efficiency at reduced fuel input rate.* If the option in Section 8.9 of this appendix is not employed, calculate the part-load efficiency at the reduced fuel input rate, $Effy_{U,R,}$ for condensing furnaces equipped with either step-modulating or two-stage controls, expressed as a percent and defined as:

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

If the option in section 8.9 of this appendix is employed, calculate $Effy_{U,R}$ 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 103–1993,

$L_G$ = value as defined in Section 11.3.11.1 of ASHRAE 103–1993, at reduced input rate,

$L_C$ = value as defined in Section 11.3.11.2 of ASHRAE 103–1993 at reduced input rate,

$L_J$ = value as defined in Section 11.4.8.1.1 of ASHRAE 103–1993 at maximum input rate,

$t_{ON}$ = value as defined in Section 11.4.9.11 of ASHRAE 103–1993,

$Q_P$ = pilot fuel input rate determined in accordance with Section 9.2 of ASHRAE 103–1993 in Btu/h,

$Q_{IN}$ = value as defined in Section 11.4.8.1.1 of ASHRAE 103–1993,

$t_{OFF}$ = value as defined in Section 11.4.9.12 of ASHRAE 103–1993 at reduced input rate,

$L_{S,ON}$ = value as defined in Section 11.4.10.5 of ASHRAE 103–1993 at reduced input rate,

$L_{S,OFF}$ = value as defined in Section 11.4.10.6 of ASHRAE 103–1993 at reduced input rate,

$L_{I,ON}$ = value as defined in Section 11.4.10.7 of ASHRAE 103–1993 at reduced input rate,

$L_{I,OFF}$ = value as defined in Section 11.4.10.8 of ASHRAE 103–1993 at reduced input rate,

$C_J$ = jacket loss factor and equal to:

= 0.0 for furnaces intended to be installed indoors

= 1.7 for furnaces intended to be installed as isolated combustion systems

= 3.3 for furnaces intended to be installed outdoors

$L_{S,SS}$ = value as defined in Section 11.4.6 of ASHRAE 103–1993 at reduced input rate,

$C_S$ = value as defined in Section 11.3.10.1 of ASHRAE 103–1993 at reduced input rate.

10.3 *Part-Load Efficiency at Maximum Fuel Input Rate.* If the option in section 8.9 of this appendix is not employed, calculate the part-load efficiency at maximum fuel input rate, $Effy_{U,H}$, for condensing furnaces equipped with two-stage controls, expressed as a percent and defined as:

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

If the option in section 8.9 of this appendix is employed, calculate $Effy_{U,H}$ 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 103–1993,

$L_G$ = value as defined in Section 11.3.11.1 of ASHRAE 103–1993 at maximum input rate,

$L_C$ = value as defined in Section 11.3.11.2 of ASHRAE 103–1993 at maximum input rate,

$L_J$ = value as defined in Section 11.4.8.1.1 of ASHRAE 103–1993 at maximum input rate,

$t_{ON}$ = value as defined in Section 11.4.9.11 of ASHRAE 103–1993,

$Q_P$ = pilot fuel input rate determined in accordance with Section 9.2 of ASHRAE 103–1993 in Btu/h,

$Q_{IN}$ = value as defined in Section 11.4.8.1.1 of ASHRAE 103–1993,

$t_{OFF}$ = value as defined in Section 11.4.9.12 of ASHRAE 103–1993 at maximum input rate,

$L_{S,ON}$ = value as defined in Section 11.4.10.5 of ASHRAE 103–1993 at maximum input rate,

$L_{S,OFF}$ = value as defined in Section 11.4.10.6 of ASHRAE 103–1993 at maximum input rate,

$L_{I,ON}$ = value as defined in Section 11.4.10.7 of ASHRAE 103–1993 at maximum input rate,

$L_{I,OFF}$ = value as defined in Section 11.4.10.8 of ASHRAE 103–1993 at maximum input rate,

$C_J$ = value as defined in Section 10.2 of this appendix,

$L_{S,SS}$ = value as defined in Section 11.4.6 of ASHRAE 103–1993 at maximum input rate,

$C_S$ = value as defined in Section 11.4.10.1 of ASHRAE 103–1993 at maximum input rate.

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

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

$BOH_{SS}$ = 2,080 (0.77) (A) DHR − 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/[341,200 ($y_P$ PE + $y_{IG}$ $PE_{IG}$ + y BE) + ($Q_{IN}$ − $Q_P$) $Effy_{HS}$], for forced draft unit, indoors

= 100,000/[341,200 ($y_P$ PE $Eff_{motor}$ + $y_{IG}$ $PE_{IG}$ + y BE) + ($Q_{IN}$ − $Q_P$) $Effy_{HS}$], for

forced draft unit, isolated combustion system,
= 100,000/[341,200 ($y_P$ PE (1 − $Eff_{motor}$) + $y_{IG}$ $PE_{IG}$ + y BE) + ($Q_{IN}$ − $Q_P$) $Effy_{HS}$], for induced draft unit, indoors, and
= 100,000/[341,200 ($y_{IG}$ $PE_{IG}$ + y BE) + ($Q_{IN}$ − $Q_P$) $Effy_{HS}$], for induced draft unit, isolated combustion system.

DHR = typical design heating requirements as listed in Table 8 (in kBtu/h) of ASHRAE 103–1993, using the proper value of $Q_{OUT}$ defined in Section 11.2.8.1 of ASHRAE 103–1993.

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

Where:

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

100,000 = factor that accounts for percent and kBtu

$y_P$ = ratio of induced or forced draft blower on-time to average burner on-time, as follows:
1 for units without post-purge;
1 + ($t_P$/3.87) for single stage furnaces with post purge; or
1 + ($t_P$/10) for two-stage and step modulating furnaces with post purge.

PE = all electrical power related to burner operation at full load steady-state operation, including electrical ignition device if energized, controls, gas valve or oil control valve, and draft inducer, as determined in section 8.2 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;
($t_{IG}$/3.87) for single-stage furnaces; or
($t_{IG}$/10) for two-stage and step modulating furnaces;

$PE_{IG}$ = electrical input rate to the interrupted ignition device on burner (if employed), as defined in section 8.3 of this appendix

y = ratio of blower on-time to average burner on-time, as follows:
1 for furnaces without fan delay;
1 + ($t^+$ − $t^-$)/3.87 for single-stage furnaces with fan delay; or
1 + ($t^+$ − $t^-$)/10 for two-stage and step modulating furnaces with fan delay.

BE = circulating air fan electrical energy input rate at full-load steady-state operation as defined in section 8.2 of this appendix.

$t_P$ = post-purge time as defined in section 8.5 of this appendix
= 0 if $t_P$ is equal to or less than 30 seconds

$t_{IG}$ = on-time of the burner interrupted ignition device, as defined in section 8.3 of this appendix

$Q_{IN}$ = as defined in Section 11.2.8.1 of ASHRAE 103–1993

$Q_P$ = as defined in Section 11.2.11 of ASHRAE 103–1993

$Effy_{HS}$ = as defined in Section 11.2.11 (non-condensing systems) or Section 11.3.11.3 (condensing systems) of ASHRAE 103–1993, percent, and calculated on the basis of:
isolated combustion system installation, for non-weatherized warm air furnaces; or
outdoor installation, for furnaces that are weatherized.

2 = ratio of the average length of the heating season in hours to the average heating load hours

$t^+$ = delay time between burner shutoff and the blower shutoff measured as defined in Section 9.5.1.2 of ASHRAE 103–1993

$t^-$ = as defined in Section 9.6.1 of ASHRAE 103–1993

10.4.1.1 For furnaces equipped with two stage or step modulating controls the average annual energy used during the heating season, $E_M$, is defined as:

$E_M$ = ($Q_{IN}$ − $Q_P$) $BOH_{SS}$ + (8,760 − 4,600) $Q_P$

Where:

$Q_{IN}$ = as defined in Section 11.4.8.1.1 of ASHRAE 103–1993

$Q_P$ = as defined in Section 11.4.12 of ASHRAE 103–1993

$BOH_{SS}$ = as defined in section 10.4.1 of this appendix, in which the weighted $Effy_{HS}$ as defined in Section 11.4.11.3 or 11.5.11.3 of ASHRAE 103–1993 is used for calculating the values of A and B, the term DHR is based on the value of $Q_{OUT}$ defined in Section 11.4.8.1.1 or 11.5.8.1.1 of ASHRAE 103–1993, and the term ($y_P$PE + $y_{IG}$$PE_{IG}$ + yBE) in the factor A is increased by the factor R, which is defined as:
R = 2.3 for two stage controls
= 2.3 for step modulating controls when the ratio of minimum-to-maximum output is greater than or equal to 0.5
= 3.0 for step modulating controls when the ratio of minimum-to-maximum output is less than 0.5

A = 100,000/[341,200 ($y_P$ PE + $y_{IG}$ $PE_{IG}$ + y BE) R + ($Q_{IN}$ − $Q_P$) $Effy_{HS}$], for forced draft unit, indoors
= 100,000/[341,200 ($y_P$ PE $Eff_{motor}$ + $y_{IG}$ $PE_{IG}$ + y BE) R + ($Q_{IN}$ − $Q_P$) $Effy_{HS}$], for forced draft unit, isolated combustion system,
= 100,000/[341,200 ($y_P$ PE (1 − $Eff_{motor}$) + $y_{IG}$ $PE_{IG}$ + y BE) R + ($Q_{IN}$ − $Q_P$) $Effy_{HS}$], for induced draft unit, indoors, and
= 100,000/[341,200 ($y_{IG}$ $PE_{IG}$ + y BE) R + ($Q_{IN}$ − $Q_P$) $Effy_{HS}$], for induced draft unit, isolated combustion system.

Where:

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

$Effy_{HS}$ = as defined in Section 11.4.11.3 or 11.5.11.3 of ASHRAE 103–1993, and calculated on the basis of:
isolated combustion system installation, for non-weatherized warm air furnaces; or
outdoor installation, for furnaces that are weatherized.

8,760 = total number of hours per year

4,600 = as defined in Section 11.4.12 of ASHRAE 103–1993

10.4.1.2 For furnaces equipped with two-stage or step-modulating controls, the national average number of burner operating hours at the reduced operating mode ($BOH_R$) is defined as:

$BOH_R$ = $X_R$ $E_M$/$Q_{IN,R}$

Where:

$X_R$ = as defined in Section 11.4.8.7 of ASHRAE 103–1993

$E_M$ = as defined in section 10.4.1.1 of this appendix

$Q_{IN,R}$ = as defined in Section 11.4.8.1.2 of ASHRAE 103–1993

10.4.1.3 For furnaces equipped with two-stage controls, the national average number of burner operating hours at the maximum operating mode ($BOH_H$) is defined as:

$BOH_H$ = $X_H$ $E_M$/$Q_{IN}$

Where:

$X_H$ = as defined in Section 11.4.8.6 of ASHRAE 103–1993

$E_M$ = as defined in section 10.4.1.1 of this appendix

$Q_{IN}$ = as defined in Section 11.4.8.1.1 of ASHRAE 103–1993

10.4.1.4 For furnaces equipped with step-modulating controls, the national average number of burner operating hours at the modulating operating mode ($BOH_M$) is defined as:

$BOH_M$ = $X_H$ $E_M$/$Q_{IN,M}$

Where:

$X_H$ = as defined in Section 11.4.8.6 of ASHRAE 103–1993

$E_M$ = as defined in section 10.4.1.1 of this appendix

$Q_{IN,M}$ = $Q_{OUT,M}$/($Effy_{SS,M}$/100)

$Q_{OUT,M}$ = as defined in Section 11.4.8.10 or 11.5.8.10 of ASHRAE 103–1993, as appropriate

$Effy_{SS,M}$ = as defined in Section 11.4.8.8 or 11.5.8.8 of ASHRAE 103–1993, as appropriate, in percent

100 = factor that accounts for percent

10.4.2 *Average annual fuel energy consumption for gas or oil fueled furnaces.* For furnaces 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 10.4.1 of this appendix

$Q_{IN}$ = as defined in Section 11.2.8.1 of ASHRAE 103–1993

$Q_P$ = as defined in Section 11.2.11 of ASHRAE 103–1993

8,760 = as defined in section 10.4.1.1 of this appendix

10.4.2.1 For furnaces equipped with either two-stage or step modulating controls, $E_F$ is defined as:

$E_F$ = $E_M$ + 4,600 $Q_P$

Where:

$E_M$ = as defined in section 10.4.1.1 of this appendix

4,600 = as defined in Section 11.4.12 of ASHRAE 103–1993

$Q_P$ = as defined in Section 11.2.11 of ASHRAE 103–1993

10.4.3 *Average annual auxiliary electrical energy consumption for gas or oil-fueled furnaces.* For furnaces equipped with single-stage controls, the average annual auxiliary

electrical consumption ($E_{AE}$) is expressed in kilowatt-hours and defined as:

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

Where:

$BOH_{SS}$ = as defined in section 10.4.1 of this appendix
$y_P$ = as defined in section 10.4.1 of this appendix
PE = as defined in section 10.4.1 of this appendix
$y_{IG}$ = as defined in section 10.4.1 of this appendix
$PE_{IG}$ = as defined in section 10.4.1 of this appendix
y = as defined in section 10.4.1 of this appendix
BE = as defined in section 10.4.1 of this appendix
$E_{SO}$ = as defined in section 10.11 of this appendix

10.4.3.1 For furnaces equipped with two-stage controls, $E_{AE}$ is defined as:

$E_{AE} = BOH_R (y_P PE_R + y_{IG} PE_{IG} + yBE_R) + BOH_H (y_P PE_H + y_{IG} PE_{IG} + y BE_H) + E_{SO}$

Where:

$BOH_R$ = as defined in section 10.4.1.2 of this appendix
$y_P$ = as defined in section 10.4.1 of this appendix
$PE_R$ = as defined in section 8.2 of this appendix and measured at the reduced fuel input rate
$y_{IG}$ = as defined in section 10.4.1 of this appendix
$PE_{IG}$ = as defined in section 10.4.1 of this appendix
y = as defined in section 10.4.1 of this appendix
$BE_R$ = as defined in section 8.2 of this appendix and measured at the reduced fuel input rate
$BOH_H$ = as defined in section 10.4.1.3 of this appendix
$PE_H$ = as defined in section 8.2 of this appendix and measured at the maximum fuel input rate
$BE_H$ = as defined in section 8.2 of this appendix and measured at the maximum fuel input rate
$E_{SO}$ = as defined in section 10.11 of this appendix

10.4.3.2 For furnaces equipped with step-modulating controls, $E_{AE}$ is defined as:

$E_{AE} = BOH_R (y_P PE_R + y_{IG} PE_{IG} + y BE_R) + BOH_M (y_P PE_H + y_{IG} PE_{IG} + y BE_H) + E_{SO}$

Where:

$BOH_R$ = as defined in section 10.4.1.2 of this appendix
$y_P$ = as defined in section 10.4.1 of this appendix
$PE_R$ = as defined in section 8.2 of this appendix and measured at the reduced fuel input rate
$y_{IG}$ = as defined in section 10.4.1 of this appendix
$PE_{IG}$ = as defined in section 10.4.1 of this appendix
y = as defined in section 10.4.1 of this appendix
$BE_R$ = as defined in section 8.2 of this appendix and measured at the reduced fuel input rate
$BOH_M$ = as defined in 10.4.1.4 of this appendix
$PE_H$ = as defined in section 8.2 of this appendix and measured at the maximum fuel input rate
$BE_H$ = as defined in section 8.2 of this appendix and measured at the maximum fuel input rate
$E_{SO}$ = as defined in section 10.11 of this appendix

10.5 *Average annual electric energy consumption for electric furnaces.* For electric furnaces, the average annual electrical energy consumption ($E_E$) is expressed in kilowatt-hours and defined as:

$E_E = 100 (2{,}080) (0.77) DHR/(3.412 AFUE) + E_{SO}$

Where:

100 = to express a percent as a decimal
2,080 = as defined in section 10.4.1 of this appendix
0.77 = as defined in section 10.4.1 of this appendix
DHR = as defined in section 10.4.1 of this appendix
3.412 = conversion factor from watt-hours to Btu
AFUE = as defined in Section 11.1 of ASHRAE 103–1993, in percent, and calculated on the basis of:
Isolated combustion system installation, for non-weatherized warm air furnaces; or
outdoor installation, for furnaces that are weatherized.
$E_{SO}$ = as defined in section 10.11 of this appendix.

10.6 *Energy factor.*

10.6.1 *Energy factor for gas or oil furnaces.* Calculate the energy factor, EF, for gas or oil furnaces 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 10.4.2 of this appendix
4,600 = as defined in Section 11.4.12 of ASHRAE 103–1993
$Q_P$ = pilot fuel input rate determined in accordance with Section 9.2 of ASHRAE 103–1993 in Btu/h
$Effy_{HS}$ = annual fuel utilization efficiency as defined in Sections 11.2.11, 11.3.11, 11.4.11 or 11.5.11 of ASHRAE 103–1993, in percent, and calculated on the basis of:
Isolated combustion system installation, for non-weatherized warm air furnaces; or
outdoor installation, for furnaces that are weatherized.
3,412 = conversion factor from kW to Btu/h
$E_{AE}$ = as defined in section 10.4.3 of this appendix

10.6.2 *Energy factor for electric furnaces.* The energy factor, EF, for electric furnaces is defined as:

EF = AFUE

Where:

AFUE = annual fuel utilization efficiency as defined in section 10.4.3 of this appendix, in percent

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

10.7.1 *Average annual fuel energy consumption for gas or oil-fueled furnaces located in a different geographic region of the United States and in buildings with different design heating requirements.* For gas or oil-fueled furnaces, 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 10.4.2 of this appendix
8,760 = as defined in section 10.4.1.1 of this appendix
$Q_P$ = as defined in Section 11.2.11 of ASHRAE 103–1993
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 10.4.1 of this appendix

10.7.2 *Average annual auxiliary electrical energy consumption for gas or oil-fueled furnaces located in a different geographic region of the United States and in buildings with different design heating requirements.* For gas or oil-fueled furnaces, 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 10.4.3 of this appendix
$E_{SO}$ = as defined in section 10.11 of this appendix
HLH = as defined in section 10.7.1 of this appendix
2,080 = as defined in section 10.4.1 of this appendix
$E_{SOR}$ = as defined in section 10.7.3 of this appendix.

10.7.3 *Average annual electric energy consumption for electric furnaces located in a different geographic region of the United States and in buildings with different design heating requirements.* For electric furnaces, 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:

$E_{ER} = 100 (0.77) DHR HLH/(3.412 AFUE) + E_{SOR}$

Where:

100 = as defined in section 10.4.3 of this appendix
0.77 = as defined in section 10.4.1 of this appendix
DHR = as defined in section 10.4.1 of this appendix
HLH = as defined in section 10.7.1 of this appendix
3.412 = as defined in section 10.4.3 of this appendix

AFUE = as defined in section 10.4.3 of this appendix

$E_{SOR}$ = $E_{SO}$ as defined in section 10.11 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.

10.8 *Annual energy consumption for mobile home furnaces.*

10.8.1 *National average number of burner operating hours for mobile home furnaces ($BOH_{SS}$).* $BOH_{SS}$ is the same as in section 10.4.1 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.

10.8.2 *Average annual fuel energy for mobile home furnaces ($E_F$).* $E_F$ is same as in section 10.4.2 of this appendix except that the burner operating hours, $BOH_{SS}$, is calculated as specified in section 10.8.1 of this appendix.

10.8.3 *Average annual auxiliary electrical energy consumption for mobile home furnaces ($E_{AE}$).* $E_{AE}$ is the same as in section 10.4.3 of this appendix, except that the burner operating hours, $BOH_{SS}$, is calculated as specified in section 10.8.1 of this appendix.

10.9 *Calculation of sales weighted average annual energy consumption for mobile home furnaces.* 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.

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

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

Where:

$E_F$ = as defined in section 10.8.2 of this appendix

8,760 = as defined in section 10.4.1.1 of this appendix

$Q_P$ = as defined in section 10.2 of this appendix

$HLH_{MHF}$ = 1880, sales weighted average heating load hours for mobile home furnaces

2,080 = as defined in section 10.4.1 of this appendix

10.9.2 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 10.8.3 of this appendix

$HLH_{MHF}$ = as defined in section 10.9.1 of this appendix

2,080 = as defined in section 10.4.1 of this appendix

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

10.11 *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:

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

Where:

$P_{W,SB}$ = furnace standby mode power, in watts, as measured in section 8.10.1 of this appendix

4,160 = average heating season hours per year

BOH = total burner operating hours as calculated in section 10.4 of this appendix for gas or oil-fueled furnaces. Where for gas or oil-fueled furnaces equipped with single-stage controls, $BOH = BOH_{SS}$; for gas or oil-fueled furnaces equipped with two-stage controls, $BOH = (BOH_R + BOH_H)$; and for gas or oil-fueled furnaces equipped with step-modulating controls, $BOH = (BOH_R + BOH_M)$. For electric furnaces, $BOH = 100(2080)(0.77)DHR/(E_{in}\ 3.412(AFUE))$

4,600 = as defined in Section 11.4.12 of ASHRAE 103–1993

$P_{W,OFF}$ = furnace off mode power, in watts, as measured in section 8.10.2 of this appendix

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

Where:

100 = to express a percent as a decimal

2,080 = as defined in section 10.4.1 of this appendix

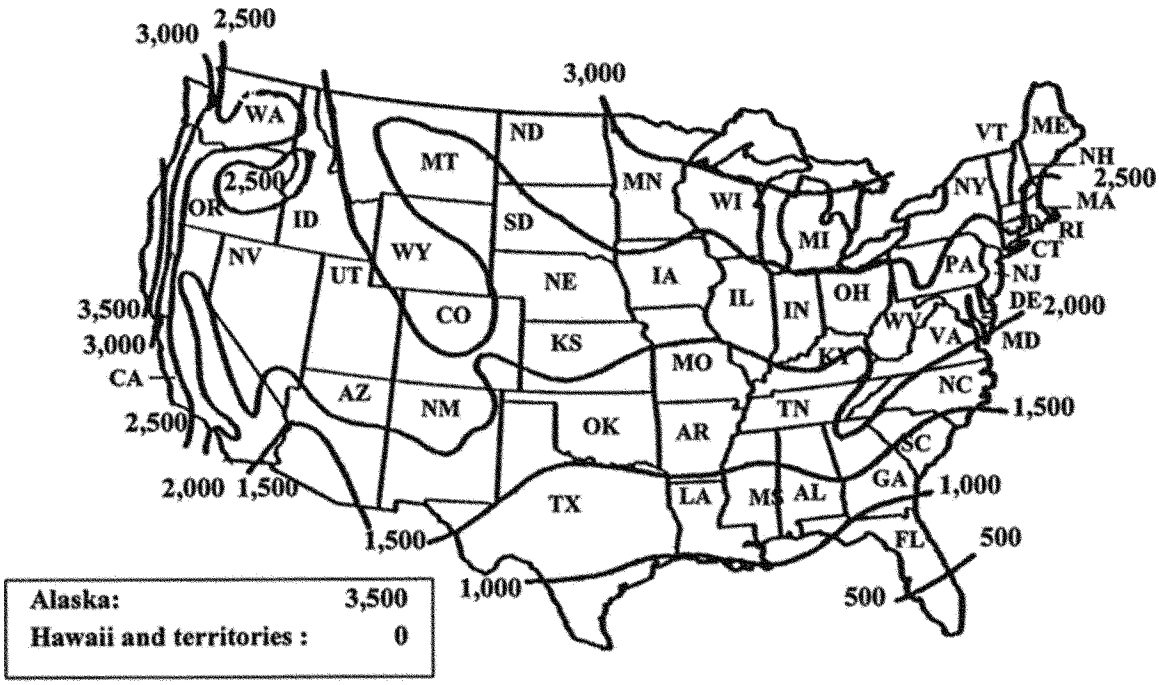
0.77 = as defined in section 10.4.1 of this appendix

DHR = as defined in section 10.4.1 of this appendix

$E_{in}$ = steady-state electric rated power, in kilowatts, from Section 9.3 of ASHRAE 103–1993

3.412 = as defined in section 10.4.3 of this appendix

AFUE = as defined in Section 11.1 of ASHRAE 103–1993 in percent




**This map is reasonably accurate for most parts of the United States but is necessarily generalized, and consequently not too accurate in mountainous regions, particularly in the rockies.**

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

■ 8. Appendix EE to subpart B of part 430 is added to read as follows:

**Appendix EE to Subpart B of Part 430—Uniform Test Method for Measuring the Energy Consumption of Consumer Boilers**

0. Incorporation by reference

DOE incorporated by reference in § 430.3, the entire standard for ANSI/ASHRAE 103–2017, ANSI/ASHRAE 41.6–2014, ASTM D2156–09 (R2018), and IEC 62301. However, only enumerated provisions of ANSI/ASHRAE 103–2017 are applicable to this appendix, as follows:

(1) ANSI/ASHRAE 103–2017

(i) section 2 ''Scope'' as referenced in section 1.0 of this appendix;

(ii) section 3 ''Definitions'' as referenced in section 2.0 of this appendix;

(iii) section 4 ''Classifications'' as referenced in section 3.0 of this appendix;

(iv) section 5 ''Requirements'' as referenced in section 4.0 of this appendix;

(v) section 6 ''Instruments'' as referenced in section 5.0 of this appendix;

(vi) section 7 ''Apparatus'' (except for sections 7.1 and 7.8) as referenced in section 6.0 of this appendix;

(vii) section 8 ''Methods of Testing'' (except for sections 8.3.1.3, 8.3.3.1, 8.4.1.1, 8.4.1.1.1, 8.4.1.2, 8.6.1.1, 8.7.2, and 8.8.3) as referenced in section 7.0 of this appendix;

(viii) section 9 ''Test Procedure'' (except for 9.1.2.2.1, 9.1.2.2.2, 9.5.2.1, 9.7.4, and 9.10) as referenced in section 8.0 of this appendix;

(ix) section 10 ''Nomenclature'' as referenced in section 9.0 of this appendix; and

(x) section 11 ''Calculations'' as referenced in section 10.0 of this appendix.

In cases where there is a conflict, the language of the test procedure in this appendix takes precedence over the incorporated standards.

1.0 *Scope.* The scope of this appendix is as specified in Section 2 of ANSI/ASHRAE 103–2017 as it pertains to low pressure steam or hot water boiler and electric boilers.

2.0 *Definitions.* Definitions include those specified in Section 3 of ANSI/ASHRAE 103–2017 and the following additional and modified definitions.

*Active mode* means the condition in which the 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.

*Boiler pump* means a pump installed on a boiler and that is separate from the circulating water pump.

*Draft inducer* means a fan incorporated in the boiler that either draws or forces air into the combustion chamber.

*Gas valve* means an automatic or semi-automatic device consisting essentially of a valve and operator that controls the gas supply to the burner(s) during normal operation of an appliance. The operator may be actuated by application of gas pressure on a flexible diaphragm, by electrical means, by mechanical means or by other means.

*Installation and operation (I&O) manual* means instructions for installing, commissioning, and operating the boiler, which are supplied with the product when shipped by the manufacturer.

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

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

*Oil control valve* means an automatically or manually operated device consisting of an oil valve for controlling the fuel supply to a burner to regulate burner input.

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

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

b. Continuous functions, including information or status displays or sensor-based functions.

*Thermal stack damper* means a type of stack damper that relies exclusively upon the changes in temperature in the stack gases to open or close the damper.

3.0 *Classifications.* Classifications are as specified in Section 4 of ANSI/ASHRAE 103–2017.

4.0 *Requirements.* Requirements are as specified in Section 5 of ANSI/ASHRAE 103–2017.

5.0 *Instruments.* Instruments must be as specified in Section 6 of ANSI/ASHRAE 103–2017.

6.0 *Apparatus.* The apparatus used in conjunction with the boiler during the testing must be as specified in Section 7 of ANSI/ASHRAE 103–2017 except for sections 7.1 and 7.8; and as specified in sections 6.1 and 6.2 of this appendix.

6.1 *General.*

a. Install the boiler in the test room in accordance with the I&O manual, as defined in section 2.5 of this appendix, except that if provisions within this appendix are specified, then the provisions herein drafted and prescribed by DOE govern. If the I&O manual and any additional provisions of this appendix are not sufficient for testing a boiler, the manufacturer must request a waiver from the test procedure pursuant to 10 CFR 430.27.

b. The apparatuses described in section 6 of this appendix are used in conjunction with the boiler during testing. Each piece of apparatus shall conform to material and construction specifications listed in this appendix and in ANSI/ASHRAE 103–2017, and the reference standards cited in this appendix and in ANSI/ASHRAE 103–2017.

c. 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 in section 6 of this appendix.

6.2 *Condensate collection.* Attach condensate drain lines to the unit as specified in the I&O manual. Maintain a continuous downward slope of drain lines from the unit. 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) must 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 must have a vent opening to the atmosphere.

7.0 *Testing conditions.* The testing conditions must be as specified in Section 8 of ANSI/ASHRAE 103–2017, except for Sections 8.3.1.3, 8.3.3.1, 8.4.1.1, 8.4.1.1.1, 8.4.1.2, 8.6.1.1, 8.7.2, and 8.8.3; and as specified in sections 7.1 to 7.8 of this appendix, respectively. For condensing furnaces and boilers, the relative humidity of the room air shall be measured in accordance with one of the methods described in ANSI/ASHRAE Standard 41.6–2014 (see Section 8.5 of ANSI/ASHRAE 103–2017).

7.1 *Fuel supply, gas.* In conducting the tests specified herein, gases with characteristics as shown in Table 1 of ANSI/ASHRAE 103–2017 shall be used. Maintain the gas supply, ahead of all controls for a boiler, at a test pressure between the normal and increased values shown in Table 1 of ANSI/ASHRAE 103–2017. Maintain the regulator outlet pressure at a level approximating that recommended in the I&O manual, as defined in section 2.5 of this appendix, or, in the absence of such recommendation, to the regulator settings used when the product is shipped by the manufacturer. Use a gas having a specific gravity as shown in Table 1 of ANSI/ASHRAE 103–2017 and with a higher heating value within ±5% of the higher heating value shown in Table 1 of ANSI/ASHRAE 103–2017. Determine the actual higher heating value in Btu per standard cubic foot for the gas to be used in the test within 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 ANSI/ASHRAE 103–2017.

7.3 *Gas burner.* Adjust the burners of gas-fired boilers to their maximum Btu input ratings at the normal test pressure specified by section 7.1 of this appendix. 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 specified by the manufacturer as measured at the maximum input rate during the steady-state performance test in section 8 of this appendix. Set the primary air shutters in accordance with the I&O manual to give a good flame at this condition. If, however, the setting results in the deposit of carbon on the burners during any test specified herein, the tester shall adjust the shutters and burners until no more carbon is deposited and shall perform the tests again with the new settings (*see* Figure 9 of ANSI/ASHRAE 103–2017). 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 ANSI/ASHRAE 103–2017. 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 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 boiler by turning the safety control valve to the ''ON'' position. 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 boilers to give a $CO_2$ reading specified in the I&O manual and an hourly Btu input within ±2% of the hourly Btu nameplate input rating as specified in the I&O manual and as measured at maximum input rate during steady-state performance test as described in section 8 of this appendix. Smoke in the flue may not exceed a No. 1 smoke during the steady-state performance test as measured by the procedure in ASTM D2156–09 (R2018). Maintain the average draft over the fire and in the flue during the steady-state performance test at the value specified in the I&O manual. 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 ANSI/ASHRAE 103–2017.

7.6 *Measurement of jacket surface temperature.* Divide the jacket of the boiler into 6-inch squares when practical, and otherwise into 36-square-inch regions comprising 4 inch by 9 inch or 3 inch by 12 inch sections, and determine the surface temperature at the center of each square or section with a surface thermocouple. Record the surface temperature of the 36-square-inch areas in groups where the temperature differential of the 36-square-inch areas is less than 10 °F for temperature up to 100 °F above room temperature, and less than 20 °F for temperatures more than 100 °F above room temperature.

7.7 *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 with the minimum vent length as specified in the I&O manual, or a 5-ft. flue pipe if there are no recommendations in the I&O manual. Do not connect a boiler employing a direct vent system to a chimney or induced-draft source. Vent combustion products solely by using the venting incorporated in the 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 section 7.5 of this appendix and Figure 4a or 4b of ANSI/ASHRAE 103–2017. For units that do significantly preheat the incoming air, *see* Figure 4c or 4d of ANSI/ASHRAE 103–2017.

7.8 *Additional optional method of testing for determining $D_P$ and $D_F$.* 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 7.8.1 of this appendix, $D_F$ and $D_P$ may be set equal to 0.05.

7.8.1 *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. The minimum default draft factor (as allowed per Sections 8.8.3 and 9.10 of ANSI/ASHRAE 103–2017) may be used only for units determined pursuant to this protocol to have no airflow through the combustion chamber and heat exchanger.

7.8.1.1 *Test apparatus.* Use a smoke stick that produces smoke that is easily visible and has a density less than or approximately equal to air. Use a smoke stick that produces smoke that is non-toxic to the test personnel and produces gas that is unreactive with the environment in the test chamber.

7.8.1.2 *Test conditions.* Minimize all air currents and drafts in the test chamber, including turning off ventilation if the test chamber is mechanically ventilated. Wait at least two minutes following the termination of the boiler on-cycle before beginning the optional test method for indicating the absence of flow through the heat exchanger.

7.8.1.3 *Location of the test apparatus.* After all air currents and drafts in the test chamber have been eliminated or minimized, position the smoke stick 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.

7.8.1.4 *Duration of test.* Establish the presence of smoke from the smoke stick and then monitor the direction of the smoke flow for no less than 30 seconds.

7.8.1.5 *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 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 ANSI/ASHRAE 103–2017.

If there is any smoke drawn into the intake, proceed with the methods of testing as prescribed in Section 8.8 of ANSI/ASHRAE 103–2017.

8.0 *Test procedure.* Conduct testing and measurements as specified in Section 9 of ANSI/ASHRAE 103–2017) except for Sections 9.1.2.2.1, 9.1.2.2.2, 9.5.2.1, 9.7.4, and 9.10; and as specified in sections 8.1 through 8.9 of this appendix. Section 8.4 of this appendix may be used in lieu of Section 9.2 of ANSI/ASHRAE 103–2017.

8.1 *Fuel input.* For gas units, measure and record the steady-state gas input rate in Btu/h, 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. For oil units, measure and record the steady-state fuel input rate. For maximum input rate, the measured burner input rate shall be within ±2% of the hourly Btu nameplate input rating ($Q_{IN}$) specified by the manufacturer. For modulating furnaces and boilers operating at reduced input rate, the measured reduced heat input rate ($Q_{IN,R}$) shall be recorded. At the discretion of the one testing, the hourly Btu nameplate minimum input rating specified by the manufacturer may be used in the calculations in place of $Q_{IN,R}$ if the measured rate is within ±2% of the nameplate rating.

8.2 *Electrical input.* During the steady-state test, perform a single measurement of all of the electrical power involved in burner operation (PE), including energizing the ignition system, controls, gas valve or oil control valve, and draft inducer, if applicable. For boilers, the measurement of PE must include the boiler pump if so equipped. If the boiler pump does not operate during the measurement of PE, add the boiler pump nameplate power to the measurement of PE. If the boiler pump nameplate power is not available, use 0.13 kW. For hot water boilers, use the circulating water pump nameplate power for BE, or if the pump nameplate power is not available, use 0.13 kW.

8.3 *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 stopwatch 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.

8.4 *Optional test procedures for condensing boilers, measurement of condensate during the establishment of steady-state conditions.* For units with step-modulating or two-stage controls, conduct the test at both the maximum and reduced inputs. In lieu of collecting the condensate immediately after the steady state conditions have been reached as required by Section 9.2 of ANSI/ASHRAE 103–2017, condensate may be collected during the establishment of steady state conditions as defined by Section 9.1.2.1 of ANSI/ASHRAE 103–2017. Perform condensate collection for at least 30 minutes. Measure condensate mass immediately at the end of the collection period to prevent evaporation loss from the sample. Record fuel input for the 30-minute condensate collection test period. Observe and record fuel higher heating value (HHV), temperature, and pressures necessary for determining fuel energy input ($Q_{C,ss}$). Measure the fuel quantity and HHV with errors no greater than 1%. The humidity for the room air shall at no time exceed 80%. Determine the mass of condensate for the establishment of steady state conditions ($M_{C,ss}$) 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 *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 ANSI/ASHRAE 103–2017.

a. During this off-period, for units that do not have pump delay after shut-off, do not allow any water 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 unit control must stop the pump. Measure and record the time between burner shut-off and pump shut-off ($t^+$) to the nearest second.

c. For units having pump delay controls that sense water temperature, operate the pump for 15 minutes and record $t^+$ as 15 minutes. While the pump is operating, maintain the inlet water temperature and flow rate at the same values as used during the steady-state test, as specified in Sections 9.1 and 8.4.2.3 of ANSI/ASHRAE 103–2017.

d. For boilers that employ post-purge, measure the length of the post-purge period with a stopwatch. Record the time from burner ''OFF'' to combustion blower ''OFF'' (electrically de-energized) as $t_P$. Measure the flue gas temperature by means of the thermocouple grid described in Section 7.6 of ANSI/ASHRAE 103–2017 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 $t_P$ is prescribed by the I&O manual or measured to be greater than 3 minutes, also measure the flue gas temperature at the midpoint of the post-purge period $t_P/2$ ($T_{F,OFF}(t_P/2)$). 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.

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

8.7 *Calculation options.* The rate of the flue gas mass flow through the boiler and the factors $D_P$, $D_F$, and $D_S$ are calculated by the equations in Sections 11.6.1, 11.6.2, 11.6.3, 11.6.4, 11.7.1, and 11.7.2 of ANSI/ASHRAE 103–2017. 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 7.8 of this appendix), $D_F$ and $D_P$ may be set equal to 0.05.

8.8 *Optional test procedures for condensing boilers that have no off-period flue losses.* For units that have applied the test method in section 7.8 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 30 seconds, the cool-down and heat-up tests specified in Sections 9.5 and 9.6 of ANSI/ASHRAE 103–2017 may be omitted. 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 ANSI/ASHRAE 103–2017 when calculating heating seasonal efficiency, $Effy_{HS}$.

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

8.9.1 *Standby power measurement.* With all electrical auxiliaries of the boiler not activated, measure the standby power ($P_{W,SB}$) in accordance with the procedures in IEC 62301, except that Section 8.5, *Room Ambient Temperature,* of ANSI/ASHRAE 103–2017 and the voltage provision of Section 8.2.1.4, *Electrical Supply,* of ANSI/ASHRAE 103–2017 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. Clarifying further, IEC 62301 Section 4.4, *Power measurement instruments,* and Section 5, *Measurements,* apply in lieu of ANSI/ASHRAE 103–2017 Section 6.10, *Energy Flow Rate.* 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.

8.9.2 *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, except that Section 8.5, *Room Ambient Temperature,* of ANSI/ASHRAE 103–2017 and the voltage provision of Section 8.2.1.4, *Electrical Supply,* of ANSI/ASHRAE 103–2017 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. Clarifying further, IEC 62301 Section 4.4, *Power measurement instruments,* and Section 5, *Measurements,* apply for this measurement in lieu of ANSI/ASHRAE 103–2017 Section 6.10, *Energy Flow Rate.* 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, in which case round the recorded value to at least three significant figures.

9.0 *Nomenclature.* Nomenclature includes the nomenclature specified in Section 10 of ANSI/ASHRAE 103–2017 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

$E_{SO}$ = Average annual electric standby mode and off mode energy consumption, in kilowatt-hours

$P_{W,OFF}$ = Boiler off mode power, in watts

$P_{W,SB}$ = Boiler standby mode power, in watts

10.0 *Calculation of derived results from test measurements.* Perform calculations as specified in Section 11 of ANSI/ASHRAE 103–2017, except for appendices B and C; and as specified in sections 10.1 through 10.7 and Figure 1 of this appendix.

10.1 *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 ANSI/ASHRAE 103–2017, except for the following:

10.1.1 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 ANSI/ASHRAE 103–2017, and is based on the assumptions that weatherized boilers are located outdoors and that non-weatherized boilers are installed indoors.

10.1.2 In Section 11.5.7.3 for the purpose of calculating the steady-state efficiency of a condensing, modulating boiler at the maximum and reduced input rates the following applies:

10.1.2.1 Calculate steady state efficiencies at the maximum and reduced input rates, $Effy_{SS}$ and $Effy_{SS,R}$, using the equations for non-condensing, non-modulating systems in Section 11.2.7 of ANSI/ASHRAE 103–2017.

10.1.2.2 Use the values for $Effy_{SS}$ and $Effy_{SS,R}$ calculated in the previous step to determine the heating capacity at the maximum and reduced input rates, $Q_{OUT}$ and $Q_{OUT,R}$, according to Sections 11.4.8.1.1 and 11.4.8.1.2 of ANSI/ASHRAE 103–2017.

10.1.2.3 Use the values for $Q_{OUT}$ and $Q_{OUT,R}$ calculated in the previous step to determine the balance point temperature, $T_C$, according to Section 11.4.8.4 of ANSI/ASHRAE 103–2017.

10.1.2.4 Use the value for $T_C$ determined in the previous step to calculate the average outdoor air temperature for the maximum and reduced input rates, $T_{OA,H}$ and $T_{OA,R}$, according to Section 11.4.8.3 of ANSI/ASHRAE 103–2017.

10.1.2.5 Use the values for $T_{OA,H}$ and $T_{OA,R}$ calculated in the previous step to calculate the steady-state heat loss due to condensate going down the drain, $L_{C,SS}$, at the maximum and reduced input rates according to Section 11.3.7.2 of ANSI/ASHRAE 103–2017.

10.1.2.6 Use the values of $L_{C,SS}$ at the maximum and reduced input rates calculated in the previous step to determine the steady-state efficiency for modulating, condensing boilers at the maximum and reduced input rates, $Effy_{SS}$ and $Effy_{SS,R}$, according to Section 11.3.7.3 of ANSI/ASHRAE 103–2017.

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

10.2.1 *National average number of burner operating hours.*

10.2.1.1 For boilers equipped with single-stage controls, the national average number of burner operating hours is defined as:

$$BOH_{SS} = 2{,}080\ (0.77)\ (A)\ [(Q_{OUT}/1000)/(1+\alpha)] - 2{,}080\ (B)$$

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

$A = 100{,}000/[341{,}200\ (y_P\ PE + y_{IG}\ PE_{IG} + y\ BE) + (Q_{IN} - Q_P)\ Effy_{HS}]$, for forced draft unit, indoors

$= 100{,}000/[341{,}200\ (y_P\ PE\ (1 - Eff_{motor}) + y_{IG}\ PE_{IG} + y\ BE) + (Q_{IN} - Q_P)\ Effy_{HS}]$, for induced draft unit, indoors, and

$Q_{OUT}$ = value as defined in Section 11.2.8.1 of ANSI/ASHRAE 103–2017.

$\alpha$ = value as defined in Section 11.2.8.2 of ANSI/ASHRAE 103–2017

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

Where:

$Eff_{motor}$ = nameplate power burner motor efficiency provided by the manufacturer,

= 0.50, an assumed default power burner efficiency if not provided by the manufacturer.

100,000 = factor that accounts for percent and kBtu

$y_P$ = 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 boilers with post purge; or

PE = all electrical power related to burner operation at full load steady-state operation, including electrical ignition device if energized, controls, gas valve or oil control valve, draft inducer, and boiler pump, as determined in section 8.2 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 boilers

$PE_{IG}$ = electrical input rate to the interrupted ignition device on burner (if employed), as defined in section 8.3 of this appendix

y = ratio of pump on-time to average burner on-time, as follows:
1 for boilers without a pump delay;
1 + ($t^+/t_{ON}$) for single-stage boilers with pump delay;
BE = circulating water pump electrical energy input rate at full-load steady-state operation as defined in section 8.2 of this appendix.
$t_P$ = post-purge time as defined in section 8.5 of this appendix
= 0 if $t_P$ is equal to or less than 30 seconds
$t_{IG}$ = on-time of the burner interrupted ignition device, as defined in section 8.3 of this appendix
$Q_{IN}$ = as defined in Section 11.2.8.1 of ANSI/ASHRAE 103–2017
$Q_P$ = as defined in Section 11.2.11 of ANSI/ASHRAE 103–2017
$Effy_{HS}$ = as defined in Section 11.2.11 (non-condensing systems) or Section 11.3.11.3 (condensing systems) of ANSI/ASHRAE 103–2017, percent, and calculated on the basis of:
Indoor installation, for non-weatherized boilers; or outdoor installation, for boilers that are weatherized.
2 = ratio of the average length of the heating season in hours to the average heating load hours
$t^+$ = delay time between burner shutoff and the pump shutoff measured as defined in section 8.5 of this appendix.
$t_{ON}$ = value as defined in Table 7 of ANSI/ASHRAE 103–2017.

10.2.1.2 For boilers equipped with two-stage or step-modulating controls, the national average number of burner operating hours at the reduced operating mode ($BOH_R$) is defined as:

$BOH_R = X_R\ (2080)(0.77)[(Q_{OUT}/1{,}000)/(1 + \alpha)](A_R) - 2080(B_R)$

Where:

$X_R$ = as defined in Section 11.4.8.6 of ANSI/ASHRAE 103–2017
2080 = as defined in section 10.2.1.1 of this appendix
0.77 = as defined in section 10.2.1.1 of this appendix
$Q_{OUT}$ = as defined in Section 11.4.8.1.1 or 11.5.8.1.1 of ANSI/ASHRAE 103–2017
$\alpha$ = as defined in Section 11.4.8.2 of ANSI/ASHRAE 103–2017
$A_R = 100{,}000/[341{,}200(y_{P,R}PE_R + y_{IG,R}PE_{IG} + y_RBE_R) + (Q_{IN,R}—Q_P)\ Effy_{U,R}]$ for forced draft unit, indoors; and
$= 100{,}000/[341{,}200(y_{P,R}PE_R\ (1 - Eff_{motor}) + y_{IG,R}PE_{IG} + y_RBE_R) + (Q_{IN,R} - Q_P)\ Effy_{U,R}]$ for induced draft unit, indoors
$B_R = 2Q_P\ (Effy_{U,R})\ (A_R)/100{,}000$
100,000 = conversion factor accounting for percent and 1,000 Btu/kBtu
341,200 = conversion factor accounting for percent and 3,412 Btu/h/kW
$y_{P,R} = 1 + (t_p/t_{ON,R})$ for two-stage and step modulating boilers with post purge
$PE_R$ = as defined in section 8.2 of this appendix and measured at the reduced fuel input rate
$y_{IG,R} = t_{IG}/t_{ON,R}$
$PE_{IG}$ = as defined in section 8.3 of this appendix
$y_R = 1 + (t^+)/t_{ON,R}$ for two-stage and step modulating boilers with fan delay
$BE_R$ = as defined in section 8.2 of this appendix and measured at the reduced fuel input rate
$Q_{IN,R}$ = as defined in Section 11.4.8.1.2 of ANSI/ASHRAE 103–2017
$Q_P$ = as defined in Section 11.4.12 of ANSI/ASHRAE 103–2017
$Effy_{U,R}$ = as defined in Section 11.4.11.1 or 11.5.11.1 of ANSI/ASHRAE 103–2017, and calculated on the basis of:
Indoor installation, for non-weatherized boilers; or
outdoor installation, for boilers that are weatherized.
$Eff_{motor}$ = nameplate power burner motor efficiency provided by the manufacturer,
= 0.50, an assumed default power burner efficiency if not provided by the manufacturer.

10.2.1.3 For boilers equipped with two-stage controls, the national average number of burner operating hours at the maximum operating mode ($BOH_H$) is defined as:

$BOH_H = X_H\ (2080)(0.77)[(Q_{OUT}/1{,}000)/(1 + \alpha)](A_H) - 2080(B_H)$

Where:

$X_H$ = as defined in Section 11.4.8.5 of ANSI/ASHRAE 103–2017
2080 = as defined in section 10.2.1.1 of this appendix
0.77 = as defined in section 10.2.1.1 of this appendix
$Q_{OUT}$ = as defined in Section 11.4.8.1.1 or 11.5.8.1.1 of ANSI/ASHRAE 103–2017
$\alpha$ = as defined in Section 11.4.8.2 of ANSI/ASHRAE 103–2017
$A_H = 100{,}000/[341{,}200(y_{P,H}PE_H + y_{IG,H}PE_{IG} + y_HBE_H) + (Q_{IN,H} - Q_P)\ Effy_{U,H}]$ for forced draft unit, indoors; and
$= 100{,}000/[341{,}200(y_{P,H}PE_H\ (1 - Eff_{motor}) + y_{IG,H}PE_{IG} + y_HBE_H) + (Q_{IN,H} - Q_P)\ Effy_{U,H}]$ for induced draft unit, indoors
$B_H = 2Q_P\ (Effy_{U,H})\ (A_H)/100{,}000$
100,000 = conversion factor accounting for percent and 1,000 Btu/kBtu
341,200 = conversion factor accounting for percent and 3412 Btu/h/kW
$y_{P,H} = 1 + (t_p/t_{ON,H})$ for two-stage and step modulating boilers with post purge
$PE_H$ = as defined in section 8.2 of this appendix and measured at the maximum fuel input rate
$y_{IG,H} = t_{IG}/t_{ON,H}$
$PE_{IG}$ = as defined in section 8.3 of this appendix
$y_H = 1 + (t^+)/t_{ON,H}$ for two-stage and step modulating boilers with fan delay
$BE_H$ = as defined in section 8.2 of this appendix and measured at the maximum fuel input rate
$Q_{IN,H}$ = as defined in Section 11.4.8.1.1 of ANSI/ASHRAE 103–2017
$Q_P$ = as defined in Section 11.4.12 of ANSI/ASHRAE 103–2017
$Effy_{U,H}$ = as defined in Section 11.4.11.2 or 11.5.11.2 of ANSI/ASHRAE 103–2017, and calculated on the basis of:
indoor installation, for non-weatherized boilers; or
outdoor installation, for boilers that are weatherized.
$Eff_{motor}$ = nameplate power burner motor efficiency provided by the manufacturer,
= 0.50, an assumed default power burner efficiency if not provided by the manufacturer.

10.2.1.4 For boilers equipped with step-modulating controls, the national average number of burner operating hours at the modulating operating mode ($BOH_M$) is defined as:

$BOH_M = X_H\ (2080)(0.77)[(Q_{OUT}/1{,}000)/(1+\alpha)](A_M) - 2080(B_M)$

Where:

$X_H$ = as defined in Section 11.4.8.5 of ANSI/ASHRAE 103–2017
2080 = as defined in section 10.2.1.1 of this appendix
0.77 = as defined in section 10.2.1.1 of this appendix
$Q_{OUT}$ = as defined in Section 11.4.8.1.1 or 11.5.8.1.1 of ANSI/ASHRAE 103–2017
$\alpha$ = as defined in Section 11.4.8.2 of ANSI/ASHRAE 103–2017
$A_M = 100{,}000/[341{,}200(y_{P,H}PE_H + y_{IG,H}PE_{IG} + y_HBE_H) + (Q_{IN,M} - Q_P)\ Effy_{U,M}]$ for forced draft unit, indoors; and
$= 100{,}000/[341{,}200(y_{P,H}PE_H\ (1 - Eff_{motor}) + y_{IG,H}PE_{IG} + y_HBE_H) + (Q_{IN,M} - Q_P)\ Effy_{U,M}]$ for induced draft unit, indoors
$B_M = 2Q_P\ (Effy_{U,M})\ (A_M)/100{,}000$
100,000 = conversion factor accounting for percent and 1,000 Btu/kBtu
341,200 = conversion factor accounting for percent and 3412 Btu/h/kW
$y_{P,H} = 1 + (t_p/t_{ON,H})$ for two-stage and step modulating boilers with post purge
$PE_H$ = as defined in section 8.2 of this appendix and measured at the maximum fuel input rate
$y_{IG,H} = t_{IG}/t_{ON,H}$
$PE_{IG}$ = as defined in section 8.3 of this appendix
$y_H = 1 + (t^+)/t_{ON,H}$ for two-stage and step modulating boilers with fan delay
$BE_H$ = as defined in section 8.2 of this appendix and measured at the maximum fuel input rate
$Q_{IN,M} = (100)(Q_{OUT,M}/Effy_{SS,M})$
$Q_{OUT,M}$ = as defined in Section 11.4.8.9 or 11.5.8.9 of ANSI/ASHRAE 103–2017
$Effy_{SS,M}$ = value as defined in Section 11.4.8.7 or 11.5.8.7 of ANSI/ASHRAE 103–2017
$Q_P$ = as defined in Section 11.4.12 of ANSI/ASHRAE 103–2017
$Effy_{U,M}$ = as defined in Section 11.4.9.2.3 or 11.5.9.2.3 of ANSI/ASHRAE 103–2017, and calculated on the basis of:
indoor installation, for non-weatherized boilers; or
outdoor installation, for boilers that are weatherized.
$Eff_{motor}$ = nameplate power burner motor efficiency provided by the manufacturer,
= 0.50, an assumed default power burner efficiency if not provided by the manufacturer.

10.2.2 *Average annual fuel energy consumption for gas or oil fueled boilers.*

10.2.2.1 For 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 10.2.1.1 of this appendix
$Q_{IN}$ = as defined in Section 11.2.8.1 of ANSI/ASHRAE 103–2017

$Q_P$ = as defined in Section 11.2.11 of ANSI/ASHRAE 103–2017
8,760 = total number of hours per year.

10.2.2.2 For boilers equipped with either two-stage or step modulating controls, $E_F$ is defined as follows. For two-stage control:

$E_F = (BOH_H)(Q_{IN})+(BOH_R)(Q_{IN,R})+[8760-(BOH_H+BOH_R)]Q_P$

For step-modulating control:

$E_F = (BOH_M)(Q_{IN,M})+(BOH_R)(Q_{IN,R})+[8760-(BOH_H+BOH_R)]Q_P$

Where:

$BOH_H$ = as defined in section 10.2.1.3 of this appendix
$BOH_R$ = as defined in section 10.2.1.2 of this appendix
$BOH_M$ = as defined in section 10.2.1.4 of this appendix
$Q_{IN}$ = as defined in Section 11.2.8.1 of ANSI/ASHRAE 103–2017
$Q_{IN,R}$ = as defined in Section 11.4.8.1.2 of ANSI/ASHRAE 103–2017
$Q_{IN,M}$ = as defined in Section 10.2.1.4 of this appendix
8,760 = total number of hours per year
$Q_P$ = as defined in Section 11.2.11 of ANSI/ASHRAE 103–2017.

10.2.3 *Average annual auxiliary electrical energy consumption for gas or oil-fueled boilers.*

10.2.3.1 For boilers equipped with single-stage controls, the average annual auxiliary electrical consumption ($E_{AE}$) is expressed in kilowatt-hours and defined as:

$E_{AE} = BOH_{SS}\ (y_P\ PE + y_{IG}\ PE_{IG} + yBE) + E_{SO}$

Where:

$BOH_{SS}$ = as defined in section 10.2.1.1 of this appendix
$y_P$ = as defined in section 10.2.1.1 of this appendix
PE = as defined in section 10.2.1.1 of this appendix
$y_{IG}$ = as defined in section 10.2.1.1 of this appendix
$PE_{IG}$ = as defined in section 10.2.1.1 of this appendix
y = as defined in section 10.2.1.1 of this appendix
BE = as defined in section 10.2.1.1 of this appendix
$E_{SO}$ = as defined in section 10.7 of this appendix.

10.2.3.2 For boilers equipped with two-stage controls, $E_{AE}$ is defined as:

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

Where:

$BOH_R$ = as defined in section 10.2.1.2 of this appendix
$y_{P,R}$ = as defined in section 10.2.1.2 of this appendix
$PE_R$ = as defined in section 8.2 of this appendix and measured at the reduced fuel input rate
$y_{IG,R}$ = as defined in section 10.2.1.2 of this appendix
$PE_{IG}$ = as defined in section 10.2.1.1 of this appendix
$y_R$ = as defined in section 10.2.1.2 of this appendix
$BE_R$ = as defined in section 8.2 of this appendix and measured at the reduced fuel input rate
$BOH_H$ = as defined in section 10.2.1.3 of this appendix
$PE_H$ = as defined in section 8.2 of this appendix and measured at the maximum fuel input rate
$y_{P,H}$ = as defined in section 10.2.1.3 of this appendix
$y_{IG,H}$ = as defined in section 10.2.1.3 of this appendix
$BE_H$ = as defined in section 8.2 of this appendix and measured at the maximum fuel input rate
$y_H$ = as defined in section 10.2.1.3 of this appendix
$E_{SO}$ = as defined in section 10.7 of this appendix.

10.2.3.3 For boilers equipped with step-modulating controls, $E_{AE}$ is defined as:

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

Where:

$BOH_R$ = as defined in section 10.2.1.2 of this appendix
$y_{P,R}$ = as defined in section 10.2.1.2 of this appendix
$PE_R$ = as defined in section 8.2 of this appendix and measured at the reduced fuel input rate
$y_{IG,R}$ = as defined in section 10.2.1.2 of this appendix
$PE_{IG}$ = as defined in section 10.2.1 of this appendix
$y_R$ = as defined in section 10.2.1.2 of this appendix
$BE_R$ = as defined in section 8.2 of this appendix and measured at the reduced fuel input rate
$BOH_M$ = as defined in 10.2.1.4 of this appendix
$y_{P,H}$ = as defined in section 10.2.1.3 of this appendix
$PE_H$ = as defined in section 8.2 of this appendix and measured at the maximum fuel input rate
$y_{IG,H}$ = as defined in section 10.2.1.3 of this appendix
$y_H$ = as defined in section 10.2.1.3 of this appendix
$BE_H$ = as defined in section 8.2 of this appendix and measured at the maximum fuel input rate
$E_{SO}$ = as defined in section 10.7 of this appendix.

10.3 *Average annual electric energy consumption for electric boilers.* For electric boilers, the average annual electrical energy consumption ($E_E$) is expressed in kilowatt-hours and defined as:

$E_E = 100\ (2{,}080)\ (0.77)\ [Q_{OUT}/(1+\alpha)]/(3412\ AFUE) + E_{SO}$

Where:

100 = to express a percent as a decimal
2,080 = as defined in section 10.2.1.1 of this appendix
0.77 = as defined in section 10.2.1.1 of this appendix
$Q_{OUT}$ = as defined in Section 11.2.8 of ANSI/ASHRAE 103–2017
$\alpha$ = as defined in Section 11.2.8.2 of ANSI/ASHRAE 103–2017
3412 = conversion factor from kilowatt-hours to Btu
AFUE = as defined in Section 11.1 of ANSI/ASHRAE 103–2017, in percent, and calculated on the basis of:
indoor installation, for non-weatherized boilers; or
outdoor installation, for boilers that are weatherized.
$E_{SO}$ = as defined in section 10.7 of this appendix.

10.4 *Energy factor.*

10.4.1 *Energy factor for gas or oil boilers.* Calculate the energy factor, EF, for gas or oil 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 10.2.2 of this appendix
4,600 = as defined in Section 11.4.12 of ANSI/ASHRAE 103–2017
$Q_P$ = pilot fuel input rate determined in accordance with Section 9.2 of ANSI/ASHRAE 103–2017 in Btu/h
$Effy_{HS}$ = annual fuel utilization efficiency as defined in Sections 11.2.11, 11.3.11, 11.4.11 or 11.5.11 of ANSI/ASHRAE 103–2017, in percent, and calculated on the basis of:
indoor installation, for non-weatherized boilers; or
outdoor installation, for boilers that are weatherized.
3,412 = conversion factor from kW to Btu/h
$E_{AE}$ = as defined in section 10.2.3 of this appendix.

10.4.2 *Energy factor for electric boilers.* The energy factor, EF, for electric boilers is defined as:

EF = AFUE

Where:

AFUE = annual fuel utilization efficiency as defined in section 10.3 of this appendix, in percent.

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

10.5.1 *Average annual fuel energy consumption for gas or oil-fueled boilers located in a different geographic region of the United States and in buildings with different design heating requirements.* For gas or oil-fueled 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 10.2.2 of this appendix
8,760 = as defined in section 10.2.2 of this appendix
$Q_P$ = as defined in Section 11.2.11 of ANSI/ASHRAE 103–2017
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 10.2.1.1 of this appendix.

10.5.2 *Average annual auxiliary electrical energy consumption for gas or oil-fueled boilers located in a different geographic region of the United States and in buildings with different design heating requirements.* For gas or oil-fueled 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 10.2.3 of this appendix

$E_{SO}$ = as defined in section 10.7 of this appendix

HLH = as defined in section 10.5.1 of this appendix

2,080 = as defined in section 10.2.1.1 of this appendix

$E_{SOR}$ = as defined in section 10.5.3 of this appendix.

10.5.3 *Average annual electric energy consumption for electric boilers located in a different geographic region of the United States and in buildings with different design heating requirements.* For electric 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 defined in section 10.2.3 of this appendix

0.77 = as defined in section 10.2.1.1 of this appendix

$Q_{OUT}$ = as defined in Section 11.2.8.1 of ANSI/ASHRAE 103–2017

$\alpha$ = as defined in Section 11.2.8.2 of ANSI/ASHRAE 103–2017

HLH = as defined in section 10.5.1 of this appendix

3.412 = as defined in section 10.2.3 of this appendix

AFUE = as defined in section 10.2.3 of this appendix

$E_{SOR} = E_{SO}$ as defined in section 10.7 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.

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

10.7 *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:

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

Where:

$P_{W,SB}$ = boiler standby mode power, in watts, as measured in section 8.9.1 of this appendix

4,160 = average heating season hours per year

BOH = total burner operating hours as calculated in section 10.2 of this appendix for gas or oil-fueled boilers. Where for gas or oil-fueled boilers equipped with single-stage controls, $BOH = BOH_{SS}$; for gas or oil-fueled boilers equipped with two-stage controls, $BOH = (BOH_R + BOH_H)$; and for gas or oil-fueled boilers equipped with step-modulating controls, $BOH = (BOH_R + BOH_M)$. For electric boilers, $BOH = 100(2080)(0.77)[Q_{OUT}/(1+\alpha)]/(E_{in}\ 3412(AFUE))$

4,600 = as defined in Section 11.4.12 of ANSI/ASHRAE 103–2017

$P_{W,OFF}$ = boiler off mode power, in watts, as measured in section 8.9.2 of this appendix

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

Where:

100 = to express a percent as a decimal

2,080 = as defined in section 10.2.1.1 of this appendix

0.77 = as defined in section 10.2.1.1 of this appendix

$Q_{OUT}$ = as defined in Section 11.2.8 of ANSI/ASHRAE 103–2017

$\alpha$ = as defined in Section 11.2.8.2 of ANSI/ASHRAE 103–2017

$E_{in}$ = steady-state electric rated power, in kilowatts, from Section 9.3 of ANSI/ASHRAE 103–2017

3412 = as defined in section 10.3 of this appendix

AFUE = as defined in Section 11.1 of ANSI/ASHRAE 103–2017 in percent.

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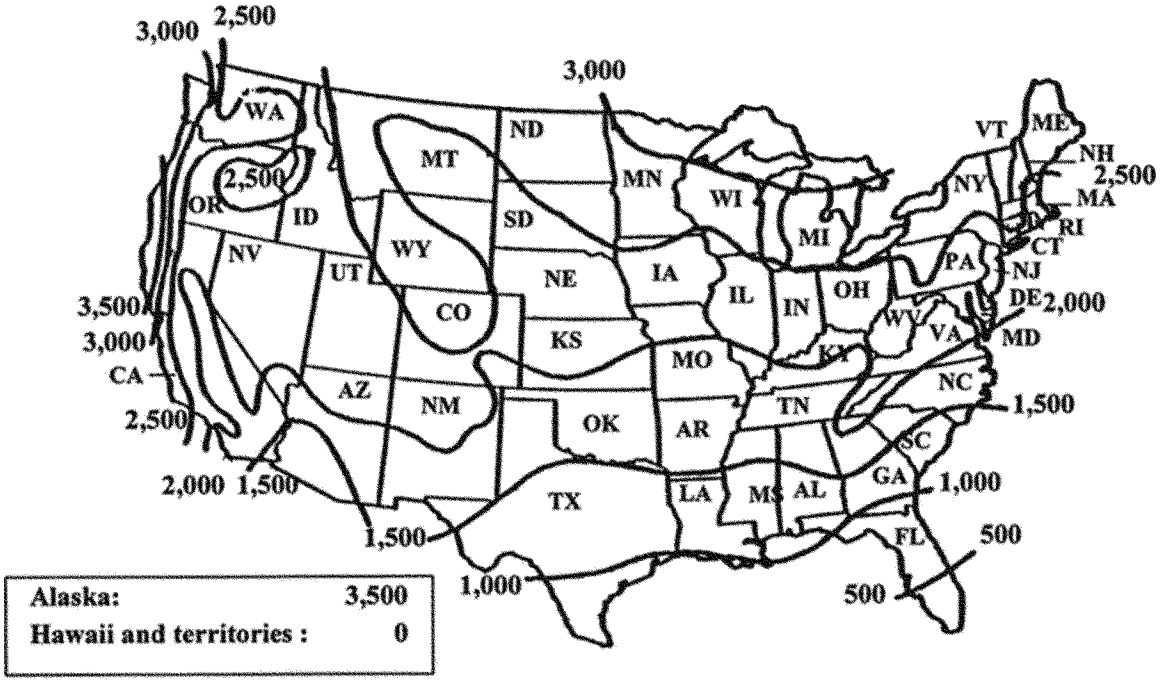


**This map is reasonably accurate for most parts of the United States but is necessarily generalized, and consequently not too accurate in mountainous regions, particularly in the rockies.**

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

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