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DEPARTMENT OF ENERGY

10 CFR Parts 429 and 431

[Docket Number EERE-2014-BT-TP-0006]

RIN 1904-AD16

Energy Conservation Program for Certain Commercial and Industrial Equipment: Test Procedures for Commercial Packaged Boilers

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

ACTION: Notice of proposed rulemaking and public meeting.

SUMMARY: The U.S. Department of Energy (DOE) proposes to amend the test procedure and applicable definitions for commercial packaged boilers, as well as modify the sampling plans for commercial packaged boilers in its regulations pertaining to energy efficiency programs for certain programs for commercial and industrial equipment. This rulemaking will fulfill DOE's statutory obligations to make its test procedure consistent with the applicable industry test procedure and to review its test procedures for covered equipment at least once every seven years. In this notice of proposed rulemaking (NOPR), DOE proposes to incorporate by reference certain sections of the American National Standards Institute (ANSI)/Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standard 1500, "2015 Standard for Performance Rating of Commercial Space Heating Boilers," and, in addition, incorporate amendments that clarify the coverage for field-constructed commercial packaged boilers and the applicability of DOE's test

procedure and standards for this category of commercial packaged boilers, provide an optional field test for commercial packaged boilers with fuel input rate greater than 5,000,000 Btu/h, provide a conversion method to calculate thermal efficiency based on combustion efficiency testing for steam commercial packaged boilers with fuel input rate greater than 5,000,000 Btu/h, modify the inlet and outlet water temperatures during tests of hot water commercial packaged boilers, establish limits on the ambient temperature and relative humidity conditions during testing, modify setup and instrumentation requirements to remove ambiguity, and standardize terminology and provisions for "fuel input rate." This NOPR also announces a public meeting to discuss and invite comments, data, and information about the issues and proposed amendments presented in this test procedure rulemaking for commercial packaged boilers.

DATES: Meeting: DOE will hold a public meeting on Monday, April 4, 2016, from 10 a.m. to 3 p.m., in Washington, DC. The meeting will also be broadcast as a webinar. See section V, "Public Participation," for webinar registration information, participant instructions, and information about the capabilities available to webinar participants.

Comments: DOE will accept written comments, data, and information regarding this NOPR before and after the public meeting, but not later than **[INSERT DATE 75 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]**. See section V, "Public Participation," for details.

ADDRESSES: The public meeting will be held at the U.S. Department of Energy, Forrestal Building, Room 6E-069, 1000 Independence Avenue, SW., Washington, DC 20585-0121.

Persons may also attend the public meeting via webinar. To attend, please notify Ms. Brenda Edwards at (202) 586-2945. For more information, refer to section V, "Public Participation," near the end of this notice.

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

- Federal eRulemaking Portal: www.regulations.gov. Follow the instructions for submitting comments.
- E-mail: CommPackagedBoilers2014TP0006@ee.doe.gov. Include docket number EERE-2014-BT-TP-0006 and/or regulation identifier number (RIN) 1904-AD16 in the subject line of the message. Submit electronic comments in WordPerfect, Microsoft Word, PDF, or ASCII file format, and avoid the use of special characters or any form of encryption.
- Postal Mail: Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Office, Mailstop EE-5B, Test Procedure for Commercial and Industrial Packaged Boilers, Docket No.EERE-2014-BT-TP-0006 and/or RIN 1904-AD16, 1000 Independence Avenue, SW., Washington, DC 20585-0121. If possible, please submit all items on a compact disc (CD), in which case it is not necessary to include printed copies.
- Hand Delivery/Courier: Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Office, 950 L'Enfant Plaza, SW., Suite 600, Washington, DC 20024.

Telephone: (202) 586-2945. If possible, please submit all items on a CD, in which case it is not necessary to include printed copies.

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

Docket: The docket, which includes Federal Register notices, public meeting attendee lists and transcripts, 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, not all documents listed in the index may be publicly available, such as those containing information that is exempt from public disclosure.

A link to the docket webpage can be found at: http://www.regulations.gov/#!docketDetail;D=EERE-2014-BT-TP-0006. This webpage contains a link to the docket for this NOPR on the www.regulations.gov site. The www.regulations.gov webpage contains simple instructions on how to access all documents, including public comments, in the docket. See section V, "Public Participation," for information on how to submit comments through www.regulations.gov.

FOR FURTHER INFORMATION CONTACT:

Mr. James Raba, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Office, EE-5B, 1000 Independence Avenue, SW.,

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

SUPPLEMENTARY INFORMATION:

This proposed rule would incorporate by reference into 10 CFR parts 429 and 431 the testing methods contained in the following commercial standard:

AHRI/ANSI Standard 1500-2015, "Performance Rating of Commercial Space Heating Boilers," Section 3 "Definitions," Section 5 "Rating Requirements," Appendix C "Methods of Testing for Rating Commercial Space Heating Boilers – Normative," excluding Figures C5 and C7, Appendix D "Properties of Saturated Steam – Normative," and Appendix E "Correction Factors for Heating Values of Fuel Gases – Normative," ANSI approved November 28, 2014.

Copies of AHRI standards may be purchased from the Air-Conditioning, Heating, and Refrigeration Institute, 2111 Wilson Blvd., Suite 500, Arlington, VA 22201, or by visiting http://www.ahrinet.org/site/686/Standards/HVACR-Industry-Standards/Search-Standards.

See section IV.M for additional information on this standard.

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I. Authority and Background

Title III of the Energy Policy and Conservation Act of 1975 (42 U.S.C. 6311, et seq.; "EPCA" or, "the Act") sets forth a variety of provisions designed to improve energy efficiency.[1] Part C of Title III establishes the "Energy Conservation Program for Certain Industrial Equipment," which covers certain industrial equipment (hereafter referred to as "covered equipment"), including commercial packaged boilers.[2] (42 U.S.C. 6311(1)(J))

Under EPCA, the energy conservation program consists essentially of four parts: (1) testing, (2) labeling, (3) Federal energy conservation standards, and (4) certification and enforcement procedures. The testing requirements consist of test procedures that manufacturers of covered equipment must use as the basis for (1) certifying to the Department of Energy (DOE) that their equipment complies with applicable energy conservation standards adopted under

[1]All references to EPCA in this document refer to the statute as amended through the Energy Efficiency Improvement Act of 2015 (April 30, 2015).
[2]For editorial reasons, Part C was codified as Part A-1 in the U.S. Code.

EPCA, and (2) making representations about the efficiency of the equipment. Similarly, DOE must use these test procedures to determine whether the equipment complies with any relevant standards promulgated under EPCA.

With respect to commercial packaged boilers (CPB), EPCA requires DOE to use industry test procedures developed or recognized by the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) or the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), as referenced in ASHRAE/IES[3] Standard 90.1, "Energy Standard for Buildings Except Low-Rise Residential Buildings." (42 U.S.C. 6314(a)(4)(A)) Further, if such an industry test procedure is amended, DOE is required to amend its test procedure to be consistent with the amended industry test procedure, unless it determines, by rule published in the Federal Register and supported by clear and convincing evidence, that the amended test procedure would be unduly burdensome to conduct or would not produce test results that reflect the energy efficiency, energy use, and estimated operating costs of that equipment during a representative average use cycle. (42 U.S.C. 6314(a)(4)(B))

EPCA also requires that, at least once every 7 years, DOE evaluate test procedures for each type of covered equipment, including commercial packaged boilers, 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. (42 U.S.C. 6314(a)(1)(A)) DOE last reviewed the test

[3] Illuminating Engineering Society.

procedures for commercial packaged boilers on July 22, 2009. 74 FR 36312. Therefore, DOE is required to re-evaluate the test procedures no later than July 22, 2016, and this rulemaking satisfies that requirement. As the industry standard for commercial packaged boilers was recently updated, this rulemaking will also fulfill DOE's statutory obligations to make its test procedure consistent with the applicable industry test procedure.

On September 3, 2013, DOE initiated a test procedure and energy conservation standards rulemaking for commercial packaged boilers and published a notice of public meeting and availability of the Framework document (September 2013 Framework document). 78 FR 54197. Both in the September 2013 Framework document and during the October 1, 2013 public meeting, DOE solicited public comments, data, and information on all aspects of, and any issues or problems with, the existing DOE test procedure, including whether the test procedure is in need of updates or revisions. More recently, DOE also received comments on the test procedure in response to the notice of availability of the preliminary technical support document (TSD) for the standards rulemaking, which was published in the Federal Register on November 20, 2014 (November 2014 Preliminary Analysis). 79 FR 69066.

Additionally, on February 20, 2014, DOE published in the Federal Register a request for information (February 2014 RFI) seeking comments on the existing DOE test procedure for commercial packaged boilers, which incorporates by reference Hydronics Institute (HI)/AHRI Standard BTS–2000 (Rev 06.07), "Method to Determine Efficiency of Commercial Space Heating Boilers" (BTS–2000). 79 FR 9643. BTS–2000 provides test procedures for measuring steady-state combustion and thermal efficiency of a gas-fired or oil-fired commercial packaged

boiler capable of producing hot water and/or steam and operating at full load only. In the February 2014 RFI, DOE requested comments, information, and data about a number of issues, including (1) part-load testing and part-load efficiency rating, (2) typical inlet and outlet water temperatures for hot water commercial packaged boilers, (3) the steam pressure for steam commercial packaged boilers operating at full load, and (4) design characteristics of commercial packaged boilers that are difficult to test under the existing DOE test procedure.

Subsequently, on April 29, 2015, AHRI, together with the American National Standards Institute (ANSI), published the "2015 Standard for Performance Rating of Commercial Space Heating Boilers" (ANSI/AHRI Standard 1500-2015). ANSI/AHRI Standard 1500-2015 states "this standard supersedes AHRI Hydronics Institute Standard BTS-2000 Rev. 06.07" in the front matter of the document. DOE believes that ANSI/AHRI Standard 1500-2015 is consistent with the existing metrics and approach incorporated in BTS-2000 but also incorporates provisions that improve the accuracy and repeatability of the test procedure over the BTS–2000 standard. ANSI/AHRI Standard 1500-2015 also adopts several changes that were suggested in public comments submitted by interested parties in response to DOE's September 2013 Framework document, November 2014 Preliminary Analysis, and February 2014 RFI.[4] Therefore, as required by 42 U.S.C. 6314(a)(4)(B), DOE is replacing BTS-2000 with the updated industry standard, ANSI/AHRI Standard 1500-2015, as the basis for the DOE test procedure. Section

[4] Comments received as part of the February 2014 RFI about test procedures for commercial packaged boilers are in Docket Number EERE-2014-BT-TP-0006. In some cases, earlier comments that address or are relevant to test procedures for commercial packaged boilers are in the energy conservation standards docket, Docket Number EERE-2013-BT-STD-0030. These comments in response to the September 2013 Framework Document relevant to the test procedure are also placed in the test procedure rulemaking docket, Docket Number EERE-2014-BT-TP-0006

III.A contains a more detailed discussion of the basis for transitioning to the commercial packaged boiler test procedures outlined in ANSI/AHRI Standard 1500-2015.

II. Synopsis of the Notice of Proposed Rulemaking

In this notice of proposed rulemaking (NOPR), DOE proposes to amend its existing test procedures for commercial packaged boilers at 10 CFR 431.86. DOE proposes to incorporate by reference certain sections of ANSI/AHRI Standard 1500-2015 as a direct replacement for BTS–2000 since, as discussed in section I, ANSI/AHRI Standard 1500-2015 supersedes BTS–2000 and DOE has found ANSI/AHRI Standard 1500-2015 to be more accurate compared to BTS-2000 and not unduly burdensome to conduct for the purposes of testing commercial packaged boilers.

To obtain information and data regarding its current test procedures for commercial packaged boilers, DOE sought public comment in the September 2013 Framework document, February 2014 RFI, and November 2014 Preliminary Analysis. In response to the September 2013 Framework document, DOE received comments from the American Boiler Manufacturers Association (ABMA), AHRI, Burnham Holdings (Burnham), Cleaver-Brooks, HTP Incorporated (HTP), and a joint submission[5] from the American Council for an Energy-Efficient Economy (ACEEE), the Appliance Standards Awareness Project (ASAP), and the National Resources Defense Council (NRDC). In response to the February 2014 RFI, DOE received comments from ACEEE, AHRI, Burnham, HTP, the National Propane Gas Association (NPGA), and Sidel

[5] The joint submission by ACEEE, ASAP, and NRDC is referred to as the "Joint Advocates" comment in references to the documents submitted to the docket.

Systems (Sidel) (three submittals). Sidel submitted two comments prior to the publication of the February 2014 RFI that also pertain to commercial packaged boilers. In response to the November 2014 Preliminary Analysis, DOE received comments from ABMA, AHRI, Lochinvar LLC (Lochinvar), Raypak, and joint submissions[6] from Pacific Gas and Electric (PGE) and Southern California Edison (SCE), and ACEEE, ASAP, and NRDC.

The comments received from stakeholders typically concern BTS–2000 since ANSI/AHRI Standard 1500-2015 had not yet been published at the time DOE solicited comments. Some of the comments received from stakeholders that concerned BTS–2000 apply equally to ANSI/AHRI Standard 1500-2015, whereas other comments are not applicable to ANSI/AHRI Standard 1500-2015.

ANSI/AHRI Standard 1500-2015 updates several provisions from BTS–2000 to: (1) improve repeatability of testing; (2) further clarify the test procedure; and (3) increase the allowable operating steam pressure during steam commercial packaged boiler testing. ANSI/AHRI Standard 1500-2015 also incorporates provisions that accommodate the testing of large commercial packaged boilers that have difficulty meeting the requirements in the existing DOE test procedure.

In addition to adopting ANSI/AHRI Standard 1500-2015 as a replacement for BTS–2000 in the DOE test procedure, DOE further proposes several modifications to its test procedure that

[6] The joint submission by PGE and SCE is referred to as the "Joint Utilities" comment in references to the documents submitted to the docket.

are not captured in ANSI/AHRI Standard 1500-2015. The additional proposed amendments include the following:

- clarifying the coverage of field constructed commercial packaged boilers under DOE's regulations;
- incorporating an optional field test for commercial packaged boilers with fuel input rate greater than 5,000,000 Btu/h;
- incorporating an optional conversion method to calculate thermal efficiency based on combustion efficiency test for steam commercial packaged boilers with fuel input rate greater than 5,000,000 Btu/h;
- modifying the inlet and outlet water temperatures required during tests of hot water commercial packaged boilers to be more representative of field conditions;
- requiring additional limits on the room ambient temperature and relative humidity during testing;
- modifying setup and instrumentation requirements to remove ambiguity; and
- standardizing terminology and provisions in regulatory text related to "fuel input rate."

These proposed amendments are intended to improve the repeatability of the test and to accommodate some commercial packaged boilers for which testing has previously been difficult or burdensome. DOE reviewed these additional proposed amendments as well as the proposal to incorporate by reference ANSI/AHRI Standard 1500-2015 under 42 U.S.C. 6314(a)(4)(C) and, in aggregate, DOE has tentatively concluded that there would not be an overall effect on efficiency ratings. Accordingly, DOE proposes that the amended test procedure would be

effective 30 days after publication of any final rule in the Federal Register and would be required for any representations made with regard to the energy efficiency of commercial packaged boilers 360 days following publication of any final rule in the Federal Register. (42 U.S.C. 6314(d)) DOE's rationale regarding the impact of the proposed test procedure amendments on measured energy efficiency of commercial packaged boilers is discussed in the subsequent sections.

III. Discussion

Based on DOE's review of the existing test procedure for commercial packaged boilers and comments submitted by interested parties, DOE has determined that certain amendments and clarifications are necessary in order to improve the repeatability of the DOE test procedure, accommodate certain commercial packaged boilers for which manufacturers have expressed difficulty testing under the provisions of the existing test procedure, and clarify the applicability of DOE's test procedure and energy conservation standards to field-constructed equipment. The following sections address comments received and propose specific improvements for DOE's test procedures for commercial packaged boilers.

A. Proposing to Adopt Certain Sections of ANSI/AHRI Standard 1500-2015

The existing DOE test procedure for commercial packaged boilers incorporates by reference BTS–2000 to determine the steady-state efficiency of steam or hot water commercial packaged boilers while operating at full load. As described in section I, on April 29, 2015, AHRI published a new ANSI/AHRI Standard 1500-2015 (ANSI approved November 28, 2014),

which supersedes BTS-2000. On May 29, 2015, AHRI submitted a request directly to DOE to update the incorporation by reference in the DOE test procedure to reference the new ANSI/AHRI Standard 1500-2015. (Docket EERE-2014-BT-TP-0006, AHRI, No. 29 at p. 1)[7] DOE reviewed both documents and DOE believes that the recently published ANSI/AHRI Standard 1500-2015 standard is not unduly burdensome to conduct and represents an improvement over BTS–2000 while retaining the general testing methodology and metrics (i.e., thermal and combustion efficiency) of the existing test procedure.[8]

Specifically, ANSI/AHRI Standard 1500-2015 contains the following key substantive changes as compared to BTS-2000:

- improvements in instrumentation accuracy specifications, including removing outdated instrumentation; use of more appropriate measurement units; and revising gas chemistry instrumentation accuracy requirements to reflect those of commonly used devices;
- more specific instructions for establishing test procedure configuration, particularly for water piping and positioning of temperature measurement devices in fluid stream;
- establishment of criteria that indicate when a steady-state condition is met;[9]
- allowance of steam operating pressure up to 15 psig; and

[7] A notation in this form provides a reference for information that is in Docket No. EERE-2014-BT-TP-0006. This particular notation refers to a comment from AHRI on p. 1 of document number 29 in the docket.
[8] Thermal efficiency is measured for all commercial packaged boilers except for oil-fired and gas-fired commercial packaged boilers that provide hot water and have greater than 2,500,000 Btu/h in fuel input rate, for which combustion efficiency is used. See 10 CFR 431.87(b).
[9] BTS 2000 noted in section 9.1.1.1.6 that "a state of equilibrium shall have been reached when consistent readings are obtained during a 30 minute period," but did not explicitly define what "consistent" meant. ANSI/AHRI Standard 1500-2015 incorporates specific thresholds for steam pressure and percent CO_2 or O_2 in the flue gas to specify the maximum allowable fluctuations that may occur during "steady-state" operation.

- instructions addressing how to conduct testing when manufacturers do not provide sufficient information within their installation materials shipped with the commercial packaged boiler.

DOE notes that several of the changes incorporated into ANSI/AHRI Standard 1500-2015 were also suggested by interested parties in public comments responding to DOE's September 2013 Framework document, November 2014 Preliminary Analysis, and February 2014 RFI.

DOE seeks comment on its proposal to replace BTS–2000 with ANSI/AHRI Standard 1500-2015 in its test procedure for commercial packaged boilers. This is identified as Issue 1 in section V.E.

B. Scope and Definitions

DOE proposes to incorporate several new definitions that help clarify the scope and applicability of DOE's commercial packaged boiler test procedure. DOE notes that any changes or amendments to DOE's definitions at 10 CFR 431.82, if adopted, would also apply to DOE's energy conservation standards for commercial packaged boilers.

1. Definition of Commercial Packaged Boiler

While EPCA authorizes DOE to establish, subject to certain criteria, test procedures and energy conservation standards for packaged boilers, to date, DOE has only established test procedures and standards for commercial packaged boilers, a subset of packaged boilers. In

2004, DOE published a final rule (October 2004 final rule) establishing definitions, test procedures, and energy conservation standards for commercial packaged boilers. 69 FR 61949 (Oct. 21, 2004). In the October 2004 final rule, DOE defined "commercial packaged boiler" as a type of packaged low pressure boiler that is industrial equipment with a capacity (fuel input rate) of 300,000 Btu per hour (Btu/h) or more which, to any significant extent, is distributed in commerce: (1) for heating or space conditioning applications in buildings; or (2) for service water heating in buildings but does not meet the definition of "hot water supply boiler." DOE also defined "packaged low pressure boiler" as a packaged boiler that is: (1) a steam boiler designed to operate at or below a steam pressure of 15 psig; or (2) a hot water commercial packaged boiler designed to operate at or below a water pressure of 160 psig and a temperature of 250 °F; or (3) a boiler that is designed to be capable of supplying either steam or hot water, and designed to operate under the conditions in paragraphs (1) and (2) of this definition. 69 FR 61960.

DOE notes that, because commercial packaged boilers are currently defined as a subset of packaged low pressure boilers, all commercial packaged boilers have to meet the pressure and temperature criteria established in the definition of a "packaged low pressure boiler." Consequently, DOE is proposing to modify DOE's definition of "commercial packaged boiler" to explicitly include the pressure and temperature criteria established by the "packaged low pressure boiler" definition. DOE believes such a modification will clarify the characteristics of the equipment to which DOE's test procedure and energy conservation standards apply. As a result, DOE proposes to remove its definition for packaged low pressure boiler, as it is no longer necessary. DOE notes that the term "packaged high pressure boiler" also is no longer used in the

commercial packaged boiler subpart, and therefore proposes to remove its definition. DOE seeks comment on these proposals. This is identified as Issue 2 in section V.E.

2. Field-Constructed Commercial Packaged Boilers

EPCA establishes the statutory authority by which DOE may regulate "packaged boilers" and defines a "packaged boiler" as a boiler that is shipped complete with heating equipment, mechanical draft equipment, and automatic controls; usually shipped in one or more sections. (42 U.S.C. 6311(11)(B)) In adopting the EPCA definition for a "packaged boiler," DOE amended the definition to: (1) include language to address the various ways in which packaged boilers are distributed in commerce; and (2) explicitly exclude custom-designed, field-constructed boilers. 69 FR 61949, 61952. "Custom-designed, field-constructed" boilers were excluded because DOE believed the statutory standards for "packaged boilers" were not intended to apply to these boiler systems, which generally require alteration, cutting, drilling, threading, welding or similar tasks by the installer. As a result, DOE defined a "packaged boiler" as a boiler that is shipped complete with heating equipment, mechanical draft equipment and automatic controls; usually shipped in one or more sections and does not include a boiler that is custom designed and field constructed. If the boiler is shipped in more than one section, the sections may be produced by more than one manufacturer, and may be originated or shipped at different times and from more than one location. 10 CFR 431.82.

In this NOPR, DOE wishes to further clarify the differentiation between field-constructed commercial packaged boilers, which are excluded from DOE's commercial packaged boiler regulations, and field-assembled commercial packaged boilers, which are subject to DOE's

regulations. A field-constructed commercial packaged boiler is a custom-designed commercial packaged boiler that requires welding of structural components in the field during installation. Specifically, DOE considers structural components to include heat exchanger sections, flue tube bundles and internal heat exchanger surfaces, external piping to one or more heat exchanger sections or locations, and the mechanical supporting structure the heat exchanger rests upon in the case where a support structure is not provided with the commercial packaged boiler. For the purposes of this clarification, welding does not include attachment using mechanical fasteners or brazing; and any jackets, shrouds, venting, burner, or burner mounting hardware are not structural components.

Conversely, a field-assembled commercial packaged boiler can be assembled in the field without the welding of the structural components that were previously listed. DOE reiterates that field-assembled equipment is covered, is required to be tested using the DOE test procedure, and is required to comply with the applicable energy conservation standards and certification requirements.

In this NOPR, DOE also proposes to clarify that the field-constructed exemption pertains to commercial packaged boilers specifically, not the broader definition of packaged boiler. Therefore, DOE proposes to remove this exclusionary language from its definition for “packaged boiler” and to incorporate the exclusion for field-constructed equipment into its definition for commercial packaged boiler.

DOE seeks comment on its proposed definition for "field-constructed" and this is identified as Issue 3 in section V.E.

C. Testing of Large Commercial Packaged Boilers

In response to the energy conservation standards September 2013 Framework document, Cleaver-Brooks, Burnham, and ABMA stated that for practical reasons, testing requirements should be limited to boilers with rated maximum input capacities less than 2,500,000 Btu/h. These commenters raised concerns regarding the time and expense of testing larger boilers, and the ability of some independent testing laboratories and manufacturers to test larger boilers due to heat sink requirements for the hot water generated. (Docket EERE-2013-BT-STD-0030, Cleaver-Brooks, No. 12 at p. 1; Docket EERE-2013-BT-STD-0030, Burnham, No. 15 at p. 2; Docket EERE-2013-BT-STD-0030, ABMA, No. 14 at p. 3) ABMA reiterated these concerns in response to the November 2014 Preliminary Analysis. (Docket EERE-2013-BT-STD-0030, ABMA, No. 33 at pp. 1–2) Lochinvar, in response to the November 2014 Preliminary Analysis, stated that alternative efficiency determination method (AEDM) rules mitigated test burden concerns for large boilers. (Docket EERE-2013-BT-STD-0030, Lochinvar, No. 34 at p. 1)

In response, DOE notes that neither the statutory definition for "packaged boiler" at 42 U.S.C. 6311(11)(B) nor the definition for "commercial packaged boiler" at 10 CFR 431.82 set an upper limit on the maximum fuel input rate of covered equipment. The energy conservation standards for commercial packaged boilers at 10 CFR 431.87 also do not establish any limitations based on the fuel input rate of equipment. Consequently, commercial packaged boiler models with high fuel input rates are subject to DOE's existing standards for commercial

packaged boilers, and to establish such a fuel input rate limit for covered equipment with existing standards would violate the anti-backsliding provisions of EPCA found at 42 U.S.C. 6313(a)(6)(B)(iii)(I) for those equipment larger than the limit. Additionally, both BTS-2000 (incorporated by reference in the existing DOE test procedure) and ANSI/AHRI Standard 1500-2015 (proposed to be incorporated by reference) include any commercial packaged boiler with fuel input rate of 300,000 Btu/h or greater.

DOE recognizes the commenters' concerns that it may be difficult to test thermal efficiency for large commercial packaged boilers and notes that EPCA requires that test procedures shall not be unduly burdensome to conduct. (42 U.S.C. 6314(a)(2)) Specifically, DOE recognizes that large commercial packaged boilers may not be fully assembled until they are installed at the field site, which may preclude them from being tested in a laboratory setting. DOE also recognizes that, as the size of the equipment increases, testing costs incurred to condition the incoming water and air to the test procedure rating conditions, as well as management of the hot water generated during testing, also increases.

In this NOPR, DOE proposes several amendments to the DOE test procedure in order to provide greater flexibility for testing certain large commercial packaged boilers and field-assembled commercial packaged boilers. Specifically, DOE proposes the following provisions:

- a field test of combustion efficiency for commercial packaged boilers with fuel input rate greater than 5,000,000 Btu/h;
- a calculation method to convert combustion efficiency to thermal efficiency for steam commercial packaged boilers with fuel input rate greater than 5,000,000 Btu/h; and

- an increase in allowable steam pressure to 15 psi (by incorporating by reference AHRI Standard 1500-2015).

DOE notes that the continued allowance for the use of an AEDM also facilitates the ability to ascertain the efficiency of large commercial packaged boilers. These proposed amendments for providing greater flexibility in the testing of large commercial packaged boilers are discussed in the following subsections.

1. Field Tests for Commercial Packaged Boilers

DOE proposes to adopt an optional test method for commercial packaged boilers with fuel input rate greater than 5,000,000 Btu/h which would allow for: (1) measuring a steam or hot water commercial packaged boiler's combustion efficiency in the field; and (2) converting the measured combustion efficiency to thermal efficiency via a calculation method for steam commercial packaged boilers (discussed in section III.C.2).

DOE understands "field test" to mean a combustion efficiency test that is conducted at the location in which a given commercial packaged boiler is or will be installed and commissioned for use. DOE understands that the combustion efficiency test is less burdensome to conduct on large commercial packaged boilers than the thermal efficiency test and is more feasible to conduct in the field than the thermal efficiency test. Specifically, the test setup required for obtaining the combustion efficiency according to ANSI/AHRI Standard 1500-2015 is less involved and requires less instrumentation in the working fluid stream (flow meters are not required) than the thermal efficiency test, and involves calculations using primarily the flue

gas temperature and constituents. The combustion efficiency test also requires less time to run than the thermal efficiency test and therefore requires less fuel and water, which must be managed and disposed of as part of the test. DOE believes that allowance for testing commercial packaged boilers with fuel input rates greater than 5,000,000 Btu/h in the field would reduce the burden associated with testing this equipment and would mitigate the concerns of interested parties regarding laboratory limitations. However, DOE notes that changes to the test procedure are necessary to account for the following issues associated with testing in the field:

- Ambient conditions in the field may be difficult to control (see section III.E of this NOPR).
- Setup requirements of thermal efficiency test (both ANSI/AHRI Standard 1500-2015 and proposed DOE test procedure amendments) may not be possible to achieve in field (see section III.F of this NOPR).
- Maintaining inlet and outlet water temperatures or steam quality (as applicable) may not be possible in the field (see section III.D of this NOPR).

Consequently, DOE proposes that the aforementioned requirements for ambient conditions, certain setup requirements, steam quality, and inlet and outlet water temperatures not apply for field tests. While DOE believes such flexibility is necessary to limit burden when testing large commercial packaged boilers in the field, DOE recognizes that eliminating these requirements regarding testing conditions may decrease the accuracy and repeatability of the test. As such, DOE is proposing that the optional field test only be available for commercial packaged boilers with fuel input rates greater than 5,000,000 Btu/h, for which testing in a laboratory setting is difficult, expensive, or impractical.

To help improve the consistency and repeatability of field tests, DOE also proposes that manufacturers measure these values (inlet water temperature, outlet water temperature, ambient relative humidity, and ambient temperature) and maintain the records of these measurements as part of the test data underlying the manufacturer's compliance certification in accordance with the requirements in 10 CFR 429.71. If a manufacturer elects to use the field test option in the test procedure, the manufacturer would also be required to report that the rated efficiency is based on a field test.

Since DOE proposes this optional methodology primarily to accommodate commercial packaged boilers with fuel input rate greater than 5,000,000 Btu/h, DOE proposes to allow certification based on a sample size of one for manufacturers utilizing the field test and conversion methodology. DOE has never intended that a manufacturer build more than one unit solely for the purposes of testing and clarified this during the Commercial Certification Working Group meetings (Docket No. EERE-2013-BT-NOC-0023). Additionally, 10 CFR 429.12(a) requires that certification of equipment occur before distribution in commerce. With respect to commercial packaged boilers that are not field assembled, distribution in commerce would be determined, similar to other covered equipment, using the factors specified in the certification, compliance, and enforcement final rule published on March 7, 2011. 76 FR 12422, 12426-12427. Any field tested basic model of a commercial packaged boiler that has not been previously certified through testing or an AEDM would be required to be certified by the manufacturer to DOE within 15 days of commissioning. (Note: by "commissioning," DOE means adapting the boiler operating conditions and parameters to those required for the building

space heating load.) DOE proposes to adopt this exception in recognition of the high test burden and practical limitations of testing these boilers prior to distributing them in commerce; however, DOE notes that, if the field test demonstrates that the unit does not meet the applicable standard, then the manufacturer would have to decommission the unit until it can be modified and retested to demonstrate compliance with the standard. Failure to decommission the unit immediately (i.e., allowing the unit to be used during any time period while the unit is being redesigned, parts are being built or ordered, etc. to make the unit compliant) would constitute a violation of the standards and the certification requirements. DOE also notes that, when a single unit is tested, there is no tolerance on the performance; the tested unit must meet the standard.

Since commercial packaged boilers with fuel input rates greater than 5,000,000 Btu/h would not be easily transported between manufacturer, laboratory, and consumer facilities, DOE also proposes that, at its discretion, assessment and enforcement testing of commissioned units could also be conducted as field tests. The location at which the enforcement field test is performed may or may not be the same location at which the manufacturer conducted its field test. DOE recognizes that a field test could not meet the existing laboratory accreditation requirements found at 10 CFR 429.110(a)(3) and there proposes an exception in this section specifically for field tests of commercial packaged boilers.

DOE seeks comments on the following issues, and these are also listed in section V.E:

- The feasibility of conducting a combustion efficiency test in the field for steam and hot water commercial packaged boilers with fuel input rate greater than 5,000,000 Btu/h (Issue 4).

- Whether the thermal efficiency test can be conducted for steam commercial packaged boilers with fuel input rate greater than 2,500,000 Btu/h and less than or equal to 5,000,000 Btu/h (Issue 5).
- The specific limitations, if any, that preclude combustion efficiency testing in a laboratory setting for steam commercial packaged boilers with fuel input rate greater than 2,500,000 Btu/h and less than or equal to 5,000,000 Btu/h (Issue 6).
- The specific additional equipment or facilities and their associated cost that would be required to accommodate testing commercial packaged boilers with fuel input rate greater than 2,500,000 Btu/h and less than or equal to 5,000,000 Btu/h in a laboratory setting (Issue 7).
- Whether the 5,000,000 Btu/h fuel input rate is an adequate threshold for the allowance of the field combustion test and conversion methodology, and if not, what threshold should be used (Issue 8).
- Whether certification should be permitted for field tested units after distribution in commerce and after commissioning, in particular the impact of this approach on building inspectors (Issue 9).

2. Method to Convert Combustion Efficiency to Thermal Efficiency for Steam Commercial Packaged Boilers

DOE also proposes a method for converting the combustion efficiency of a steam commercial packaged boiler to thermal efficiency. Such a conversion would be necessary for steam commercial packaged boilers because the efficiency metric for this equipment at 10 CFR 431.86 is thermal efficiency. DOE proposes this conversion method only for those steam

commercial packaged boilers with a fuel input rate greater than 5,000,000 Btu/h based on the concerns presented in section III.C. This conversion methodology would be available to manufacturers or laboratories to perform a combustion efficiency test in a laboratory setting or as a field test as described in III.C.1.

The proposed conversion method calculates thermal efficiency by subtracting a constant value from the combustion efficiency, which must be measured in accordance with ANSI/AHRI Standard 1500-2015. Thermal efficiency includes heat exchanger effectiveness and jacket losses which are not captured in the combustion efficiency. The constant value subtracted from the tested combustion efficiency value represents those additional losses. In order to determine such a value, DOE analyzed the AHRI directory (as of January 2015).[10] DOE looked at the difference between rated combustion and thermal efficiency for all steam commercial packaged boilers with rated input larger than 5,000,000 Btu/h. DOE found 52 basic models of steam commercial packaged boilers with a rated input larger than 5,000,000 Btu/h and the difference between rated combustion and thermal efficiency ranged between 0.5 percent and 2.0 percent. Based on these values, DOE proposes subtracting 2.0 percent from the measured combustion efficiency of steam commercial packaged boilers with fuel input rating 5,000,000 Btu/h or greater in order to calculate a rated thermal efficiency. DOE believes that subtracting 2.0 percent from the measured combustion efficiency determined during the field test would result in conservative thermal efficiency ratings of models, thereby encouraging manufacturers to conduct thermal efficiency tests.

[10] Available at: https://www.ahridirectory.org/ahridirectory/pages/home.aspx

Manufacturers must use the certified rating for any representation of efficiency no matter which methodology is used. That is, for equipment certified under the calculation procedure, any representations of the energy efficiency must be made based on the calculated value and any equipment certified using the tested value of thermal efficiency must be made based on the results of that testing.

DOE seeks comments on the following issues, which are also listed in section V.E:

- The proposed conversion method for calculating thermal efficiency based on measured combustion efficiency for steam commercial packaged boilers with fuel input rate greater than 5,000,000 Btu/h (Issue 10);
- The proposed value for the difference between the combustion efficiency and thermal efficiency in the conversion method (proposed value of 2.0 percent of the combustion efficiency), whether the value would result in conservative ratings, and what number DOE should use instead if the proposed value is not adequate (Issue 11);
- Whether the 5,000,000 Btu/h fuel input rate is an adequate threshold for the allowance of the field test (for combustion efficiency) and/or conversion methodology, and if not, what threshold should be used (Issue 12); and
- If the field test (for hot water and steam commercial packaged boilers) and conversion methodologies (for steam commercial packaged boilers) do not adequately accommodate commercial packaged boilers with fuel input rate greater than 5,000,000 Btu/h, what procedure should DOE implement in order to do so (Issue 13).

3. Alternative Efficiency Determination Methods

The provisions under 10 CFR 429.70 provide for alternative methods for determining energy efficiency and energy use of certain equipment, including commercial packaged boilers. An AEDM must first be validated for a particular validation class in accordance with the requirements of 10 CFR 429.70(c) using the applicable test procedure (e.g., the test procedure under 10 CFR 431.86 for commercial packaged boilers). For each validation class of commercial packaged boilers, at least two (2) distinct basic models must be tested in order to validate the AEDM before using the AEDM to predict the fuel input rate or efficiency of a commercial packaged boiler. 10 CFR 429.70(c)(2)(iv). Such a test may be performed on any individual models in a validation class that meet or exceed the current applicable Federal energy conservation standard, regardless of size. As noted by Lochinvar in response to the November 2014 Preliminary Analysis, the AEDM process mitigates test burden concerns for large commercial packaged boilers. (Docket EERE-2013-BT-STD-0030, Lochinvar, No. 34 at p. 1)

However, in light of DOE's proposal to allow field tests for commercial packaged boilers with fuel input rates than 5,000,000 Btu/h (described in section III.C.1), DOE proposes to limit the cases in which field tests may be used for AEDM validation pursuant to 10 CFR 429.70(c)(2). Specifically, DOE proposes that AEDMs validated using data derived from field tests may only be used to rate commercial packaged boilers with fuel input rate greater than 5,000,000 Btu/h. As discussed in section III.C.1, DOE proposes a field test option for commercial packaged boilers with fuel input rates greater than 5,000,000 Btu/h that disregards certain testing requirements, measures combustion efficiency, and applies a calculation method to convert combustion efficiency to thermal efficiency (for steam commercial packaged boilers).

While this field test option reduces testing burden, it also leads to more variability and uncertainty in the test results. As such, DOE believes that the proposed allowances for field tests of commercial packaged boilers with fuel input rate greater than 5,000,000 Btu/h would not provide sufficient validation of an AEDM for use on smaller units that must undergo laboratory tests. Therefore, DOE proposes that AEDMs validated based on field test data may only be used for commercial packaged boilers with fuel input rates greater than 5,000,000 Btu/h. Laboratory tests of commercial packaged boilers of any size (i.e., not field tested) can continue to be used to validate an AEDM that is used to rate commercial packaged boilers of any size, including those with fuel input rate greater than 5,000,000 Btu/h.

4. Steam Commercial Packaged Boiler Operating Pressure

Section 8.6.1 of BTS–2000 provides that tests may be made at atmospheric pressure or at pressure not exceeding 2 psi gauge, and section 8.6.3 of BTS–2000 requires that the moisture in steam not exceed 2 percent of the water fed to the commercial packaged boiler during the test. These provisions are incorporated by reference in the existing DOE test procedure for commercial packaged boilers. DOE solicited public comments on test pressure and steam moisture content in the September 2013 Framework document; during the October 1, 2013 energy conservation standards Framework document public meeting; and in the February 2014 RFI. In particular, DOE requested comments about (1) the appropriate steam pressure for steam commercial packaged boilers operating at full load, (2) the effect of different steam pressures on steady-state efficiency (thermal or combustion), and (3) the impacts of the steam pressure testing requirements on the amount of water carryover and the system operation.

ABMA expressed concern that the steam pressure requirements in BTS–2000 may be suitable for certain boilers but not for some larger-capacity models. For example, ABMA indicated that a fire-tube boiler cannot operate successfully at 2 psig steam pressure. Instead, ABMA argued that a fire-tube boiler should be operated at 10 to 12 psig steam pressure to achieve acceptable steam quality. (Docket EERE-2013-BT-STD-0030, ABMA, No. 13 at p. 31) ABMA also commented that while steam pressure not greater than 0–2 psig has been adequate for the majority of boilers, the 0–2 psig test pressure is unrealistic for larger-capacity steam boilers, as it causes high steam velocity at the steam/water interface and the steam outlet nozzle, which results in excessive water entrainment and carryover (i.e., poor steam quality). (Docket EERE-2013-BT-STD-0030, ABMA, No. 14 at p. 2) Cleaver-Brooks commented that it cannot test its steam boilers at such low operating pressures because its boilers are designed to operate near or at 10 psig. (Docket EERE-2013-BT-STD-0030, Cleaver-Brooks, No. 12 at p. 1) Burnham encouraged DOE to raise the limit of the required steam test pressure to give manufacturers flexibility for equipment designed to operate at pressures above 2 psig. (Docket EERE-2014-BT-TP-0006, Burnham, No. 4 at p. 2) AHRI opined that an alternative steam pressure requirement may have an effect on the steady-state measurement, but that such change would be minimal. (Docket EERE-2014-BT-TP-0006, AHRI, No. 6 at p. 2)

DOE notes that it has also received several requests for test procedure waivers, citing the inability to simultaneously meet the maximum steam pressure requirement (of between 0 and 2 psig) and the steam moisture requirement (of less than or equal to 2 percent moisture). Based on the public comments and the waiver requests DOE has received to date, DOE understands that larger commercial packaged boilers are designed for operating pressures greater than 2 psig and

have difficulty being tested in accordance with the DOE existing test procedure for commercial packaged boilers; that is, at a pressure not exceeding 2 psig and also not exceeding 2 percent moisture in the produced steam.

DOE notes that, to accommodate testing of these commercial packaged boilers, section 5.3.6 of ANSI/AHRI Standard 1500-2015 requires that tests shall be made at atmospheric pressure or at the pressure required to comply with Section 5.3.7 [of ANSI/AHRI Standard 1500-2015], not exceeding 15 psi gauge. Therefore, DOE recognizes that amending 10 CFR 431.86 to replace BTS-2000 with ANSI/AHRI Standard 1500-2015 would permit steam operating pressures up to but not exceeding 15 psig and therefore resolve the issues associated with testing large commercial packaged boilers designed to operate at higher pressures. DOE does not anticipate this change would have an effect on measured efficiency ratings because it is being made to accommodate only certain large commercial packaged boilers that manufacturers have claimed cannot be tested under the existing DOE test procedure and for which manufacturers submitted waiver requests under 10 CFR 431.401.

DOE also notes that ANSI/AHRI Standard 1500-2015 allows for any steam pressure from 0−15 psig to be used for testing. However, DOE believes that it is important to maintain consistency and repeatability within the CPB test procedure and subsequent ratings. Therefore, DOE proposes that only those commercial packaged boilers that cannot operate at a steam pressure below 2 psig would be able to apply such a provision in order to also meet the steam quality requirement. However, DOE recognizes that, theoretically, variation in steam pressure would result in changes in both thermal and combustion efficiency. Therefore, to ensure

commercial packaged boilers that cannot be tested at the prescribed 0−2 psig steam pressure are tested in a consistent manner, DOE proposes that such equipment be tested at the steam pressure closest to 2 psig that it can maintain while also maintaining the requirement of less than 2 percent moisture in the steam, not exceeding 15 psig. DOE notes that a manufacturer may need to incrementally increase steam test pressure above atmospheric pressure or the 2 psig requirement to meet the moisture requirement, thereby maintaining steam quality. DOE is not aware of any commercial packaged boilers that would require higher operating pressures than 15 psig to maintain the steam quality requirements.

DOE seeks comments, data, and information about pressures recommended by manufacturers and relevance to actual operating conditions in buildings. This is identified as Issue 14 in section V.E. DOE also seeks comment on whether DOE should require testing to be performed at the lowest possible steam pressure where steam quality requirements can be met. This is identified as Issue 15 in section V.E. DOE also requests comment on if there are any commercial packaged boilers that require steam pressures greater than 15 psig to maintain 2 percent moisture in the produced steam. This is identified as Issue 16 in section V.E.

D. Hot Water Commercial Packaged Boiler Operating Temperatures

In the energy conservation standards September 2013 Framework document, the February 2014 RFI, and the November 2014 Preliminary Analysis DOE requested comments, data, and information about the appropriate inlet and outlet water temperatures for part-load and full-load testing conditions of hot water commercial packaged boilers, and information about how these equipment are currently tested. Issues pertaining to the inlet water temperature and

the temperature rise required by the test procedure were also raised during the public meeting regarding the energy conservation standards September 2013 Framework document. In addition to the comments solicited in response to the September 2013 Framework document, February 2014 RFI, and the November 2014 Preliminary Analysis; DOE conducted confidential manufacturer interviews as part of the energy conservation standards rulemaking process for commercial packaged boilers (manufacturer interviews), during which manufacturers also discussed issues regarding the commercial packaged boiler test procedure. In the subsequent sections, DOE discusses the existing requirements regarding hot water temperatures, issues identified by interested parties, proposed changes to the hot water temperature requirements, and potential impacts of those proposed changes.

1. Existing Requirements

The existing DOE test procedure for commercial packaged boilers incorporates by reference BTS-2000 which includes test requirements for inlet and outlet water temperatures for non-condensing and condensing commercial packaged boilers. For a non-condensing commercial packaged boiler, section 8.5.1.1 of BTS–2000 requires inlet water temperature to be between 35 °F and 80 °F (at Point A in Figure III.1), and outlet water temperature to be 180 °F ± 2 °F (at Point C in Figure III.1). For a condensing commercial packaged boiler, section 8.5.1.2 of BTS–2000 requires inlet water temperature to be 80 °F ± 5 °F (at Point A in Figure III.1 and outlet water temperature to be 180 °F ± 2 °F (at Point C in Figure III.1). These temperature requirements are consistent with those in ANSI/AHRI Standard 1500-2015. Specifically, Figure III.1 (taken from Figure C9 in ANSI/AHRI Standard 1500-2015) identifies the location of the

measurement of the inlet water temperature (Point A: T_{IN}) and the outlet water temperature (Point C: T_{OUT}).

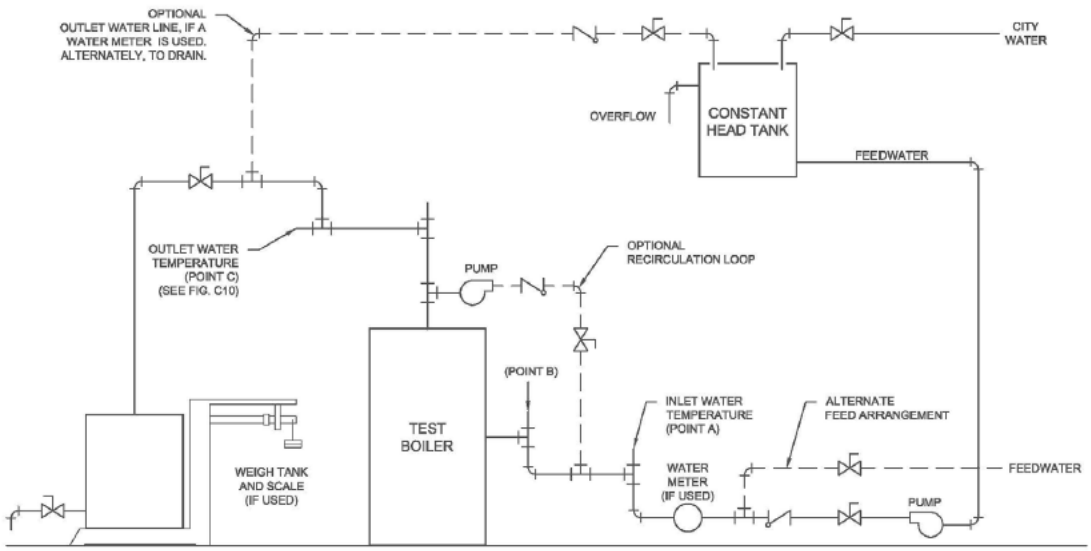

Figure III.1. Piping Arrangement for Testing Hot Water Commercial Packaged Boilers (Taken from Figure C9 in ANSI/AHRI Standard 1500-2015)

The difference between the inlet and outlet water temperatures describes the temperature rise across the commercial packaged boiler. BTS-2000 also includes an allowance in section 8.5.1.1.1 for tubular commercial packaged boilers to use a recirculating loop, which reduces the temperature rise across the commercial packaged boiler itself (Point B to Point C), while maintaining the inlet water temperature requirements specified in the DOE test procedure as measured at Point A. That is, in cases where a recirculating loop is used, BTS-2000 requires that the temperature requirements described previously must still be met at Point A in Figure III.1 prior to mixing with the warmer recirculating loop water. BTS-2000 (and ANSI/AHRI Standard 1500-2015 at section 5.3.5.3) also limits the temperature rise between Point B and Point C to not less than 20 °F for commercial packaged boilers tested using a recirculating loop. ANSI/AHRI

Standard 1500-2015 expands the allowable use of a recirculating loop to all commercial packaged boilers in section 5.3.5.3, where previously it was allowed for commercial packaged boilers with tubular heat exchangers only.

The measurements of inlet and outlet water temperature at Points A and C are used in Equation 1 to calculate the amount of energy transferred into the heated water, as described by item C7.2.11.3 in ANSI/AHRI Standard 1500-2015 (also in 11.1.11.3 of BTS–2000). This equation is given by

$$\mathbf{Q_S = \frac{W \times C_{P,H2O}(T_{OUT} - T_{IN})}{t_T}} \qquad \textbf{Equation 1}$$

where Q_S is the rate of heat transferred in Btu/h, W is the weight of heated water in pounds (lb) measured during the test, $C_{P,H2O}$ is the specific heat of water in Btu/lb/°F, T_{OUT} is the outlet water temperature at Point C (°F), T_{IN} is the inlet water temperature at Point A (°F), and t_T is the test duration in hours.

In general, the efficiency of a commercial packaged boiler is proportional to the amount of water heated and the amount of heat energy added to this amount of water. As shown in Equation **1**, the amount of heat energy transferred is proportional to the product of the weight of the water fed (W) and the temperature rise across the commercial packaged boiler ($T_{OUT} - T_{IN}$). The efficiency is therefore dependent on the inlet water temperature, whereby lower inlet temperatures result in greater amounts of heat energy transferred and therefore higher thermal efficiencies. As the energy from the flue gases is only transferred to the hot water in the heat exchanger, the first law of thermodynamics establishes a lower limit on the temperature the flue gas can achieve, which is the lowest water temperature within the commercial packaged boiler.

Therefore as the inlet water temperature is reduced, more energy may be extracted from the combustion gases, resulting in potentially higher efficiency. These conditions hold true for both non-condensing and condensing commercial packaged boilers.

2. Issues with Water Temperature Requirements and Proposed Changes

Through the October 2013 Framework document, February 2014 RFI, the November 2014 Preliminary Analysis, manufacturer interviews, and a review of the existing DOE test procedure, DOE identified the following concerns regarding its existing water temperature requirements for commercial packaged boilers:

- The current temperature rise is unrepresentative of actual operating conditions.
- The current temperature rise may induce excessive stresses on some commercial packaged boilers.
- The presence of recirculating loops during testing leads to significant variability in the actual temperature rise across the commercial packaged boiler (Point B to Point C in Figure III.1).

These issues are discussed in detail in this section.

During the manufacturer interviews, a number of manufacturers indicated that the 100 °F temperature rise in BTS-2000 (for both condensing or non-condensing commercial packaged boilers) was unrepresentative of real-world conditions, and instead indicated that commercial packaged boilers are typically designed for a 20 °F to 40 °F temperature rise. These manufacturers suggested that testing with a 20 °F to 40 °F temperature rise would better reflect

conditions found in typical building applications. DOE understands this to mean the actual temperature rise across the commercial packaged boiler itself (i.e., between Point B and Point C in Figure III.1).

During the public meeting regarding the September 2013 energy conservation standards Framework document, ACEEE asserted that a 100 °F temperature rise is an inadequate way to characterize modern boilers, does not provide sufficient information about performance of a boiler with a 20 °F temperature rise between inlet and outlet water temperature at part-load conditions, and is essentially irrelevant for comparing efficiencies among a range of boiler sizes. (Docket EERE-2013-BT-STD-0030, ACEEE, No. 13 at pp. 20, 36) In later comments, ACEEE recommended a 20 °F temperature rise, arguing that it is within the range of the most common temperature rise and provides the most conservative value for full-load, steady-state efficiency. ACEEE also commented that a manufacturer should be able to publish "application ratings" (informational ratings obtained at different operating conditions) for different temperature rise values. In addition, whether for a fixed capacity or modulating boiler, ACEEE observed that the lower inlet water temperatures result in higher efficiencies, and ACEEE stated its understanding that almost all the efficiency gain is due to the release of latent energy at inlet water temperatures less than 140 °F. ACEEE then suggested that a commercial packaged boiler should be rated at the lowest inlet water temperature that remains under the manufacturer's warranty for continuous service, whether for a fixed capacity or modulating boiler. (Docket EERE-2014-BT-TP-0006, ACEEE, No. 2 at p. 2.)

A joint comment from ACEEE, ASAP, and NRDC suggested that the existing DOE test procedure for commercial packaged boilers is obsolete because it obscures the annual energy savings potential of condensing boilers in commercial building applications. BTS–2000 measures efficiency at peak load, using a minimum 100 °F temperature rise between inlet and outlet (note: BTS-2000 defines inlet temperature at a location preceding the reentry of any recirculating loop water), and requires 180 °F outlet temperature. (This continues to be the case in ANSI/AHRI Standard 1500-2015.) However, the commenters argued that the existing test procedure does not consider condensing boilers that can operate at part load with greater efficiency if the system design allows for inlet water at condensing temperatures (<140 °F). (Docket EERE-2013-BT-STD-0030, Joint Advocates, No. 16 at p. 2)

In response to the November 2014 Preliminary Analysis, Raypak suggested that the wide range in allowable inlet water temperatures in BTS-2000 is to accommodate the wide range of ground water temperatures throughout the year. (Docket EERE-2013-BT-STD-0030, Raypak, No. 35 at p. 3)

ABMA expressed concerns on behalf of its members that (1) water temperatures required by BTS–2000 are obsolete or do not represent installed boilers; (2) the temperature rise resulting from the required inlet and outlet water temperatures set forth in BTS–2000 can place excessive stress on the boiler pressure vessel, thereby leading to shorter boiler life; and (3) the considerable cost of testing larger boilers could approach $1 million. ABMA added that test pressures and temperatures should be more realistic in terms of normal system operating conditions and that an appropriate inlet temperature would be 140 °F or the manufacturer's recommended minimum.

(Docket EERE-2013-BT-STD-0030, ABMA, No. 14 at p. 1–3) DOE notes that these concerns continue to apply to ANSI/AHRI Standard 1500-2015 since these temperatures are the same as those found in BTS–2000.

Cleaver-Brooks stated that BTS–2000 specifies an outlet temperature of 180 °F and an inlet water temperature of 38 °F [sic] to 80 °F for non-condensing boilers. (Note: BTS–2000 prescribes an inlet water temperature of 35 °F.) Instead, for much of its equipment, Cleaver-Brooks stated that it specifies a minimum inlet water temperature of 140 °F to reduce damage from thermally induced stresses. Cleaver-Brooks asserted that neither the required steam nor the hot water test conditions set forth in the existing DOE test procedure for commercial packaged boilers reflect actual conditions in buildings, and that test conditions overestimate boiler efficiency compared to what an end-user would be expected to experience in actual applications. The commenter suggested modifying the test procedure to require an outlet water temperature of 180 °F and an inlet water temperature of 140 °F or, at a minimum, to allow such test conditions as an alternative. (Docket EERE-2013-BT-STD-0030, Cleaver-Brooks, No. 12 at p. 1) Again, DOE notes that these concerns also apply to ANSI/AHRI Standard 1500-2015, as the standard maintains the same inlet and outlet water temperature requirements as BTS−2000. DOE also believes that the inlet water temperatures described by Cleaver-Brooks and ABMA are intended to mean the inlet water temperature in the absence of a recirculating loop. As noted earlier, the existing DOE test procedure (section 8.5.1.1.1 of BTS-2000) allows for the use of a recirculating loop for tubular commercial packaged boilers, thereby increasing the inlet water temperature seen by the commercial packaged boiler (shown as Point B in Figure III.1) and reducing the actual temperature rise across the commercial packaged boiler.

Similarly, Lochinvar stated in response to the November 2014 Preliminary Analysis that the allowance in BTS-2000 for a recirculation loop in some instances would result in higher water temperature going into the commercial packaged boiler. Lochinvar noted that efficiency curves that present the efficiency of a commercial packaged boiler as a function of return (inlet) water temperature (and are sometimes provided in marketing literature) are not based on the methodology of BTS-2000. Lochinvar further recommended that DOE not attempt to correct the efficiency of commercial packaged boilers for inlet water temperature. (Docket EERE-2013-BT-STD-0030, No. 34 at p. 3)

In order to address the issues presented in section III.D.2, DOE proposes amendments to the inlet and outlet water temperatures for both condensing and non-condensing commercial packaged boilers. Upon consideration of the above comments about inlet and outlet water temperatures; review of commercial packaged boiler manufacturer literature; and consideration of results of testing of commercial packaged boilers at temperatures that, according to commercial packaged boiler manufacturers, would reflect normal system operating conditions; DOE agrees with interested parties that a 100°F to 145°F nominal temperature rise does not necessarily reflect conditions typically associated with installed non-condensing or condensing commercial packaged boilers.

Further, DOE acknowledges that the presence of recirculating loops in testing obscures the actual inlet water temperature entering the commercial packaged boiler at Point B in Figure III.1 (and therefore the actual temperature rise experienced by the commercial packaged boiler)

because the inlet water temperature is measured and maintained at Point A only, under the existing procedure. Specifically, DOE observed that, based on the permissible inlet and outlet temperatures, the tolerances on those temperatures, and the use of recirculating loops, the temperature rises between Point B and Point C in Figure III.1 allowable by both BTS–2000 and ANSI/AHRI Standard 1500-2015 can range from 20 °F to 147 °F for non-condensing commercial packaged boilers (section 8.5.1.1 of BTS 2000 and section 5.3.5.1 of ANSI/AHRI Standard 1500-2015) and 20 °F to 107 °F for condensing commercial packaged boilers (section 8.5.1.2 of BTS 2000 and section 5.3.5.2 of ANSI/AHRI Standard 1500-2015). (Note: the minimum temperature rise of 20 °F across the commercial packaged boiler assumes that recirculating loops are currently being used for these tests.) DOE notes that such variability has the potential to yield variability in tested combustion efficiency and thermal efficiency ratings.

Accordingly, to improve the consistency and repeatability of the DOE test procedure, DOE proposes to revise the hot water temperature requirements to require the inlet water temperature to be 140°F ±1°F for non-condensing equipment, as determined at Point B (see Figure III.1). For non-condensing equipment, DOE is maintaining the outlet temperature of 180°F but is specifying a new tolerance for this measurement, which is discussed further in section III.D.3). Similarly, DOE proposes to require an outlet water temperature of 120°F ±1°F for condensing equipment, as determined at Point C (see Figure III.1). For condensing equipment, DOE is proposing an inlet water temperature specification of 80°F as measured at Point B in Figure III.1 and updating the measurement tolerance to ±1°F, as discussed section III.D.3. DOE believes these test temperatures will more accurately represent the energy efficiency of commercial packaged boilers and are more consistent with the conditions typically

observed in field installations. DOE also notes that the proposed temperature requirements result in equivalent temperature rises across the commercial packaged boiler for condensing and non-condensing equipment in order to maintain comparability. The proposed temperature requirements also incorporate inlet water temperatures that more accurately represent the efficiencies of non-condensing and condensing commercial packaged boilers. DOE does not believe that maintaining the same outlet water temperature for non-condensing and condensing commercial packaged boilers is important for maintaining comparability of ratings.

DOE is proposing to modify the location at which the inlet water temperature is maintained from Point A to Point B, which is immediately preceding the commercial packaged boiler, downstream of the recirculation loop (see Figure III.1). DOE believes that the comments of interested parties refer to the temperature rise experienced across the commercial packaged boiler itself (Point B to Point C) and that, therefore, DOE's proposal is consistent with the input of interested parties. In addition, DOE notes that specifying the inlet water temperature at Point B, immediately prior to entering the commercial packaged boiler would remove ambiguity and improve the consistency and repeatability of the DOE test procedure. This temperature is more directly related to the measured thermal or combustion efficiency than the temperature rise determined with the inlet water upstream of the recirculation loop (between Point C and Point A of Figure III.1).

DOE recognizes that these inlet temperatures would typically be produced through the use of a recirculating loop to temper incoming feedwater to the appropriate inlet temperature. In proposing to adopt ANSI/AHRI Standard 1500-2015, DOE is proposing to allow recirculation

loops to be used on all commercial packaged boilers and, as such, DOE clarifies that recirculation loops could be used to meet the new proposed inlet water requirements. However, DOE proposes that the efficiency calculations in section C7.2.11.3 in ANSI/AHRI Standard 1500-2015 would continue to use the water temperature and flow rate measured upstream of the recirculating loop, if present (Point A in Figure III.1). DOE acknowledges that this would require measurements of water temperature at both Point A and Point B for equipment tested with recirculating loops. However, DOE notes that by continuing to use the temperature at Point A in the calculation of thermal efficiency, the precision of the resulting thermal efficiency will not be impacted as compared to the current methodology.

While DOE believes that the proposed inlet and outlet temperature requirements are applicable and representative for the majority of commercial packaged boilers available on the market, DOE is aware that some commercial packaged boilers are unable to operate at a temperature rise across the commercial packaged boiler of 40 °F. Specifically, DOE is aware that some commercial packaged boilers are only capable of operating with lower temperature differentials, such as 20 °F. As such, DOE is proposing to adopt provisions for commercial packaged boilers that cannot operate with a temperature rise of 40 °F across the boiler (Point B to Point C), as indicated in the manufacturer literature. For non-condensing commercial packaged boilers, DOE is proposing that, if the commercial packaged boiler cannot operate with an inlet temperature of 140 °F ± 1 °F at Point B in Figure III.1 when the outlet temperature is 180 °F ± 1 °F, DOE is proposing that the inlet temperature be maintained as close to 140 °F ± 1 °F as possible, consistent with manufacturer's instructions provided in the literature for that basic model and that the average inlet water temperature measured at Point B in Figure III.1 be

reported as part of the certification report for the basic model. Similarly, for condensing commercial packaged boilers that cannot operate with a temperature rise of 40 °F across the commercial packaged boiler, DOE is proposing that the inlet temperature at Point B in Figure III.1 be maintained as close to 80 °F ± 1 °F as possible, consistent with manufacturer's instructions provided in the literature for that basic model, while the outlet temperature is maintained at 120 °F ± 1 °F, consistent with the DOE test procedure. Again, the average inlet water temperature measured at Point B in Figure III.1 would be reported as part of the certification report for the basic model

DOE seeks comments, data, and information about whether the proposed testing conditions related to water temperatures are appropriate both for a non-condensing commercial packaged boiler and a condensing commercial packaged boiler. This is identified as Issue 17 in Section V.E.

DOE also requests comment on the proposed test provisions to accommodate commercial packaged boilers that cannot be tested with a temperature rise of 40 °F across the commercial packaged boiler (Point B to Point C). This is identified as Issue 18 in Section V.E.

Under EPCA, DOE is required to determine what impacts, if any, its amendments to a test procedure will have on ratings. (42 U.S.C. 6293(e); 42 U.S.C. 6314(a)(4)(C)) DOE proposes using the temperature rise across the commercial packaged boiler itself as described in order to improve the repeatability of the tests. Whereas the existing test procedure (using BTS-2000, incorporated by reference) allows for a wide range of temperature rises across the

commercial packaged boiler due to the allowance of recirculating loops and a measurement location upstream of the recirculation loop, which obscures the actual temperature rise across the commercial packaged boiler, DOE's proposed amendments would remove ambiguity by standardizing this temperature rise across all commercial packaged boilers where possible. DOE notes that the effect on any individual commercial packaged boiler could be to slightly increase or slightly decrease measured efficiency, depending on how the test was previously performed. Further, based on discussions with manufacturers, DOE believes that testing is already performed using a recirculating loop for equipment that does not utilize a tubular heat exchanger in order to prevent damaging the equipment and provide the boiler with inlet water temperatures more representative of typical field conditions. Therefore, in combination with the other proposed amendments to the test procedure, DOE has tentatively determined that the proposed amendments, in aggregate, would not result in an overall measurable impact on ratings.

3. Allowable Uncertainty in Water Temperature Measurement

HTP initially expressed concern about several operating conditions being either unspecified or unrealistic, and suggested updated test parameters for commercial packaged boilers that would be more reasonable. (Docket EERE-2013-BT-STD-0030, HTP, No. 18 at p.4) However, in later comments and after further analysis, HTP concluded that the test conditions should not be amended because manufacturers cannot be confident that the DOE test method would maintain an acceptable level of uncertainty if different test points or temperature rises were to be used. Instead, HTP commented that an acceptable test method uncertainty analysis should be completed to verify the Appliance Standards and Rulemaking Federal Advisory Committee (ASRAC) agreed-upon 5-percent allowable tolerance on ratings in order to account

for variations in manufacturing and testing. (Docket EERE-2014-BT-TP-0006, HTP, No. 5 at p. 4)

In response to HTP's concerns regarding the uncertainty of the test, DOE proposes to reduce the tolerances for inlet and outlet water temperatures during the test period to ±1 °F for both non-condensing and condensing commercial packaged boilers so that testing uncertainties are not increased. DOE notes that the required minimum accuracy of the inlet and outlet water temperature measurement instrumentation is ±0.2 °F (Table C1 of ANSI/AHRI Standard 1500-2015 and Table 1 of BTS–2000). Therefore, the instrumentation required by the test procedure is sufficiently precise to accommodate this tolerance. Investigative testing performed by DOE showed that reducing the temperature rise did not substantially increase the variability in thermal efficiency between repeated tests compared to the expected variability of the currently allowable temperature rises. Furthermore, a review of the data obtained during investigative testing showed little variation over time in the temperatures themselves, typically less than ±1 °F over the course of the test. DOE seeks additional comments, data, and analysis concerning thermal efficiency test measurement uncertainty. This is identified as Issue 19 in section V.E.

4. Water Flow Rate During Testing

Burnham and AHRI observed that a change in the specified water temperatures would potentially change the water flow rate and the calculated efficiency resulting from the test procedure. Higher flow rates and a resulting higher total volume of water are necessary to achieve smaller temperature rises. According to the commenters, decreasing the temperature rise would require a higher water flow rate and may exceed the water handling, cooling, processing,

and disposal capabilities of many laboratories currently testing using the existing DOE test procedure (i.e., BTS-2000). Further, the commenters argued that reducing the temperature rise by lowering the outlet temperature may result in increased measured thermal efficiency. In view of these concerns, both AHRI and Burnham recommended that the current operating temperatures should be retained. (Docket EERE-2014-BT-TP-0006, Burnham, No. 4 at p. 2; Docket EERE-2014-BT-TP-0006, AHRI, No. 6 at p. 2)

DOE is aware that the water temperature rise across the commercial packaged boiler is inversely related to the flow rate of the working fluid (water or steam) at a given burner fuel input rate, and that increasing water flow rates to achieve lower temperature rises may reduce the commercial packaged boiler size that laboratories are capable of testing. However, as stated previously, DOE also acknowledges that, under the proposed test procedure, recirculating loops, which reduce the temperature rise across the commercial packaged boiler with modest flow rates of incoming feedwater and outgoing water for disposal, would be allowed for all commercial packaged boilers, not just commercial packaged boilers with tubular heat exchangers as is currently allowed in section 8.5.1.1.1 of BTS-2000. This is supported by Lochinvar's assertion that recirculating loops are used in testing and increase the inlet water temperature to the commercial packaged boiler. (Docket EERE-2013-BT-STD-0030, No. 34 at p. 3) In addition, DOE notes that the 100 °F temperature rise required by both BTS-2000 and ANSI/AHRI Standard 1500-2015 is not directly comparable to DOE's proposed temperature rise of 40 °F due to the difference in where the inlet temperature requirement is measured.

DOE believes that requiring the temperature to be measured and maintained at the location downstream of the recirculation loop and just prior to the commercial packaged boiler inlet would allow manufacturers and laboratories to continue using incoming water at much lower temperatures (at or near the current 35 °F to 80 °F of BTS-2000 and ANSI/AHRI Standard 1500-2015). That is, under these proposed inlet and outlet temperature conditions (when utilizing a recirculation loop), the same temperatures and test conditions could be established under the existing and new test procedures (due to the different measurement locations). DOE therefore believes that the concerns regarding an increase in water flow rate (and therefore reduction in laboratory capacity) may be overstated in view of the proposed change in location of where the inlet water temperature would be measured under the proposed test procedure.

DOE seeks comment regarding the prevalence of using recirculating loops in testing; specifically, DOE requests comment about the kinds of commercial packaged boilers utilizing recirculation loops during testing and the conditions at which these commercial packaged boilers and recirculating loops operate. This is identified as Issue 20 in section V.E.

DOE estimates the impact on manufacturers of requiring higher water flow rates in section IV.B. DOE seeks further comments, data, and information concerning the capabilities of test laboratories, particularly in light of the specific proposed conditions contained in this NOPR. This is identified as Issue 21 in section V.E.

E. Testing Conditions

For non-condensing commercial packaged boilers, the existing DOE test procedure does not prescribe test room requirements for ambient temperature or humidity. For combustion efficiency tests of condensing commercial packaged boilers, the existing DOE test procedure requires that the "humidity of the room shall at no time exceed 80 percent." 10 CFR 431.86(c)(2)(ii). Additionally, BTS–2000 requires that test air temperature, as measured at the burner inlet, be within ±5 °F of the ambient temperature, where ambient temperature is measured within 6 feet of the front of the unit at mid-height. ANSI/AHRI Standard 1500-2015 prescribes an allowable ambient temperature during the test between 30 °F and 100 °F (section 5.3.8) with the relative humidity not exceeding 80 percent in the test room or chamber (section 5.3.9). Section C3.6 of ANSI/AHRI Standard 1500-2015 also requires that test air temperature, as measured at the burner inlet, be within ±5 °F of the ambient temperature (which is measured within 6 feet of the commercial packaged boiler at mid-height; see section C3.7 of ANSI/AHRI Standard 1500-2015).

DOE understands that ambient temperature and humidity, including test air temperature, can have a measurable effect on the tested efficiency of commercial packaged boilers, particularly condensing commercial packaged boilers.[11] High humidity or any increase in humidity over a baseline would enable a commercial packaged boiler to capture more latent heat from combustion gases, thereby resulting in a higher measured efficiency. DOE recognizes that this effect would be noticeable both in tests for combustion efficiency and thermal efficiency. Therefore, DOE proposes to amend 10 CFR 431.86 so as to minimize this effect.

[11] Test air temperature is defined in ANSI/AHRI Standard 1500-2015 as the temperature of the air being supplied to the burner from the room.

As noted previously, the existing DOE test procedure requires a maximum of 80-percent ambient relative humidity in the test room or chamber when testing a condensing commercial packaged boiler for combustion efficiency only. DOE proposes to require that ambient relative humidity at all times be 60 percent ± 5 percent during thermal and combustion efficiency testing of commercial packaged boilers.[12] While DOE acknowledges that the effect of ambient humidity on the efficiency of non-condensing commercial packaged boilers is less than that for condensing commercial packaged boilers, DOE nevertheless proposes the same ambient humidity requirements for all commercial packaged boilers in order to maintain consistency and comparability between ratings. Also, DOE proposes that the ambient relative humidity be measured and recorded at each 30-second interval during the entire test. DOE seeks comments, data, and information about room ambient relative humidity, whether the proposed constraints are appropriate, and if not, what are appropriate constraints on room ambient relative humidity when testing commercial packaged boilers. This is identified as Issue 22 in section V.E.

In addition to proposed limits to ambient relative humidity when testing commercial packaged boilers, DOE proposes an ambient room temperature of 75 °F ± 5 °F during testing of commercial packaged boilers. The ambient temperature would be measured and recorded at each 30-second interval during the entire test. Additionally, DOE proposes that the ambient room temperature cannot differ by more than ± 2 °F from the average ambient room temperature

[12] Humidity is the amount of water vapor in the air. Absolute humidity is the water content of air. Relative humidity, expressed as a percent, measures the current absolute humidity relative to the maximum for that temperature. Specific humidity is a ratio of the water vapor content of the mixture to the total air content on a mass basis.

during the “Test Period” (as described in section C4 of Appendix C of ANSI/AHRI Standard 1500-2015; proposed for incorporation by reference) at any reading.

DOE believes that limiting ambient room temperature and relative humidity during testing will improve repeatability and provide for test conditions that more closely reflect the ambient conditions that commercial packaged boilers experience in normal operation. For non-condensing hot water and steam commercial packaged boilers, DOE anticipates negligible changes in the rated efficiency for a particular commercial packaged boiler due to the proposed changes to room ambient temperature and relative humidity requirements. Nevertheless, DOE proposes limits to ambient conditions for non-condensing commercial packaged boilers to prevent testing from occurring at extreme ambient temperature or relative humidity, which would be outside the expected range of conditions that commercial packaged boilers experience in normal operation. In comparison, ambient room temperature and relative humidity would have some effect on the test results for condensing commercial packaged boilers. However, Because DOE expects that current efficiency ratings generally have been determined at typical ambient room temperatures and relative humidity levels, DOE also expects that reported rating values will not change as a result of the proposed limits on ambient room temperature and relative humidity, which fall within the typical ambient room temperatures and relative humidity levels.

DOE seeks comments, data, and information about the aforementioned proposed room ambient temperatures, whether the proposed constraints are appropriate, and if not, what are

appropriate constraints on room ambient temperature. This is identified as Issue 23 in section V.E.

F. Setup and Instrumentation

In DOE's review of the existing test procedure, DOE identified several setup instructions and instrumentation requirements for which clarifications are expected to improve the accuracy and repeatability of test results. These include: (1) additional specifications regarding the steam riser/header geometry, (2) additional requirements regarding the use of steam condensate return piping, and (3) additional insulation requirements for the steam and water piping.

First, in section C2.3, "Steam Piping," of ANSI/AHRI Standard 1500-2015 (section 7.3 of BTS-2000), the description of the steam riser/header geometry may lead to different interpretations which can impact the amount of entrained water reaching the steam separator and result in variability in the measured thermal efficiency of commercial packaged boilers. Specifically, variations in the nominal pipe diameter or size of the pipe of the steam riser and the height of the steam riser above the water line may impact the amount of entrained water in the steam and may result in exceeding the DOE test procedure's 2 percent limit for moisture content in the steam. In order to reduce the amount of entrained water in the steam to satisfy this steam moisture requirement, the water level within the commercial packaged boiler is typically lowered during testing (within the allowable tolerance for the water level pursuant to manufacturer literature or ANSI/AHRI Standard 1500-2015 section C4.1.1.1.3, as applicable). However, lowering the water level inside the heat exchanger decreases the thermal efficiency of the commercial packaged boiler because as the water level is lowered, less heat exchanger surface

area is in contact with water. Therefore, variations in the steam riser and header geometry can affect the amount of moisture in the steam and require changes in the water level to meet the 2 percent moisture content requirement, which can then result in decreased thermal efficiency measurements for the same commercial packaged boiler model.

To decrease the variability and increase the repeatability and precision of the DOE test procedure, DOE therefore proposes to clarify the description of the steam riser and header geometry in its test procedure. Specifically, DOE proposes to adopt section C2.3 of ANSI/AHRI Standard 1500-2015 with additional provisions regarding the description of the steam riser and header geometries. The proposed additional specifications and the reason for inclusion are as follows:

- No reduction in diameter shall be made in any horizontal header piping, as a reduction in pipe diameter in the horizontal header prevents entrained water from draining properly and typically leads to non-steady-state operation. In the case of commercial packaged boilers with multiple steam risers, the cross-sectional area of the header must be no less than 80 percent of the summed total cross-sectional area of the risers, and the header pipe must be constant in diameter along its entire length.
- The diameter of the vertical portion of the steam condensate return pipe that is above the manufacturer's recommended water level may be reduced to no less than one half of the header pipe diameter to ensure adequate operation of the return loop and draining of entrained water back into the commercial packaged boiler.

DOE notes that section C2.3 of ANSI/AHRI Standard 1500-2015 specifies that the steam riser shall be connected in accordance with the manufacturer's instructions. However, in the event the manufacturer's literature does not specify necessary height and dimension characteristics for steam risers, headers, and return piping, DOE proposes the following requirements to ensure consistent and repeatable testing:

- The header pipe diameter must be the same size as the commercial packaged boiler's steam riser (steam take-off) pipe diameter. In the case of commercial packaged boilers with multiple steam risers, the cross-sectional area of the header must be no less than 80 percent of the summed total cross-sectional area of the risers, and the header pipe must be constant in diameter along its entire length.
- The height measured from the top of the header to the manufacturer's recommended water level must be no less than the larger of 24 inches or 6 times the header pipe diameter.
- The distance between the vertical steam riser (steam take-off) leading to the water separator and the elbow leading to the condensate return loop must be a minimum of three (3) header pipe diameters to prevent entrained water from entering the separator piping.
- If a water separator is used, piping must pitch downward to the separator at a rate of at least 1/4 inch per foot of pipe length in order to assure proper collection of moisture content and steady-state operation during testing.
- A vented water seal is required in steam moisture collection plumbing to prevent steam from escaping through the moisture collection plumbing.

DOE notes that header diameters that are larger than the diameter of the steam outlet can result in atypically low steam flow rate in the header, affecting carryover of entrained water, while smaller diameter headers may reduce the measured steam quality, possibly requiring tests to be conducted at lower water levels, which may result in lower efficiencies. Undersized headers with pipe diameters that are smaller than the diameter of the steam outlet on the commercial packaged boiler can also impede or prevent adequate draining of entrained water.

Second, Figure C5, "Suggested Piping Arrangement for Steam Boilers, Condensate Measurement," and Figure C7, "Suggested Piping Arrangement for Steam Boilers, Feedwater Measurement," in ANSI/AHRI Standard 1500-2015 both allow a steam commercial packaged boiler to be tested without a steam condensate return pipe. DOE proposes that all steam commercial packaged boiler test setups be required to include a steam condensate return pipe to minimize variation in tests. DOE also proposes to prohibit use of the "suggested" piping arrangements in Figures C5 and C7 for steam commercial packaged boiler testing setups. DOE believes these changes would ensure that commercial packaged boilers that typically require a steam condensate return pipe for adequate operation have one installed during testing. DOE believes that requiring a steam condensate return pipe, with the criteria specified in this section, would ensure consistent and repeatable test results. DOE further believes that such requirement would not have a significant impact upon thermal efficiency or steam moisture content for a steam commercial packaged boiler that may operate without a steam condensate return pipe.

Third, Sections C2.3 and C2.4 in ANSI/AHRI Standard 1500-2015 provide only minimal guidance about insulation requirements for steam and water piping components that are used in

the thermal efficiency test. To provide for repeatability and minimize heat losses in the piping, DOE proposes to adopt the minimum pipe insulation thickness and conductivity requirements in ASHRAE/IES Standard 90.1–2013, Table 6.8.3-1. DOE also believes these requirements would be more representative of insulation requirements for outlet piping used in most commercial applications.

In view of all the above, DOE seeks comment about its proposed changes to the steam riser, header, and return water loop testing requirements. This is identified as Issue 24 in section V.E.

DOE recognizes that for oil-fired commercial packaged boilers, burners are not always included when shipped from the manufacturer. In such cases, DOE proposes that the unit be tested with the particular make and model of burner certified by the manufacturer. Since each basic model distributed in commerce must be certified, DOE expects that using a manufacturer's certification will provide the most complete list of all burners for use with a particular boiler. Furthermore, DOE expects all burners specified in the installation and operation manual would be certified to the Department as part of the commercial packaged boiler basic model. If multiple burners are specified in the installation and operation manualor in one or more certification reports, then DOE proposes that any of the listed burners may be used for testing and all must be certified to the Department. DOE believes these provisions provide manufacturers with ample opportunity to specify burners that should be used with their commercial packaged boilers for testing, and will reduce ambiguity concerning what burner a commercial packaged boiler can be tested with. DOE believes these changes represent a

clarification in how burners are specified and therefore does not anticipate any changes in ratings for commercial packaged boilers. DOE seeks comment regarding the specification of burners for oil-fired commercial packaged boilers and this is identified as Issue 25 in section V.E.

With respect to outdoor commercial packaged boilers, units with multiple outdoor venting arrangements provided by the manufacturer are required by ANSI/AHRI Standard 1500-2015 section C2.2.5 to be tested using the arrangement having the least draft loss. However, draft loss is not defined nor are provisions provided in ANSI/AHRI Standard 1500-2015 for determining which arrangement has the least draft loss. DOE proposes language in its test procedure to clarify how this is determined, specifically by adding the straight lengths of venting for each arrangement supplied with the equipment and using the one with the shortest total length. DOE believes this is a clarification only and does not believe ratings for commercial packaged boilers would be affected by this clarification.

In addition to these proposed clarifications regarding the setup and configuration of commercial packaged boilers for testing, DOE proposes clarifications and provisions regarding the test instrumentation and calibration. Specifically, regarding section 7.6, "Application of Additional Instruments (Steam)," of BTS–2000 (now section C2.6 of ANSI/AHRI Standard 1500-2015), ABMA commented that references to mercury and use of a mercury manometer should be removed, suggesting that mercury is no longer an industry-acceptable pressure measuring fluid for testing steam boilers.[13] (Docket EERE-2013-BT-STD-0030, ABMA, No. 14 at p. 3–4) DOE has concluded that the mercury-based instrumentation is outdated and recognizes that the ANSI/AHRI Standard 1500-2015 does not require or reference the use of mercury

[13] A "manometer" is an instrument that uses a column of liquid, such as mercury or water, contained in a glass or plastic tube and is used to measure the pressure of gases.

manometers. As such, DOE notes that by incorporating by reference ANSI/AHRI Standard 1500-2015 as proposed in this NOPR, the DOE test procedure would no longer specify or reference use of mercury manometers (or other mercury-based instrumentation).

Additionally, ABMA suggested that some other required instrumentation prescribed in BTS–2000 is outdated and that some calculation methods contained therein are laborious. In particular, ABMA inquired whether an oxygen (O_2) combustion analyzer may be used to determine combustion efficiency rather than the existing calculation procedures if it can be shown that its results are equivalent. (Docket EERE-2013-BT-STD-0030, ABMA, No. 14 at pp. 3–4) ANSI/AHRI Standard 1500-2015 includes a methodology for using an O_2 combustion analyzer for measurements of combustion efficiency, and DOE's proposal to incorporate by reference this industry standard would adopt this methodology. DOE recognizes ABMA's concern on this topic and seeks additional comments, and particularly data, about whether the oxygen combustion analyzer produces equivalent combustion efficiencies to the carbon monoxide (CO) and carbon dioxide (CO_2) calculations provided by ANSI/AHRI Standard 1500-2015 and BTS– 2000. This is identified as Issue 26 in section V.E.

DOE acknowledges that section C.1.1, "Calibration," of ANSI/AHRI Standard 1500-2015 requires instruments to be calibrated to a recognized standard at regular intervals. DOE believes that such a requirement is sufficient for ensuring appropriate calibration procedures for applicable test equipment. However, in order to ensure accurate and repeatable test measurements, DOE is proposing a provision that would require all instrumentation to be calibrated at least once per year. For combustion measurement equipment (instruments listed in

the "Gas Chemistry" row of Table C1 in ANSI/AHRI Standard 1500-2015), DOE proposes to require calibration using standard gases with purities of greater than 99.9995 percent for all constituents analyzed. DOE acknowledges that manufacturers and laboratories may have existing calibration and documentation protocols in place that already meet these requirements.

Finally, DOE proposes to require that data obtained digitally be sampled and recorded at 30-second intervals or less, and data related to rates, flows, or flux be integrated over the 15-minute intervals required throughout ANSI/AHRI Standard 1500-2015. Data not related to rates, flows, or fluxes shall be averaged over the 15-minute interval. DOE proposes this requirement as a means of confirming that ambient condition requirements and water temperatures are maintained for the duration of the test. This requirement would apply to digital flow meters for measuring water flow. However, DOE proposes that this requirement would not apply to the use of a scale for measuring the weight of feedwater collected, which would continue to be recorded in 15-minute intervals as provided in ANSI/AHRI Standard 1500-2015. DOE seeks comment on its proposal to require digital data acquisition, and this is identified as Issue 27 in section V.E.

DOE seeks general comment as to the proposed clarifications to test procedure setup and instrumentation. This is identified as Issue 28 in section V.E.

G. Fuel Input Rate

In DOE's existing regulations, equipment classes and the standards that apply to them are determined partly on the basis of the size of the commercial packaged boiler. However, several terms are used interchangeably in BTS 2000, ANSI/AHRI Standard 1500-2015, and in the

existing DOE test procedure and energy conservation standards to describe the size of the commercial packaged boiler, each of which is derived from the maximum rated fuel input rate to the commercial packaged boiler. For example, the existing DOE test procedure for commercial packaged boilers at 10 CFR 431.86 uses the term "rated input capacity" and "fuel input" while the energy conservation standards for commercial packaged boilers at 10 CFR 431.87 use "capacity," "rated maximum input," "maximum rated capacity," and "size category (input)," all of which are intended to mean the same thing. BTS-2000, which is incorporated by reference in the existing DOE test procedure for commercial packaged boiler, uses the terms "input," "input rating," and "manufacturer's nameplate input." ANSI/AHRI Standard 1500-2015 defines "input rating" as the maximum Btu/h or gph [gallons per hour] input located on the Boiler rating plate. Furthermore, neither the existing DOE regulatory text nor BTS-2000 specify how to determine this "rated" or "nameplate" maximum fuel input rate for a commercial packaged boiler. However, BTS-2000 and ANSI/AHRI Standard 1500-2015 require that the input be within ±2 percent of the "manufacturer's nameplate input" (BTS-2000) or "Input Rating" (ANSI/AHRI Standard 1500-2015).

To clarify how to determine the appropriate equipment class for commercial packaged boilers, DOE proposes to adopt a definition for the term "fuel input rate." DOE believes this is necessary to reduce ambiguity and standardize terminology throughout its commercial packaged boiler regulations. The proposed definition for "fuel input rate" states that it is determined using test procedures prescribed under 10 CFR 431.86 and represents the maximum rate, or "high fire rate," at which the commercial packaged boiler uses energy. DOE proposes to use this term in the division of equipment classes and applicable testing provisions to determine the fuel input

rate. Manufacturers would be required to measure the fuel input rate during certification testing and use the mean of the measured values, after applying the applicable rounding provisions,[14] in certification reports pursuant to 10 CFR 429.60(b)(2). DOE also notes that, for commercial packaged boilers certified using an AEDM, that AEDM would be used to determine the fuel input rate and the same rounding provisions would apply. DOE believes it is critical to clarify how the fuel input rate is to be determined because the applicable standards for a commercial packaged boiler are based in part on the fuel input rate of the commercial packaged boiler. These proposed additions would clarify for manufacturers what energy conservation standard applies to a given basic model.

DOE also proposes clarifications in its regulatory text that specify precisely how the fuel input rate is to be determined when using the DOE test procedure. DOE notes sections C4.1.1.2.3 and C4.1.2.2.3 of ANSI/AHRI Standard 1500-2015 require the total measured fuel input during the test to be within 2 percent of the "boiler Input Rating" and sections C4.1.1.1.4 and C4.1.2.1.5 require the measured fuel input rate, measured at 15-minute intervals to confirm steady-state, to be within 2 percent of the fuel input rate listed on the commercial packaged boiler nameplate. However, ANSI/AHRI Standard 1500-2015 does not specify the quantities and calculation procedure to be used in determining this value. DOE's clarifications specify the amount of oil or gas, as applicable, needed to ensure the fuel input rate is at steady-state (which is evaluated at 15-minute intervals). Moreover, DOE also proposes that steady-state is confirmed when the measured fuel input rate does not vary by more than ± 2 percent between 15 minute interval readings rather than in comparison to the commercial packaged boiler nameplate.

[14] The proposed calculations for the fuel input rate include a rounding requirement to the nearest 1,000 Btu/h; this is discussed in this section 0.

Section 5.2.2 of ANSI/AHRI Standard 1500-2015 specifies rounding gross output (as defined in section 3.20 of ANSI/AHRI Standard 1500-2015) to the nearest 1,000 Btu/h. DOE does not propose to adopt this section of ANSI/AHRI Standard 1500-2015 because DOE regulations are not based on gross output. Instead, DOE proposes adding a requirement to the DOE test procedure that values of fuel input rate for each unit tested be rounded to the nearest 1,000 Btu/h. Also, the representative value of fuel input rate for a model would be rounded to the nearest 1,000 Btu/h for representation purposes (including certification).

Additionally, DOE proposes that, for its enforcement testing, this rate would be measured pursuant to 10 CFR 431.86 and compared against the fuel input rate certified by the manufacturer. If the measured fuel input rate is within 2 percent of the certified value, then DOE will use the certified value when determining equipment class and calculating combustion and/or thermal efficiency for the model. If the measured fuel input rate is not within ±2 percent of the certified value, then DOE will follow these steps to bring the fuel input rate to within ±2 percent of the certified value. First, DOE will attempt to adjust the gas pressure in order to increase or decrease the fuel input rate as necessary. If the fuel input rate is still not within ±2 percent of the certified value, DOE will then attempt to modify the gas inlet orifice (e.g., drill) accordingly. Finally, if these measures do not bring the fuel input rate to within ±2 percent of the certified value, DOE will use the measured fuel input rate when determining equipment class and the associated combustion and/or thermal efficiency standard level for the basic model. DOE proposes a fuel input rate tolerance of ±2 percent based on the steady-state criteria already present in ANSI/AHRI Standard 1500-2015 sections C4.1.1.1.4 and C4.1.2.1.5, and believes that

such a requirement would not impose additional testing burden or affect ratings. DOE proposes this verification process to provide manufacturers with additional information about how DOE will evaluate compliance. DOE also notes that modification of the orifice to meet these conditions would not be considered a field constructed modification.

DOE considers these provisions to be clarifications to its test procedure, and this is supported by the existing requirement in BTS–2000 that the measured fuel input rate during testing must be within ±2 percent of the fuel input rate listed on commercial packaged boiler nameplates. DOE seeks comment regarding its proposed definition and methodology for measuring and verifying fuel input rate and steady-state, identified as Issue 29 in section V.E.

H. Clerical Issues

DOE proposes an amendment to the regulatory text to clarify those places in AHRI/ANSI Standard 1500-2015 that refer to manufacturer's "specifications or recommendations," to mean as specified or recommended in the installation and operation manual shipped with the commercial packaged boiler or in supplemental instructions provided by the manufacturer pursuant to 10 CFR 429.60(b)(4). Furthermore, DOE proposes amendments to the regulatory text that clarify the order in which these manufacturer instructions must be used should a conflict arise between them. For parameters or considerations not specified by the DOE test procedure, the manual shipped with the commercial packaged boiler must first be consulted and used. Should the manual shipped with the commercial packaged boiler not provide the necessary information, the supplemental instructions must be consulted and used. The supplemental instructions provided pursuant to 10 CFR 429.60(b)(4) do not replace or alter any requirements

in the DOE test procedure and are not meant to override the manual shipped with the commercial packaged boiler. In cases where these supplemental instructions conflict with any instructions or provisions provided in the manual shipped with the commercial packaged boiler, the manual shipped with the commercial packaged boiler must be used. DOE also proposes to clarify that unless otherwise noted, in all incorporated sections of ANSI/AHRI Standard 1500-2015 the term "boiler" means "commercial packaged boiler" as defined in 10 CFR 431.82.

DOE found two clerical issues in its review of ANSI/AHRI Standard 1500-2015. First, DOE notes that while section C2.3 of ANSI/AHRI Standard 1500-2015 anticipates that steam could be superheated and therefore temperature measurement of the steam would be required, it does not provide sufficient steam property tables or provisions for using the superheated steam temperature for calculating the thermal efficiency. DOE therefore proposes provisions for using this temperature and includes expanded steam property tables. Second, DOE notes that section C4.1.1.1.2 of ANSI/AHRI Standard 1500-2015 states that tests shall be conducted at atmospheric pressure or at the minimum steam pressure required to comply with Section 5.3.5. However, Section 5.3.5 describes the hot water rating conditions for ANSI/AHRI Standard 1500-2015. DOE believes that this was intended to refer instead to Section 5.3.6, and therefore proposes language in order to correct this.

Upon review of its definitions at 10 CFR 431.82 concerning commercial packaged boilers, DOE determined that additional description of the term "combustion efficiency" was warranted and is therefore proposing to modify that definition. Specifically, the existing definition for "combustion efficiency" does not describe what the metric represents and so DOE

is proposing additional language to indicate that the combustion efficiency measures how much of the fuel input energy is converted to useful heat in combustion.

DOE proposes rounding requirements for thermal efficiency and combustion efficiency values. DOE notes that while section 5.2.1 of ANSI/AHRI Standard 1500-2015 includes rounding requirements to the nearest tenth of a percent for thermal and combustion efficiency, DOE proposes to clarify in its regulations that values used for purposes of DOE compliance certification (representative values) must be values rounded to the nearest tenth of a percent.

With respect to the requirements for testing and certifying commercial packaged boiler models capable of supplying either steam or hot water, DOE notes that commercial packaged boilers that are capable of producing steam and commercial packaged boilers that are capable of producing hot water are subject to different energy conservation standards. However, DOE is also aware that some commercial packaged boiler models are capable of supplying both steam and hot water. DOE notes that such commercial packaged boiler models span two equipment classes (both the steam and hot water variations of the applicable fuel type and fuel input rate category combination) and therefore are subject to the energy conservation standards and testing requirements for both equipment classes. Models capable of producing both steam and hot water must be certified as two basic models.

DOE also proposes to move the requirements related to representative values of efficiency for such commercial packaged boilers. For commercial packaged boiler models capable of supplying either steam or hot water and with fuel input rate less than or equal to

2,500,000 Btu/h, under the existing test procedure (10 CFR 431.86(c)(2)(iii)) manufacturers must:

- Determine the representative value of the thermal efficiency in steam mode based on thermal efficiency in steam mode determined in accordance with the test procedure in §431.86 or determined with an AEDM; and
- Determine the representative value of the thermal efficiency in hot water mode based on either:
    - The thermal efficiency in hot water mode determined in accordance with the test procedure in §431.86 or determined with an AEDM; or
    - The thermal efficiency in steam mode determined in accordance with the test procedure in §431.86 or determined with an AEDM.

For commercial packaged boiler models capable of supplying either steam or hot water and with fuel input rate greater than 2,500,000 Btu/h, under the existing test procedure (10 CFR 431.86(c)(2)(iii)) manufacturers must:

- Determine the representative value of the thermal efficiency in steam mode based on thermal efficiency in steam mode determined in accordance with the test procedure in §431.86 or determined with an AEDM; and
- Determine the representative value of the combustion efficiency in hot water mode based on either:

- The combustion efficiency in hot water mode determined in accordance with the test procedure in §431.86 or determined with an AEDM; or
- The combustion efficiency in steam mode determined in accordance with the test procedure in §431.86 or determined with an AEDM.

DOE notes that these are existing provisions for such boilers at 10 CFR 431.86(c)(2)(iii) that establish the testing and rating requirements for commercial packaged boiler models capable of supplying either steam or hot water. Because provisions related to representations are typically in 10 CFR part 429, DOE is moving and rephrasing these requirements. Therefore, DOE notes that these regulations do not alter testing or rating options compared to the existing test procedure.

DOE seeks comment on its proposed clerical corrections and clarifications, identified as Issue 30 in section V.E.

I. Other Issues

In response to the September 2013 Framework document and February 2014 RFI, DOE received several comments about other issues, not discussed previously in this notice, concerning the test procedure for determining the energy efficiency of a commercial packaged boiler. These issues and comments are addressed in the following subsections.

1. Stack Temperature Adjustment for Using Combustion Efficiency in Steam Mode to Represent Hot Water Mode

DOE's existing test procedure allows commercial packaged boilers with fuel input rate greater than 2,500,000 Btu/h capable of producing steam and hot water to use the combustion efficiency as measured in steam mode to represent the combustion efficiency in hot water mode. 10 CFR 431.86(c)(2)(iii)(B). DOE has received multiple waiver requests that asked to use an adjustment to the stack temperature for using this rating method in order to more accurately reflect the combustion efficiency of a commercial packaged boiler operating in hot water mode. The adjustment is given by Equation 2:

$$T_{F,SS,adjusted} = T_{F,SS} - T_{sat} + 180 \qquad \textbf{Equation 2}$$

where $T_{F,SS,adjusted}$ is the adjusted steady-state flue temperature used for subsequent calculations of combustion efficiency, $T_{F,SS}$ is the measured steady-state flue temperature during combustion efficiency testing in steam mode, T_{sat} is the saturated steam temperature that corresponds to the measured steam pressure, and 180 is the hot water outlet temperature.

The proposed adjustment equation is derived by assuming that the heat transfer properties of the heat exchanger operating in hot water mode are roughly the same as the heat transfer properties of the heat exchanger operating in steam mode. This assumption is already implicit in the DOE allowance for using combustion efficiency ratings in steam mode to represent those in hot water mode, and, thus, this methodology is consistent with the intent of DOE's existing regulations. DOE believes that the methodology is technically sound and may result in more accurate representations of the performance of these commercial packaged boilers operating in hot water mode.

However, to further validate the proposed procedure, DOE seeks comments, as well as sample stack temperature data, sample calculations and estimates of the impact of this methodology. This is identified as Issue 31 in section V.E.

Relatedly, DOE proposes additional provisions for enforcement testing of commercial packaged boilers that are capable of producing both steam and hot water. Specifically, DOE is proposing that DOE could choose to test a given model that is capable of producing both steam and hot water in either mode for the purposes of assessing compliance with the applicable standard. DOE seeks comment regarding this proposed provision, and this is identified as Issue 32 in section V.E.

2.Testing at Part Load

In response to the September 2013 Framework document, ACEEE, ASAP, and NRDC asserted that the existing DOE test procedure for commercial packaged boilers, which is based on BTS–2000 and measures efficiency at peak load, is obsolete and that the rating method for boilers with modulating burners (including high/low fire) must incorporate some part-load efficiency measure. (Docket EERE-2013-BT-STD-0030, Joint Advocates, No. 16 at p. 2)

In the February 2014 RFI, DOE requested additional public comment, data, and information about adopting methodologies and measurements to determine part-load efficiency of commercial packaged boilers, including appropriate inlet and outlet water temperatures under part-load testing conditions, number of hours a modulating burner would operate under part-load

and full-load conditions over the course of a year, and any added test burden to account for part-load operation (e.g., measurement of jacket, sensible, and infiltration losses). 79 FR 9643, 9644.

ACEEE stated that whether for a fixed capacity or modulating boiler, the lower the inlet water temperature the higher the efficiency, and suggested that a boiler be rated at the lowest inlet water temperature permissible under a manufacturer's warranty. Also, in response to expected hours that modulating burners would operate under part-load and full-load conditions, ACEEE advocated for a review of industry designs, operational data, and simulations for boiler operation over the course of a year. (Docket EERE-2014-BT-TP-0006, ACEEE, No. 2 at pp. 2 and 3)

Burnham suggested using the same inlet/outlet water temperatures for part-load testing as for full [load] input testing because the design of modulating burners is indifferent to operating at full load or part load, and actual operation would vary according to the application. As for added test burden associated with part-load operation, Burnham asserted that test costs would double and that additional testing equipment would be needed to accommodate more precise control of lower flows and measurement. (Docket EERE-2013-BT-STD-0030, Burnham, No. 4 at pp. 1 and 2)

HTP stated that part-load testing would burden manufacturers when multiple operating conditions are required and, given possible misunderstanding of the systems-level aspects of efficiency, there may be market confusion over multiple efficiency ratings. HTP posited that DOE should only regulate single-point minimum efficiencies for commercial packaged boilers to

maintain consistency with historical use of "high fire rate." (Docket EERE-2014-BT-TP-0006, HTP, No. 5 at p. 2)

Although ACEEE suggested that DOE require enough testing to describe the entire performance map of the boiler (Docket EERE-2014-BT-TP-0006, ACEEE, No. 2 at p. 1), several parties expressed the concern that additional test points would greatly increase the testing burden for minimal added benefit. (Docket EERE-2013-BT-STD-0030, ABMA, No. 39 at p. 68; Docket EERE-2014-BT-TP-0006, Burnham, No. 4 at p. 1; Docket EERE-2014-BT-TP-0006, HTP, No. 5 at p. 2)

DOE understands that while a modulating burner can greatly reduce the annual energy consumption of a condensing commercial packaged boiler, the effect of a modulating burner on the measured steady-state efficiency of a non-condensing commercial packaged boiler is small.[15] Thus, DOE has tentatively determined that small increases in steady-state efficiency of non-condensing commercial packaged boilers at reduced firing rates do not warrant additional test procedures or efficiency metrics for non-condensing commercial packaged boilers operating at reduced firing rates. DOE also acknowledges the concerns from manufacturers (testing at different input ratings would require tests to be repeated, at least in part, multiple times). Therefore, DOE tentatively concludes that additional part-load testing for any commercial packaged boiler is not warranted at this time, but seeks further comment about part-load testing. This is identified as Issue 33 in section V.E.

[15] See Lochinvar website for example efficiency curves at various firing rates: http://www.lochinvar.com/products/documentation.aspx?mode=filetype&filetypeid=25.

3. Other Industry Test Procedures

Instead of using BTS–2000 to measure commercial packaged boiler efficiencies, Cleaver-Brooks suggested using the American Society of Mechanical Engineers (ASME) PTC 4.1–1964 (Reaffirmed 1991), "Power Test Codes: Test Code for Steam Generating Units" (with 1968 and 1969 Addenda) (ASME PTC 4.1), particularly the abbreviated test form and the heat loss method incorporated therein. Cleaver-Brooks added that ASME PTC 4.1 is the most common standard used by manufacturers of larger commercial packaged boilers (i.e., boilers greater than 2,500,000 Btu/h rated input), and that the heat loss method in that standard essentially provides the same efficiency values as BTS–2000 combustion efficiency if radiation losses are included. (Docket EERE-2013-BT-STD-0030, Cleaver-Brooks, No. 12 at p. 2) ABMA agreed that ASME PTC–4.1 is the more appropriate testing standard for larger boilers. ABMA cited general concerns about BTS–2000 from its member manufacturers, including (1) the high cost of testing larger boilers; (2) the 0–2 psig test pressure requirement that causes high steam velocity and poor steam quality; (3) large temperature rises causing high strain and fatigue in larger boilers; (4) the custom-built nature of larger combustion equipment; and (5) safety compliance requirements of other entities such as the National Board of Boiler and Pressure Vessel Inspectors. (Docket EERE-2013-BT-STD-0030, ABMA, No. 14 at pp. 2, 3) ABMA suggested in its comments responding to the November 2014 Preliminary Analysis that ASME PTC 4 (note: not PTC-4.1) should be used for testing. (Docket EERE-2013-BT-STD-0030, ABMA No. 33 at p. 2)

As part of the energy conservation standards and test procedure rulemaking for commercial packaged boilers that concluded with the final rule published in the Federal Register

on October 21, 2004 (69 FR 61949), DOE evaluated five other industry test procedures for potential incorporation by reference under 10 CFR 431.85.[16] At that time, DOE considered both ASME PTC 4–1998, "Fired Steam Generators Test Codes," and ASME PTC 4.1–1964, "Steam Generating Units Power Test Codes," as potential alternatives to BTS–2000. However, DOE adopted BTS–2000 for testing all covered commercial packaged boilers manufactured after October 21, 2006. Prior to that date, a manufacturer could use either BTS–2000 or the alternative test method ASME PTC 4.1–1964 for steel commercial packaged boilers. 69 FR 61949, 61961.

For this NOPR, DOE re-examined the test procedures and public comments addressed in the October 21, 2004 final rule and the rationale behind each. For example, public comments from GAMA about ASME PTC 4.1 included the following observations and critiques: (1) it lacks "tolerances for input, pressure, number of tests required, and when the boiler has achieved steady-state conditions;" (2) test duration of 4 hours is too long for a combustion test, and the locations "of temperature, pressure, flue sampling, and stack configuration are not specified;" (3) it is a test standard for the acceptance test of a boiler after it is installed where the test conditions are less controllable than a laboratory test; and (4) it has been replaced by the standard ASME PTC 4–1998 which is vastly different from the original ASME PTC 4.1. As such, DOE believed then and continues to believe that ASME PTC 4.1 would be too burdensome, that hours of

[16] The version of ASHRAE Standard 90.1 in effect on June 30, 1992, referenced five industry test standards that apply to gas-fired boilers or oil-fired boilers or both. These are the ANSI Standard Z21.13–1987 for gas-fired boilers (revised as ANSI Z21.13–1991 with Addendum ANSI Z21.13–1993a); the HI Testing and Rating Standard for Heating Boilers, sixth edition, 1989, for gas and oil-fired boilers (HI 1989); ASME Power Test Codes (PTC) 4.1–1964 (reaffirmed R1991) for Steam Generating Units for fossil fuel boilers (revised in 1998 as ASME PTC 4–1998, Fired Steam Generators, issued on December 31, 1999); the Underwriters Laboratory Standard 795–1973 for gas heating equipment (UL 795, revised in 1994 as UL 795–94); and the Underwriters Laboratory Standard UL Standard 726–1990 for oil-fired boilers (UL 726). See 69 FR 61955 (October 21, 2004).

testing are longer than needed, and that there are differences in results between PTC 4.1 and BTS–2000. In the October 2004 final rule, DOE found that ASME PTC 4.1–1964 (PTC 4.1) and its successor ASME PTC 4–1998 (PTC 4) were not fit for adoption as the required test procedure for the following reasons:

- The abbreviated test form of PTC 4.1, while a sound test, was removed in the PTC 4 version and its use was discouraged by the PTC 4 standard.
- Since the abbreviated test form of PTC 4.1 was not part of PTC 4, the test burden of the new standard was excessive for the purposes of rating smaller commercial packaged boilers.
- DOE believed there may be some differences in efficiency ratings between the PTC 4.1 and BTS–2000 tests, and, therefore, only one test method would be adopted.[17]
- BTS–2000 was simple to conduct, and converting from the abbreviated test form of PTC 4.1 to BTS–2000 would not be overly burdensome.

69 FR 61949, 61954–57.

DOE notes that these findings from the October 2004 final rule concerning BTS-2000 continue to apply to ANSI/AHRI Standard 1500-2015 because ANSI/AHRI Standard 1500-2015 is an updated version of BTS-2000.

On July 22, 2009, DOE published a final rule adopting the thermal efficiency metric as the energy efficiency descriptor for eight of ten equipment classes of commercial packaged

[17] The analysis conducted at the time of the NOPR used the document's previous version, HI-1989. 65 FR 48838 (August 9, 2000). At the time of final rule, DOE was provided with the updated BTS–2000 and found sufficient similarity such that BTS–2000 could be adopted as the test procedure without further analysis. 69 FR 61949, 61955-56 (October 21, 2004).

boilers in order to conform to ASHRAE Standard 90.1–2007. 74 FR 36314. The thermal efficiency metric was required for purposes of compliance starting March 2, 2012. DOE notes that BTS–2000 was incorporated by reference as the foundation of the DOE test procedure on October 21, 2004. 69 FR 61949. Manufacturers have been required to use BTS–2000 for purposes of compliance since October 24, 2006. 69 FR 61961. DOE has not been provided with new data that substantiate claims from ABMA or manufacturers regarding possible test complications or burden since these previous rulemakings were undertaken.

With regard to ABMA's specific claims concerning the BTS–2000 methodology (Docket EERE-2013-BT-STD-0030, ABMA, No. 14 at p. 2, 3), DOE proposes modified inlet and outlet water temperatures for hot water commercial packaged boiler tests (section III.D) and a wider allowable range of steam operating pressures for steam commercial packaged boiler tests (see section III.C.4), as provided in ANSI/AHRI Standard 1500-2015. DOE believes these proposals would alleviate ABMA's concerns regarding excessive commercial packaged boiler stresses and steam quality and are consistent with ABMA's suggestions. (Docket EERE-2013-BT-STD-0030, ABMA, No. 14 at p. 4)

AHRI commented that ASHRAE Standard 155, "Method of Testing for Rating Commercial Space Heating Boiler Systems," is being developed as a replacement for BTS–2000 (and ANSI/AHRI Standard 1500-2015) and that DOE could adopt this new standard as a new reference for the commercial packaged boiler test procedure. (Docket EERE-2014-BT-TP-0006, AHRI, No. 6 at pp. 2–3) AHRI suggested that DOE should defer considering alterations to its test procedure until ASHRAE Standard 155 is published. PGE and SCE also urged DOE to

consider using the ASHRAE Standard 155, which is currently under development, as the basis for the Federal test procedure. (Docket EERE-2013-BT-STD-0030, Joint Utilities, No. 38 at p. 3) DOE understands that the development of ASHRAE Standard 155 is currently a proposed standards project.[18] DOE is not aware of any scheduled publication date, and is now subject to a statutory requirement to review the test procedure. As stated previously, DOE last reviewed the test procedures for commercial packaged boilers in a final rule published in the Federal Register on July 22, 2009 (74 FR 36312), and thus is required to re-evaluate the test procedures no later than July 22, 2016. Consequently, DOE plans to move forward with this test procedure rulemaking for commercial packaged boilers. However, DOE will monitor developments related to ASHRAE Standard 155 and may consider incorporation of that standard in a future test procedure rulemaking. As noted previously, in this NOPR, DOE proposes to incorporate by reference the recently published ANSI/AHRI Standard 1500-2015 that supersedes the BTS–2000 standard and corrects some minor issues therein.

IV. Procedural Issues and Regulatory Review

A. Review Under Executive Order 12866

The Office of Management and Budget (OMB) has determined that test procedure rulemakings do not constitute "significant regulatory actions" under section 3(f) of Executive Order 12866, "Regulatory Planning and Review," 58 FR 51735 (October 4, 1993). Accordingly,

[18] ASHRAE Standard 155 (currently identified as SPC 155P) is a proposed standards project, the purpose of which is to develop procedures for determining the steady-state thermal efficiency, part-load efficiency, and idling energy input rate of space heating boilers. See https://www.ashrae.org/standards-research--technology/standards--guidelines/titles-purposes-and-scopes#SPC155P

this regulatory 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 (IFRA) 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 (August 16, 2002), DOE published procedures and policies on February 19, 2003, to ensure that the potential impacts of its rules on small entities are properly considered during the DOE rulemaking process. 68 FR 7990. DOE has made its procedures and policies available on the Office of the General Counsel's website: http://energy.gov/gc/office-general-counsel.

This proposed rule prescribes test procedure amendments that would be used to determine compliance with energy conservation standards for commercial packaged boilers. The proposed amendments modify the inlet and outlet water temperatures for hot water tests, increase the allowable steam pressure for steam tests, implement more specific criteria for determining when steady-state has been reached during testing, and establish room temperature and relative humidity limits.

DOE reviewed this proposed rule under the provisions of the Regulatory Flexibility Act and DOE's own procedures and policies published on February 19, 2003. DOE has concluded

that the proposed rule would not have a significant impact on a substantial number of small entities. The factual basis for this certification is as follows.

The Small Business Administration (SBA) considers a business entity to be a small business, if, together with its affiliates, it employs less than a threshold number of workers specified in 13 CFR part 121. These size standards and codes are established by the North American Industry Classification System (NAICS). The threshold number for NAICS classification code 333414, which applies to "heating equipment (except warm air furnaces) manufacturing' and includes commercial packaged boilers, is 500 employees.

To estimate the number of companies that could be small business manufacturers of the equipment affected by this rulemaking, DOE conducted a market survey using available public information to identify potential small manufacturers. DOE's research involved reviewing the AHRI directory (a product database), individual company websites, and marketing research tools (e.g., Hoover's reports) to create a list of all domestic small business manufacturers of equipment affected by this rulemaking. DOE identified 23 manufacturers of commercial packaged boilers as domestic small business manufacturers. DOE was able to discuss the DOE test procedures with 5 of these small businesses. DOE also obtained information about small businesses and potential impacts on small businesses while interviewing manufacturers in the context of the standards rulemaking. However, DOE did not receive any detailed quantifications about the incremental burden small businesses would face as compared to larger businesses in light of the proposed methods.

The proposed amendments would alter water temperatures for hot water commercial packaged boilers tests, increase the allowable steam pressure for steam tests, add specific criteria for establishing steady-state, and place limits on the ambient temperature and relative humidity during testing. DOE recognizes that by reducing the temperature rise across the commercial packaged boiler, the water flow rate will necessarily increase proportionally. The required flow rate for a 10 million Btu/h fuel input rate commercial packaged boiler with a 100 °F minimum temperature rise (as is the case currently for non-condensing commercial packaged boilers) would be approximately 200 gallons per minute (gpm). Reducing the temperature rise across the commercial packaged boiler to 40 °F would increase the water flow rate requirement to approximately 500 gpm for a 10 million Btu/h fuel input rate commercial packaged boiler. If a laboratory or manufacturer does not currently have a pump capable of handling the flow rates of the commercial packaged boilers they are testing, they may need to purchase a pump rated for a higher flow rate. Based on internet research of several HVAC equipment vendors, DOE estimates that the cost of a pump capable of 500 gpm is $3,000. The number of models for which this investment would be required would vary by manufacturer and laboratory; however, DOE estimates the average to be 15 models.[19] Therefore, DOE estimates the cost per model of this investment to be approximately $200, which DOE believes to be a modest amount compared to the total product development and certification costs of a model, which can be in the tens of thousands of dollars.[20]

[19] Based on product model listing compiled for commercial packaged boilers standards rulemaking using the AHRI directory, docket EERE-2013-BT-STD-0030.
[20] Based on information obtained during confidential manufacturer interviews as part of the commercial packaged boilers standards rulemaking, docket EERE-2013-BT-STD-0030.

Regarding the increase in allowable steam pressure for steam commercial packaged boiler tests, manufacturers will likely initiate a test at low pressure (much less than 15 psi) and increase as necessary (up to 15 psi) to achieve the necessary steam quality. While the setup and operation of the test is unchanged, this process may increase the amount of time necessary to perform the test. DOE estimates that this would increase test time by, at most, 2 hours. For a 10 million Btu/h fuel input rate commercial packaged boiler, and assuming a rate of $40 per hour for a laboratory technician, $8.89 per thousand cubic feet of natural gas, and 1,025 Btu per cubic foot high heating value (HHV), DOE estimates the additional testing cost to be $253.46.[21] DOE believes this amount is modest in comparison to the overall cost of product development and certification.

In the case of the criteria for establishing steady-state, DOE believes that the requirements do not add to the time or cost necessary to conduct the test. The test procedure already requires a period of 30 minutes prior to starting the test, during which steady-state is established. DOE is clarifying the conditions that must be satisfied to meet steady-state, and does not believe any additional time is required to meet such conditions.

[21] The laboratory technician hourly wage is based on mean hourly wage of $26.67 from the Bureau of Labor Statistics for a Mechanical Engineering Technician, occupational code 17-3027: http://www.bls.gov/oes/current/oes173027.htm. (Last accessed January 21, 2016.) Mean hourly wage is multiplied by 1.5 to estimate associated benefits and overhead. The price of natural gas is the 5-year average (May 2009 to May 2014) obtained from the "U.S. Price of Natural Gas Sold to Commercial Consumers" from U.S. Energy Information Administration (EIA) (Available at: http://www.eia.gov/dnav/ng/hist/n3020us3m.htm).

With regard to the test room ambient temperature and relative humidity limits, DOE notes that the limits are intended to prevent the test from being conducted in extreme ambient conditions, and that the allowable temperature and relative humidity ranges are typical for building heating, ventilating, and air-conditioning systems in normal operating conditions. DOE is aware that the proposed constraints may in some cases require laboratories to move testing from an uncontrolled environment (i.e., outdoors or facilities open to the outdoors) to a controlled environment. However, DOE believes this to be a small number of cases, and that typically testing is performed in a laboratory setting with typical heating, ventilating, and air-conditioning systems and controls. DOE notes that the limits are intended to prevent the test from being conducted in extreme ambient conditions, and that the ambient temperature requirements are typical for building heating, ventilating, and air-conditioning systems in normal operating condition. However, if the ambient temperature or relative humidity in the testing area do not already meet these tolerances, the manufacturer may need to improve climate regulation of the test environment, possibly by improving the controls of their thermostats, or preventing hot or cold drafts from entering the testing environment. DOE estimates that improving the controls of the thermostat and preventing hot or cold drafts from entering the testing environment could involve four to eight hours of labor by a general technician. At a rate of $40 per hour for a laboratory technician, DOE estimates the cost for this amount of labor to be between $160 and $320, which DOE believes is modest in comparison to the overall cost of product development and certification.

Finally, DOE acknowledges that the proposal to require digital data acquisition may add additional test burden. DOE has estimated the following costs associated with digital data acquisition:

Table IV.1 Estimated One-Time Costs Associated with Digital Data Acquisition

Description	Cost
Laptop	$1,500
Data Acquisition Module	$2,000
Data Acquisition Software	$3,000
Installation and Setup (16 hours laboratory technician time X $40/hour)	$640
Total	$7,140

The data acquisition system could be used by the manufacturer or laboratory to test all commercial packaged boiler models. Again, DOE believes these costs are modest in comparison to the overall cost of product development and certification.

For the reasons stated previously, DOE concludes that this proposed rule would not have a significant economic impact on a substantial number of small entities, so DOE has not prepared a regulatory flexibility analysis for this rulemaking. DOE will provide its certification and supporting statement of factual basis to the Chief Counsel for Advocacy of the SBA for review under 5 U.S.C. 605(b).

DOE seeks comment on whether the proposed test procedure changes will have a significant impact on a substantial number of small entities. This is identified as Issue 34 in section V.E.

C. Review Under the Paperwork Reduction Act of 1995

Manufacturers of commercial packaged boilers must certify to DOE that their equipment complies with all applicable energy conservation standards. In certifying compliance, manufacturers must test their equipment according to the DOE test procedure for commercial packaged boilers under 10 CFR 431.86, including any amendments adopted for those test procedures, on the date that compliance is required. DOE has established regulations for the certification and recordkeeping requirements for all covered consumer products and commercial equipment, including commercial packaged boilers. See 10 CFR part 429, subpart B. The collection-of-information requirement for certification and recordkeeping is subject to review and approval by OMB under the Paperwork Reduction Act (PRA). This requirement has been approved by OMB under OMB Control Number 1910-1400. Public reporting burden for the certification is estimated to average 30 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

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

D. Review Under the National Environmental Policy Act of 1969

In this proposed rule, DOE proposes test procedure amendments that it expects will be used to develop and implement future energy conservation standards for commercial packaged

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

E. Review Under Executive Order 13132

Executive Order 13132, "Federalism," 64 FR 43255 (August 10, 1999), imposes certain requirements on Federal agencies formulating and implementing policies or regulations that preempt State law or that have Federalism implications. The Executive Order requires agencies to examine the constitutional and statutory authority supporting any action that would limit the policymaking discretion of the States, and to carefully assess the necessity for such actions. The Executive Order also requires agencies to have an accountability process to ensure meaningful and timely input by State and local officials in the development of regulatory policies that have Federalism implications. On March 14, 2000, DOE published a statement of policy describing the intergovernmental consultation process it will follow in the development of such regulations. 65 FR 13735. DOE 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 equipment that is 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); 42 U.S.C. 6316(a)) 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. Pub. L. No. 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 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 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 commercial packaged 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.

This proposed rule incorporates testing methods contained in the commercial standard ANSI/AHRI Standard 1500-2015, "2015 Standard for Performance Rating of Commercial Space Heating Boilers." While this NOPR proposes amendments that supplant various provisions of that industry standard, the test procedure is largely adopted directly from the commercial standard without amendment. DOE has evaluated this standard and is unable to conclude whether it fully complies with the requirements of section 32(b) of the FEAA, (i.e., that it was developed in a manner that fully provides for public participation, comment, and review). DOE will consult with the Attorney General and the Chairwoman of the FTC concerning the impact on competition of requiring manufacturers to use the test methods contained in this industry standard prior to prescribing a final rule.

M. Description of Materials Incorporated by Reference

In this NOPR, DOE proposes to incorporate by reference certain sections of ANSI/AHRI Standard 1500-2015, "2015 Standard for Performance Rating of Commercial Space Heating Boilers." ANSI/AHRI Standard 1500-2015 is an industry-accepted test procedure that provides methods, requirements, and calculations for determining the thermal and/or combustion efficiency of a commercial space heating boiler. ANSI/AHRI Standard 1500-2015 is available at http://www.ahrinet.org/App_Content/ahri/files/standards%20pdfs/ANSI%20standards%20pdfs/ANSI.AHRI_Standard_1500-2015.pdf.

V. Public Participation

A. Attendance at the Public Meeting

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

Please note that foreign nationals participating in the public meeting are subject to advance security screening procedures which require advance notice prior to attendance at the public meeting. Any foreign national wishing to participate in the public meeting should inform DOE as soon as possible by contacting Ms. Regina Washington at (202) 586-1214 or by email: Regina.Washington@ee.doe.gov so that the necessary procedures can be completed.

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

Due to the REAL ID Act implemented by the Department of Homeland Security (DHS), there have been recent changes regarding identification (ID) requirements for individuals wishing to enter Federal buildings from specific states and U.S. territories. As a result, driver's licenses

from the following states or territory will not be accepted for building entry and one of the alternate forms of ID listed below will be required. DHS has determined that regular driver's licenses (and ID cards) from the following jurisdictions are not acceptable for entry into DOE facilities: Alaska, American Samoa, Arizona, Louisiana, Maine, Massachusetts, Minnesota, New York, Oklahoma, and Washington. Acceptable alternate forms of Photo-ID include: U.S. Passport or Passport Card; an Enhanced Driver's License or Enhanced ID-Card issued by the states of Minnesota, New York or Washington (Enhanced licenses issued by these states are clearly marked Enhanced or Enhanced Driver's License); a military ID or other Federal government issued Photo-ID card.

In addition, you can attend the public meeting via webinar. Webinar registration information, participant instructions, and information about the capabilities available to webinar participants will be published on DOE's website at: https://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx?ruleid=87. 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 plans to present a prepared general statement may request that copies of his or her statement be made available at the public meeting. Such persons may submit requests, along with an advance electronic copy of their statement in PDF (preferred), Microsoft Word or Excel, WordPerfect, or text (ASCII) file format, to the appropriate address shown in the **ADDRESSES** section at the beginning of this NOPR. The request and advance copy of statements must be received at least one week before the public meeting and may be emailed,

hand-delivered, or sent by mail. DOE prefers to receive requests and advance copies via email. Please include a telephone number to enable DOE staff to make a follow-up contact, if needed.

C. Conduct of the Public Meeting

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

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

At the end of all prepared statements on a topic, DOE will permit participants to clarify their statements briefly and comment on statements made by others. Participants should be prepared to answer questions by DOE and by other participants concerning these issues. DOE

representatives may also ask questions of participants concerning other matters relevant to this rulemaking. The official conducting the public meeting will accept additional comments or questions from those attending, as time permits. The presiding official will announce any further procedural rules or modification of the above procedures that may be needed for the proper conduct of the public meeting.

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

D. Submission of Comments

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

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

due to technical difficulties and cannot contact you for clarification, DOE may not be able to consider your comment.

However, your contact information will be publicly viewable if you include it in the comment itself or in any documents attached to your comment. Any information that you do not want to be publicly viewable should not be included in your comment, nor in any document attached to your comment. 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, hand delivery/courier, or mail. Comments and documents submitted via email, hand delivery/courier, or mail also will be posted to www.regulations.gov. If you do not want your personal contact information to be publicly viewable, do not include it in your comment or any accompanying documents. Instead, provide your contact information in a cover letter. Include your first and last names, email address, telephone number, and optional mailing address. The cover letter will not be publicly viewable as long as it does not include any comments.

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

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

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

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

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

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

E. Issues on Which DOE Seeks Comment

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

1. DOE seeks comment on its proposal to replace BTS–2000 with ANSI/AHRI Standard 1500-2015 in its test procedure for commercial packaged boilers (section III.A).
2. DOE seeks comment on its proposal to remove its definition for packaged low pressure boiler and modify its definitions for commercial packaged boiler (section III.B.1).
3. DOE seeks comment on its proposed definition for "field-constructed." (section III.B.2)
4. DOE seeks comment on the feasibility of conducting a combustion efficiency test in the field for steam and hot water commercial packaged boilers with fuel input rate greater than 5,000,000 Btu/h (section III.C.1).
5. DOE seeks comment on whether the thermal efficiency test can be conducted for steam commercial packaged boilers with fuel input rate greater than 2,500,000 Btu/h and less than or equal to 5,000,000 Btu/h (section III.C.1).
6. DOE seeks comment on the specific limitations, if they exist, that preclude combustion efficiency testing in a laboratory setting for steam commercial packaged boilers with fuel input rate greater than 2,500,000 Btu/h and less than or equal to 5,000,000 Btu/h (section III.C.1).
7. DOE seeks comment on the specific additional equipment or facilities and their associated cost that would be required to accommodate testing commercial packaged

boilers with fuel input rate greater than 2,500,000 Btu/h and less than or equal to 5,000,000 Btu/h in a laboratory setting (section III.C.1).

8. DOE seeks comment on whether the 5,000,000 Btu/h fuel input rate is an adequate threshold for the allowance of the field combustion test and conversion methodology, and if not, what threshold should be used (section III.C.1).
9. DOE seeks comment on whether certification should be permitted for field tested units after distribution in commerce and after commissioning, in particular the impact of this approach on building inspectors (section III.C.1).
10. DOE seeks comment on its proposed conversion method for calculating thermal efficiency based on combustion efficiency for steam commercial packaged boilers with fuel input rate greater than 5,000,000 Btu/h (section III.C.2).
11. DOE seeks comment on the proposed value for the difference between the combustion efficiency and thermal efficiency in the conversion method (proposed value of 2 percent of the combustion efficiency), whether the value would result in conservative ratings, and what number DOE should use instead if the proposed value is not adequate (section III.C.2).
12. DOE seeks comment on whether the 5,000,000 Btu/h fuel input rate is an adequate threshold for the allowance of the field combustion test and/or conversion methodology, and if not, what threshold should be used (section III.C.2).
13. DOE seeks comment on if the field combustion test (for hot water and steam commercial packaged boilers) and conversion methodology (for steam commercial packaged boilers) do not adequately accommodate commercial packaged boilers with

fuel input rate greater than 5,000,000 Btu/h, what procedure should DOE implement in order to do so (section III.C.2).

14. DOE seeks comments, data, and information about pressures recommended by manufacturers and relevance to actual operating conditions in buildings (section III.C.4).
15. DOE seeks comment on whether DOE should require testing to be performed at the lowest possible steam pressure where steam quality requirements can be met (section III.C.4).
16. DOE also requests comment on if there are any commercial packaged boilers that require steam pressures greater than 15 psig to maintain 2 percent moisture in the produced steam (see section III.C.4).
17. DOE seeks comments, data, and information about whether the proposed testing conditions related to water temperatures are appropriate both for a non-condensing commercial packaged boiler and a condensing commercial packaged boiler (section III.D.2).
18. DOE also requests comment on the proposed test provisions to accommodate commercial packaged boilers that cannot be tested with a temperature rise of 40 °F across the commercial packaged boiler (Point B to Point C); (section III.D.2).
19. DOE seeks additional comments, data, and analysis concerning thermal efficiency test measurement uncertainty (section III.D.2).
20. DOE seeks comment regarding the current prevalence of using recirculating loops in testing; specifically, DOE requests comment about the kinds of commercial packaged

boilers utilizing recirculation loops and the conditions at which these commercial packaged boilers and recirculating loops operate (section III.D.4).

21. DOE seeks further comments, data, and information concerning the capabilities of test laboratories, particularly in light of the specific proposed conditions contained in this NOPR (section III.D.4).
22. DOE seeks comments, data, and information about room ambient relative humidity, whether the proposed constraints are appropriate, and if not, what are appropriate constraints on room ambient relative humidity when testing commercial packaged boilers (section III.E).
23. DOE seeks comment, data, and information about the aforementioned proposed room ambient temperatures, whether the proposed constraints are appropriate and if not, what are appropriate constraints on room ambient temperature (section III.E)
24. DOE seeks comments based upon the proposed changes to the steam riser, header, and return water loop requirements (section III.F).
25. DOE seeks comments regarding the specification of burners for oil-fired commercial packaged boilers (section III.F).
26. DOE seeks additional comment, and particularly data, about whether the oxygen combustion analyzer produces equivalent combustion efficiencies to the carbon monoxide (CO) and carbon dioxide (CO_2) calculations provided by ANSI/AHRI Standard 1500-2015 and BTS–2000 (section III.F).
27. DOE seeks comment on the proposal to require digital data acquisition (section III.F).
28. DOE seeks comment as to the proposed clarifications in set up and instrumentation (section III.F).

29. DOE seeks comment regarding its proposed definition and methodology for measuring and verifying fuel input rate and steady-state (section III.G).
30. DOE seeks comment on its proposed clerical corrections and clarifications (section III.H).
31. DOE seeks comments, as well as sample stack temperature data, sample calculations and estimates of the impact of the stack temperature adjustment methodology (section III.I.1).
32. DOE seeks comment regarding its proposed provision to conduct enforcement testing in both steam mode and hot water mode for those commercial packaged boilers capable of producing both and using either result in determining noncompliance with energy conservation standards. (section III.I.1)
33. DOE seeks further comment concerning part-load testing (section III.I.2).
34. DOE seeks comment on whether the proposed test procedure changes will have a significant impact on a substantial number of small entities (section IV.B).

VI. Approval of the Office of the Secretary

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

List of Subjects

10 CFR Part 429

Administrative practice and procedure, Confidential business information, Energy conservation, Household appliances, Imports, Incorporation by reference, Reporting and recordkeeping requirements.

10 CFR Part 431

Administrative practice and procedure, Confidential business information, Energy conservation, Incorporation by reference, Reporting and recordkeeping requirements, Test procedures.

Issued in Washington, DC, on February 22, 2016.

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Kathleen B. Hogan
Deputy Assistant Secretary for Energy Efficiency
Energy Efficiency and Renewable Energy

For the reasons stated in the preamble, DOE proposes to amend parts 429 and 431 of chapter II, subchapter D of title 10, Code of Federal Regulations, as set forth below:

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

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

Authority: 42 U.S.C. 6291–6317.

2. Section 429.4 is amended by adding paragraph (c)(2) to read as follows:

§ 429.4 Materials incorporated by reference.

* * * * *

(c) * * *

(2) AHRI Standard 1500-2015, "2015 Standard for Performance Rating of Commercial Space Heating Boilers," approved November 28, 2014: Section 3 "Definitions;"; Section 5 "Rating Requirements;" Appendix C "Methods of Testing for Rating Commercial Space Heating Boilers – Normative," excluding Figures C5 and C7; Appendix D "Properties of Saturated Steam – Normative;" and Appendix E "Correction Factors for Heating Values of Fuel Gases – Normative;" IBR approved for § 429.60.

* * * * *

3. Section 429.11 is amended by revising paragraph (b) to read as follows:

§ 429.11 General sampling requirements for selecting units to be tested.

* * * * *

(b) The minimum number of units tested shall be no less than two, except where:

(1) A different minimum limit is specified in §§ 429.14 through 429.65; or

(2) Only one unit of the basic model is produced, in which case, that unit must be tested and the test results must demonstrate that the basic model performs at or better than the applicable standard(s). If one or more units of the basic model are manufactured subsequently, compliance with the default sampling and representations provisions is required.

4. Section 429.60 is amended by:

a. Revising paragraph (a)(1)(i);

b. Adding paragraphs (a)(3), (4), and (5);

c. Revising paragraph (b)(2); and

d. Adding paragraphs (b)(3)(iii) and (b)(5).

The revisions and additions read as follows:

§ 429.60 Commercial packaged boilers.

(a) * * *

(1) * * *

(i) If the represented value is determined through testing, the general requirements of § 429.11 are applicable, except that, if the represented value is determined through testing pursuant to § 431.86(c) of this chapter, the number of units selected for testing may be one; and

* * * * *

(3) The representative value of fuel input rate of a basic model reported in accordance with paragraph (b)(2) of this section must be either the mean of the fuel input rate(s) measured for each tested unit of the basic model and determined in accordance with the test procedure in § 431.86 of this chapter, or the value determined with an AEDM, and rounded to the nearest 1,000 Btu/h.

(4) The representative value of thermal or combustion efficiency of a basic model reported in accordance with paragraph (b)(2) of this section must be either the mean of the thermal or combustion efficiency measured for each tested unit of the basic model and determined in accordance with the test procedure in § 431.86 of this chapter, or the value determined with an AEDM, and rounded to the nearest tenth of one percent.

(5) For a model of commercial packaged boiler capable of supplying either steam or hot water, representative values for steam mode must be based on performance in steam mode and representative values for hot water mode must be based on either the efficiency in hot water mode or steam mode in accordance with the test procedure in § 431.86 of this chapter and the provisions of this section.

(b) * * *

(2) Pursuant to § 429.12(b)(13), a certification report must include the following public, equipment-specific information:

(i) The manufacturer (including brand, if applicable) and model number of the burner;

(ii) The fuel input rate in British thermal units per hour (Btu/h) rounded to the nearest 1,000 Btu/h;

(iii) The representative value of combustion efficiency in percent (%) to the nearest tenth of one percent or the representative value of thermal efficiency in percent (%) to the nearest one tenth of one percent, as specified in § 431.87 of this chapter; and

(iv) For a basic model of commercial packaged boiler that cannot be tested using the standard inlet temperatures required in appendix A to subpart E of part 431 of this chapter, the average inlet water temperature measured at Point B (in Figure C9 of ANSI/AHRI Standard 1500-2015) (incorporated by reference, see § 429.4) at which the model was tested.

(3) * * *

(iii) For basic models of commercial packaged boilers that have a certified fuel input rate greater than 5,000,000 Btu/h, a declaration about whether the certified rating is based on testing conducted pursuant to § 431.86(c) of this chapter.

* * * * *

(5) Any field tested (pursuant to § 431.86(c) of this chapter) basic model of a commercial packaged boiler that has not been previously certified through testing or an AEDM must be certified within 15 days of commissioning.

* * * * *

5. Section 429.70 is amended by adding paragraph (c)(2)(iii)(D) to read as follows:

§ 429.70 Alternative methods for determining energy efficiency and energy use.

* * * * *

(c) * * *

(2) * * *

(iii) * * *

(D) An AEDM that is validated based on test results obtained from one or more field tests (commercial packaged boilers only) can only be used to certify the performance of basic models of commercial packaged boilers with a certified fuel input rate greater than 5,000,000 Btu/h.

* * * * *

6. Section 429.110 is amended by:

a. Revising paragraph (a)(3); and

b. Adding paragraph (c)(1)(iii).

The addition and revision reads as follows:

§ 429.110 Enforcement testing.

(a) * * *

(3) Testing will be conducted at a lab accredited to the International Organization for Standardization (ISO)/International Electrotechnical Commission (IEC), "General requirements `for the competence of testing and calibration laboratories," ISO/IEC 17025:2005(E) (incorporated by reference; see § 429.4). If testing cannot be completed at an independent lab, DOE, at its discretion, may allow enforcement testing at a manufacturer's lab, so long as the lab is accredited to ISO/IEC 17025:2005(E) and DOE representatives witness the testing. In addition, for commercial packaged boilers with certified fuel input rate greater than 5,000,000 Btu/h, DOE, at its discretion, may allow enforcement testing of a commissioned commercial

packaged boiler in the location in which it was commissioned for use, pursuant to the test provisions at § 431.86(c) of this chapter.

* * * * *

(c) * * *

(1) * * *

(iii) Of basic models of previously commissioned commercial packaged boilers with a certified fuel input rate greater than 5,000,000 Btu/h, DOE may test a sample of at least one unit in the location in which it was commissioned for use.

* * * * *

7. Section 429.134 is amended by adding paragraph (k) to read as follows:

§ 429.134 Product-specific enforcement provisions.

* * * * *

(k) Commercial packaged boilers--(1) Verification of fuel input rate. The fuel input rate of each tested unit will be measured pursuant to the test requirements of § 431.86 of this chapter. The results of the measurement(s) will be compared to the value of fuel input rate certified by the manufacturer. The certified fuel input rate will be considered valid only if the measurement(s) (either the measured fuel input rate for a single unit sample or the average of the measured fuel input rates for a multiple unit sample) is within two percent of the certified fuel input rate.

(i) If the representative value of fuel input rate is found to be valid, the certified fuel input rate will serve as the basis for determination of the appropriate equipment class(es) and the mean

measured fuel input rate will be used as the basis for calculation of combustion and/or thermal efficiency for the basic model.

(ii) If the representative value of fuel input rate is not within two percent of the certified fuel input rate, DOE will first attempt to increase or decrease the gas pressure within the range specified in manufacturer's installation and operation manual shipped with the commercial packaged boiler being tested (or, if not provided in the manual, in supplemental instructions provided by the manufacturer pursuant to § 429.60(b)(4)) to achieve the certified fuel input rate (within two percent). If the fuel input rate is still not within two percent of the certified fuel input rate, DOE will attempt to modify the gas inlet orifice. If the fuel input rate still is not within two percent of the certified fuel input rate, the mean measured fuel input rate will serve as the basis for determination of the appropriate equipment class(es) and calculation of combustion and/or thermal efficiency for the basic model.

(2) Models capable of producing both hot water and steam. For a model of commercial packaged boiler that is capable of producing both hot water and steam, DOE may measure the thermal or combustion efficiency as applicable pursuant to § 431.87 of this chapter for steam and/or hot water modes. DOE will evaluate compliance based on the measured thermal or combustion efficiency in steam and hot water modes, independently.

PART 431 – ENERGY EFFICIENCY PROGRAM FOR CERTAIN COMMERCIAL AND INDUSTRIAL EQUIPMENT

8. The authority citation for part 431 continues to read as follows:

Authority: 42 U.S.C. 6291–6317.

9. Section 431.82 is amended by:

a. Revising the definitions for “Combustion efficiency” and “Commercial packaged boiler”;

b. Adding in alphabetical order definitions for “Field-constructed,” and “Fuel input rate”;

c. Revising the definition for “Packaged boiler”; and

d. Removing the definitions for “Packaged high pressure boiler” and “Packaged low pressure boiler”.

The revisions and additions read as follows:

§ 431.82 Definitions concerning commercial packaged boilers.

* * * * *

Combustion efficiency for a commercial packaged boiler is a measurement of how much of the fuel input energy is converted to useful heat in combustion and is calculated as 100 percent minus percent flue loss, as determined with the test procedures prescribed under § 431.86.

Commercial packaged boiler means a packaged boiler that meets all of the following criteria:

(1) Has fuel input rate of 300,000 Btu/h or greater;

(2) Is, to any significant extent, distributed in commerce for space conditioning and/or service water heating in buildings but does not meet the definition of “hot water supply boiler” in this part;

(3) Does not meet the definition of "field-constructed" in this section; and

(4) Is designed to:

(i) Operate at a steam pressure at or below 15 psig;

(ii) Operate at or below a water pressure of 160 psig and water temperature of 250 °F; or

(iii) Operate at the conditions specified in both paragraphs (4)(i) and (ii) of this definition.

* * * * *Field-constructed means custom-designed equipment that requires welding of structural components in the field during installation; for the purposes of this definition, welding does not include attachment using mechanical fasteners or brazing; any jackets, shrouds, venting, burner, or burner mounting hardware are not structural components.

* * * * *

Fuel input rate for a commercial packaged boiler means the maximum rate at which the commercial packaged boiler uses energy and is determined using test procedures prescribed under § 431.86.

* * * * *

Packaged boiler means a boiler that is shipped complete with heating equipment, mechanical draft equipment, and automatic controls and is usually shipped in one or more sections. If the boiler is shipped in more than one section, the sections may be produced by more than one manufacturer, and may be originated or shipped at different times and from more than one location.

* * * * *

10. Section 431.85 is amended by revising paragraph (b) to read as follows:

§ 431.85 Materials incorporated by reference.

* * * * *

(b) AHRI. Air-Conditioning, Heating, and Refrigeration Institute, 2111 Wilson Blvd., Suite 500, Arlington, VA 22201, (703) 524-8800, or go to: http://www.ahrinet.org.

(1) AHRI Standard 1500-2015, "2015 Standard for Performance Rating of Commercial Space Heating Boilers," approved November 28, 2014: Section 3 "Definitions;"; Section 5 "Rating Requirements;" Appendix C "Methods of Testing for Rating Commercial Space Heating Boilers – Normative," excluding Figures C5 and C7; Appendix D "Properties of Saturated Steam – Normative;" and Appendix E "Correction Factors for Heating Values of Fuel Gases – Normative;" IBR approved for appendix A to subpart E.

(2) [Reserved]

11. Section 431.86 is revised to read as follows:

§ 431.86 Uniform test method for the measurement of energy efficiency of commercial packaged boilers.

(a) Scope. This section provides test procedures, pursuant to the Energy Policy and Conservation Act (EPCA), as amended, which must be followed for measuring the combustion efficiency and/or thermal efficiency of a gas- or oil-fired commercial packaged boiler.

(b) Testing and calculations. Determine the thermal efficiency or combustion efficiency of covered commercial packaged boilers by conducting the appropriate test procedure(s) indicated in Table 1 of this section.

Table 1 to § 431.86—Test Requirements for Commercial Packaged Boiler Equipment Classes

Equipment Type	Subcategory	Fuel Input Rate Btu/h	Standards Efficiency Rating (§ 431.87)	Test Procedure (corresponding to standards efficiency metric required by § 431.87)
Hot Water	Gas-fired	≥300,000 and ≤2,500,000	Thermal Efficiency	Appendix A, Section 2.
Hot Water	Gas-fired	>2,500,000	Combustion Efficiency	Appendix A, Section 3.
Hot Water	Oil-fired	≥300,000 and ≤2,500,000	Thermal Efficiency	Appendix A, Section 2.
Hot Water	Oil-fired	>2,500,000	Combustion Efficiency	Appendix A, Section 3.
Steam	Gas-fired (all*)	≥300,000 and ≤2,500,000	Thermal Efficiency	Appendix A, Section 2.
Steam	Gas-fired (all*)	>2,500,000 and ≤5,000,000	Thermal Efficiency	Appendix A, Section 2.
		>5,000,000	Thermal Efficiency	Appendix A, Section 2. OR Appendix A, Section 3 with Section 2.4.3.2.
Steam	Oil-fired	≥300,000 and ≤2,500,000	Thermal Efficiency	Appendix A, Section 2.
Steam	Oil-fired	>2,500,000 and ≤5,000,000	Thermal Efficiency	Appendix A, Section 2.
		>5,000,000	Thermal Efficiency	Appendix A, Section 2. OR Appendix A, Section 3. with Section 2.4.3.2.

*Product classes for commercial packaged boilers as of July 22, 2009 (74 FR 36355) distinguish between gas-fired natural draft and all other gas-fired (except natural draft). The test procedure indicated in Table 1 applies to both of these equipment classes. If these equipment classes are amended, the test procedure will continue to apply as indicated in Table 1 to all gas-fired commercial packaged boilers.

(c) Field tests. The field test provisions of appendix A may be used only to test a commissioned unit of commercial packaged boiler with fuel input rate greater than 5,000,000 Btu/h.

12. Section 431.87 is revised to read as follows:

§ 431.87 Energy conservation standards and their effective dates.

(a) Each commercial packaged boiler listed in Table 1 of this section and manufactured on or after the effective date listed must meet the indicated energy conservation standard.

Table 1 to § 431.87—Commercial Packaged Boiler Energy Conservation Standards

Equipment Type	Subcategory	Fuel Input Rate*	Efficiency Level—Effective Date: March 2, 2012*
Hot Water Commercial Packaged Boilers	Gas-fired	≥300,000 Btu/h and ≤2,500,000 Btu/h	80.0% E_T
Hot Water Commercial Packaged Boilers	Gas-fired	>2,500,000 Btu/h	82.0% E_C
Hot Water Commercial Packaged Boilers	Oil-fired	≥300,000 Btu/h and ≤2,500,000 Btu/h	82.0% E_T
Hot Water Commercial Packaged Boilers	Oil-fired	>2,500,000 Btu/h	84.0% E_C
Steam Commercial Packaged Boilers	Gas-fired—all, except natural draft	≥300,000 Btu/h and ≤2,500,000 Btu/h	79.0% E_T
Steam Commercial Packaged Boilers	Gas-fired—all, except natural draft	>2,500,000 Btu/h	79.0% E_T
Steam Commercial Packaged Boilers	Gas-fired—natural draft	≥300,000 Btu/h and ≤2,500,000 Btu/h	77.0% E_T
Steam Commercial Packaged Boilers	Gas-fired—natural draft	>2,500,000 Btu/h	77.0% E_T
Steam Commercial Packaged Boilers	Oil-fired	≥300,000 Btu/h and ≤2,500,000 Btu/h	81.0% E_T
Steam Commercial Packaged Boilers	Oil-fired	>2,500,000 Btu/h	81.0% E_T

*"Fuel Input Rate" is the representative value of input (Btu/h) of the commercial packaged boiler model.
*Where E_C is combustion efficiency and E_T is thermal efficiency.

(b) Each commercial packaged boiler listed in Table 2 of this section and manufactured on or after the effective date listed in Table 2 of this section must meet the indicated energy conservation standard.

Table 2 to § 431.87—Commercial Packaged Boiler Energy Conservation Standards

Equipment Type	Subcategory	Fuel Input Rate*	Efficiency Level—Effective Date: March 2, 2022*
Steam Commercial Packaged Boilers	Gas-fired—natural draft	≥300,000 Btu/h and ≤2,500,000 Btu/h	79.0% E_T
Steam Commercial Packaged Boilers	Gas-fired—natural draft	>2,500,000 Btu/h	79.0% E_T

*"Fuel Input Rate" is the representative value of input (Btu/h) of the commercial packaged boiler model
*Where E_T is thermal efficiency.

13. Add appendix A to subpart E of part 431 to read as follows:

Appendix A to Subpart E of Part 431—Uniform Test Method for the Measurement of Thermal Efficiency of Commercial Packaged Boilers.

NOTE: Prior to [DATE 360 DAYS AFTER PUBLICATION OF THE FINAL RULE IN THE FEDERAL REGISTER], manufacturers must make any representations with respect to the energy use or efficiency of commercial packaged boilers in accordance with the results of testing pursuant to appendix A to subpart E of part 431 or the test procedures as they appeared in 10 CFR 431.86, revised as of January 1, 2016. After [DATE 360 DAYS AFTER DATE OF PUBLICATION OF THE FINAL RULE], manufacturers must make any representations with respect to energy use or efficiency in accordance with the results of testing pursuant to this appendix.

1. DEFINITIONS

For purposes of this appendix, the Department of Energy incorporates by reference the definitions established in section 3 of the American National Standards Institute (ANSI) and Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standard 1500, "2015 Standard for

Performance Rating of Commercial Space Heating Boilers," beginning with 3.1 and ending with 3.35 (incorporated by reference, see § 431.85; hereafter "ANSI/AHRI Standard 1500-2015"), excluding section 3.23, "Input Rating"; section 3.24, "Net Rating"; and section 3.26, "Published Rating," and section 3.26.1 "Standard Rating." In cases where there is a conflict, the language of the test procedure in this appendix takes precedence over ANSI/AHRI Standard 1500-2015.

1.1. In all incorporated sections of ANSI/AHRI Standard 1500-2015, references to the manufacturer's "specifications," "recommendations," "directions," or "requests" mean the manufacturer's instructions in the installation and operation manual shipped with the commercial packaged boiler being tested or in supplemental instructions provided by the manufacturer pursuant to § 429.60(b)(4) of this chapter. For parameters or considerations not specified in this appendix, refer to the manual shipped with the commercial packaged boiler. Should the manual shipped with the commercial packaged boiler not provide the necessary information, refer to the supplemental instructions for the basic model pursuant to § 429.60(b)(4) of this chapter. The supplemental instructions provided pursuant to § 429.60(b)(4) of this chapter do not replace or alter any requirements in this appendix nor do they override the manual shipped with the commercial packaged boiler. In cases where these supplemental instructions conflict with any instructions or provisions provided in the manual shipped with the commercial packaged boiler, use the manual shipped with the commercial packaged boiler.

1.2. Unless otherwise noted, in all incorporated sections of ANSI/AHRI Standard 1500-2015, the term "boiler" means a commercial packaged boiler as defined in §431.82.

2. THERMAL EFFICIENCY TEST

2.1. Test Setup.

2.1.1. Instrumentation. Use instrumentation meeting the minimum requirements found in Table C1 of Appendix C of ANSI/AHRI Standard 1500-2015 (incorporated by reference, see § 431.85).

2.1.2. Data collection and sampling. Unless otherwise specified in Table 2.1 to this appendix, obtain all data digitally and conduct sampling at a rate not less frequently than once per 30 seconds. Digital data representing a flow, rate, or flux must be integrated over 15-minute periods (pursuant to Table 2.1 to this appendix) with the resulting values recorded. All other digital data must be averaged over 15-minute periods with the resulting values recorded. Table 2.1 to this appendix specifies the data recording interval for all relevant measured quantities and replaces Table C4 of Appendix C of ANSI/AHRI Standard 1500-2015.

Table 2.1. to Appendix A to Subpart E of Part 431—Data to be Recorded Before and During Testing

Item Recorded	Before Test	Every 30 Seconds	Every 15 Minutes[1]
Date of Test	X		
Manufacturer	X		
Boiler Model Number	X		
Burner Model Number & Manufacturer	X		
Nozzle description and oil pressure	X		
Oil Analysis - H, C, API Gravity, lb/gal and Btu/lb	X		
Gas Manifold Pressure	Start and End only		
Gas line pressure at meter	X[2]		
Gas temperature	X[2]		
Barometric Pressure (Steam and Natural Gas Only)	X[2]		
Gas Heating Value, Btu/ft^3	Start and End only		
Time, minutes/seconds		X	
Flue Gas Temperature, °F		X[3]	

Item Recorded		Before Test	Every 30 Seconds	Every 15 Minutes[1]
Pressure in Firebox, in H_2O (if required per Section C3.4)				X[3]
Flue Gas Smoke Spot Reading (oil)				X[2]
Room Air Temperature			X[3]	
Fuel Weight or volume, lb (oil) or ft^3 (gas)				X[4]
Inlet Water Temperature at Point A[4], °F			X[3]	
Test Air Temperature, °F			X[3]	
Draft in Vent, in H_2O (oil and non-atmospheric gas)				X[3]
Flue Gas CO_2 or O_2, %				X[2]
Flue Gas CO, ppm				Start and End only[2]
Relative Humidity, %			X	
Flue Condensate Weight, lb (Condensing CPB only)			X[1,2,4]	
STEAM	Separator water weight, lb			At a minimum at Start and End[2,4]
	Steam Pressure, in Hg			X[3]
	Steam Temperature, °F (if used)		X[3]	
	Condensate collected, or water fed, lb		X[1,2]	
WATER	Outlet Water Temperature, °F		X[3]	
	Water fed, lb		X[1,2]	
	Inlet Water Temperature at Points A and B, °F		X[3]	

Notes:
1. If measurement is taken manually, this measurement may be taken once every 15 minutes.
2. Measurement may be made manually.
3. Record the average value of the data over the specified time period.
4. Report the integrated value of the data over the specified time period.

2.1.3. Instrument Calibration. Instruments must be calibrated at least once per year and a calibration record containing the date of calibration and the method of calibration must be maintained as part of the data underlying each basic model certification, pursuant to § 429.71 of this chapter. Combustion measurement equipment (instruments listed in the "Gas Chemistry"

row of Table C1 in ANSI/AHRI Standard 1500-2015) must be calibrated using standard gases with purities of greater than 99.9995 percent for all constituents analyzed.

2.1.4. Test Setup and Apparatus. Set up the commercial packaged boiler for thermal efficiency testing according to the provisions of section C2 of Appendix C of ANSI/AHRI Standard 1500-2015.

2.1.4.1. For tests of oil-fired commercial packaged boilers, determine the weight of fuel consumed using one of the methods specified in paragraph 2.1.4.1.1. or 2.1.4.1.2. of this appendix:

2.1.4.1.1. If using a scale, determine the weight of fuel consumed as the difference between the weight of the oil vessel before and after each measurement period, as specified in paragraph 2.1.4.1.3.1. or 2.1.4.1.3.2. of this appendix, determined using a scale meeting the accuracy requirements of Table C1 of Appendix C of ANSI/AHRI Standard 1500-2015.

2.1.4.1.2. If using a flow meter, first determine the volume of fuel consumed as the total volume over the applicable measurement period as specified in paragraph 2.1.4.1.3.1. or 2.1.4.1.3.2. of this appendix and as measured by a flow meter meeting the accuracy requirements of Table C1 of Appendix C of ANSI/AHRI Standard 1500-2015 upstream of the oil inlet port of the commercial packaged boiler. Then determine the weight of fuel consumed by multiplying the total volume of fuel over the applicable measurement period by the density of oil, in pounds per gallon, as determined pursuant to C3.2.1.1.3. of Appendix C of ANSI/AHRI Standard 1500-2015.

2.1.4.1.3. The applicable measurement period for the purposes of determining fuel input rate must be as specified in section 2.1.4.1.3.1. of this appendix for the “Warm-Up Period” or section 2.1.4.1.3.2. of this appendix for the “Test Period.”

2.1.4.1.3.1. For the purposes of confirming steady-state operation during the "Warm-Up Period," the measurement period must be 15 minutes and t_T in equation C2 in section C7.2.3.1 of Appendix A of ANSI/AHRI Standard 1500-2015 must be 0.25 hours to determine fuel input rate.

2.1.4.1.3.2. For the purposes of determining thermal efficiency during the "Test Period," the measurement period and t_T are as specified in section C4.1.1.2.3 of Appendix C of ANSI/AHRI Standard 1500-2015.

2.1.4.2 For tests of gas-fired commercial packaged boilers, install a volumetric gas meter meeting the accuracy requirements of Table C1 of Appendix C of ANSI/AHRI Standard 1500-2015 upstream of the gas inlet port of the commercial packaged boiler. Record the accumulated gas volume consumed for each applicable measurement period. Use equation C7.2.3.2. of Appendix C of ANSI/AHRI Standard 1500-2015 to calculate fuel input rate.

2.1.4.2.1. The applicable measurement period for the purposes of determining fuel input rate must be as specified in section 2.1.4.2.1.1. of this appendix for the "Warm-Up Period" and 2.1.4.2.1.2. of this appendix for the "Test Period."

2.1.4.2.1.1. For the purposes of confirming steady-state operation during the "Warm-Up Period," the measurement period must be 15 minutes and t_T in equation C2 in section C7.2.3.1 of Appendix C of ANSI/AHRI Standard 1500-2015 must be 0.25 hours to determine fuel input rate.

2.1.4.2.1.2. For the purposes of determining thermal efficiency during the "Test Period," the measurement period and t_T are as specified in section C4.1.1.2.3 of Appendix C of ANSI/AHRI Standard 1500-2015.

2.1.5. Additional Requirements for Outdoor Commercial Packaged Boilers. If the manufacturer provides more than one outdoor venting arrangement, the outdoor commercial packaged boiler (as defined in section 3.2.6 of ANSI/AHRI Standard 1500-2015; must be tested with the shortest total venting arrangement as measured by adding the straight lengths of venting supplied with the equipment. If the manufacturer does not provide an outdoor venting arrangement, install the outdoor commercial packaged boiler venting consistent with the procedure specified in section C2.2 of Appendix C of ANSI/AHRI Standard 1500-2015.

2.1.6. Additional Requirements for Steam Tests. In addition to the provisions of section C2 of Appendix C of ANSI/AHRI Standard 1500-2015, the following requirements apply for steam tests.

2.1.6.1. Set up steam piping according to section C2.3 of Appendix C of ANSI/AHRI Standard 1500-2015 and using the following general instructions:

2.1.6.1.1. Figures C5 and C7 are prohibited from use and are not to be used to comply with the test procedure.

2.1.6.1.2. For piping above the water level specified in the installation and operation manual shipped with the commercial packaged boiler, or in manufacturer's supplemental instructions (pursuant to § 429.60(b)(4) of this chapter), if a reduction in the piping diameter is necessary, reduce the vertical portion of the steam condensate return pipe diameter to no less than one half of the riser pipe diameter.

2.1.6.1.3. Insulate all steam piping from the commercial packaged boiler to the steam separator, and extend insulation at least one foot (1 ft.) beyond the steam separator, using insulation meeting the requirements specified in Table 2.2. of this appendix.

Table 2.2. to Appendix A to Subpart E of Part 431—Minimum Piping Insulation Thickness Requirements

Fluid	Insulation Conductivity	Nominal Pipe Size

Temperature Range °F			inches				
	Conductivity BTU×in/(h×ft²×°F)	Mean Rating Temperature °F	<1	1 to < 1-1/2	1-12 to < 4	4 to <8	≥ 8
201 °F-250 °F	0.27-0.30	150	2.5	2.5	2.5	3.0	3.0
141 °F-200 °F	0.25-0.29	125	1.5	1.5	2.0	2.0	2.0
105 °F-140 °F	0.22-0.28	100	1.0	1.0	1.5	1.5	1.5

2.1.6.1.4. If a separator is used, piping must pitch downward to the separator at a rate of at least 1/4 inch per foot of pipe length.

2.1.6.2. If the pipe diameters of the header and return loop are not specified in the installation and operation manual shipped with the commercial packaged boiler or in supplemental testing instructions provided in the unit's basic model certification report (pursuant to § 429.60 of this chapter), then make the header pipe diameter equal to the commercial packaged boiler's steam take-off fitting pipe diameter. Do not reduce the diameter in any horizontal pipe. For commercial packaged boilers with multiple steam risers, do not reduce the diameter in any horizontal header pipe, and ensure that the cross-sectional area of the header is not less than 80 percent of the total cross-sectional area of the risers.

2.1.6.3. If the height of the header above the water level is not specified by the installation and operation manual shipped with the commercial packaged boiler or in supplemental testing instructions provided in the unit's basic model certification report (pursuant to § 429.60 of this chapter), then ensure that the height of the header above the water level is not less than the larger of 24 inches or 6 times the header nominal pipe diameter as defined in paragraph 2.1.6.2. of this appendix.

2.1.6.4. If the minimum distance between the last vertical steam take-off and the condensate return pipe is not specified in the installation and operation manual shipped with the commercial packaged boiler or in the manufacturer's supplemental testing instructions provided

in the unit's basic model certification report (pursuant to § 429.60 of this chapter), then the distance between the vertical steam take-off leading to the water separator and the elbow leading to the condensate return pipe must be a minimum of three (3) header pipe diameters.

2.1.6.5. A vented water seal must be located between the drain and the separator. Insulate the separator and the piping connecting it to the commercial packaged boiler to prevent the heat loss from separator and piping, using the minimum piping insulation requirements specified in Table 2.2. of this appendix. A temperature sensing device must be installed in the insulated steam piping prior to the water separator if the commercial packaged boiler produces superheated steam.

2.1.6.6. Water entrained in the steam and water condensing within the steam piping must be collected and used to calculate the quality of steam during the "Test Period." Steam condensate must be collected and measured using either a cumulative (totalizing) flow rate or by measuring the mass of the steam condensate. Instrumentation used to determine the amount of steam condensate must meet the requirements identified in Table C1 in Appendix C of ANSI/AHRI Standard 1500-2015.

2.1.6.7. All steam commercial packaged boiler setups must include a steam condensate return pipe as shown in Figures C6 and C8 of ANSI/AHRI Standard 1500-2015; labeled "Return Loop Connection"). This setup may also be used for commercial packaged boilers with multiple or single steam risers (take-offs) from the commercial packaged boiler.

2.1.6.8. Section C2.7.2.2.2 of ANSI/AHRI Standard 1500-2015 is not to be used for water meter calibration.

2.1.7. Additional Requirements for Water Tests. In addition to the provisions of section C2 of Appendix C of ANSI/AHRI Standard 1500-2015, the following requirements apply for water tests.

2.1.7.1 Insulate all water piping between the commercial packaged boiler and the location of the temperature measuring equipment, including one foot (1 ft.) beyond the sensor, using insulation meeting the requirements specified in Table 2.2. of this appendix.

2.1.7.2 In addition to the temperature measuring device at Point A in Figure C9 of ANSI/AHRI Standard 1500-2015, install a temperature measuring device at Point B of the same figure.

2.2. Test Conditions.

2.2.1. General. Use the test conditions from section 5 and section C3 of Appendix C of ANSI/AHRI Standard 1500-2015 for thermal efficiency testing but do not use section 5.1, 5.2, 5.3.5, 5.3.8, 5.3.9, or C3.1.3 of ANSI/AHRI Standard 1500-2015.

2.2.2. Burners for Oil-Fired Commercial Packaged Boilers. In addition to section C3.3 of Appendix C of ANSI/AHRI Standard 1500-2015, the following applies: for oil-fired commercial packaged boilers, test the unit with the particular make and model of burner as certified by the manufacturer. If multiple burners are specified in the certification report for that basic model, then use any of the listed burners for testing.

2.2.3. Non-condensing Commercial Packaged Boiler Water Temperatures. For tests of non-condensing boilers (as defined in section 3.2.5 of ANSI/AHRI Standard 1500-2015, maintain the outlet temperature measured at Point C in Figure C9 at 180 °F ± 1 °F and maintain the inlet temperature measured at Point B at 140 °F ± 1 °F during the "Warm-up Period" and

"Test Period" as indicated by 30-second interval data pursuant to Table 2.1. of this appendix. If the commercial packaged boiler cannot be tested at the standard inlet water temperature of 140 °F ± 1 °F, as indicated in the manufacturer literature, test the equipment at the temperature closest to the standard 140 °F ± 1 °F that the equipment is capable of operating, as indicated in the manufacturer literature. Use the inlet temperature measured at Point A in Figure C9 of Appendix C of ANSI/AHRI Standard 1500-2015 for calculation of thermal efficiency.

2.2.4. Condensing Commercial Packaged Boiler Water Temperatures. For tests of condensing boilers (as defined in section 3.2.2 of ANSI/AHRI Standard 1500-2015); maintain the outlet temperature measured at Point C in Figure C9 of Appendix C of ANSI/AHRI Standard 1500-2015 to 120 °F ± 1 °F, and maintain the commercial packaged boiler inlet temperature at Point B to 80 °F ± 1 °F during the "Warm-up Period" and "Test Period" as indicated by 30-second interval data pursuant to Table 2.1. of this appendix. If the commercial packaged boiler cannot be tested at the standard inlet water temperature of 80 °F ± 1 °F, as indicated in the manufacturer literature, test the equipment at the temperature closest to the standard 80 °F ± 1 °F that the equipment is capable of operating, as indicated in the manufacturer literature. Use the inlet temperature measured at Point A in Figure C9 of Appendix C of ANSI/AHRI Standard 1500-2015 for calculation of thermal efficiency.

2.2.5 Air Temperature. Maintain ambient room temperature at 75 °F ± 5 °F at all times during the "Warm-up Period" and "Test Period" (as described in section C4 of Appendix C of ANSI/AHRI Standard 1500-2015; as indicated by 30-second interval data pursuant to Table 2.1. of this appendix. The ambient room temperature may not differ by more than ± 2 °F from the average ambient room temperature during the entire "Test Period" at any reading.

2.2.6. Ambient Humidity. Maintain ambient room relative humidity at 60 ± 5 percent relative humidity at all times during both the "Warm-up Period" and "Test Period" (as described in section C4 of Appendix C of ANSI/AHRI Standard 1500-2015; as indicated by 30-second interval data pursuant to Table 2.1. of this appendix.

2.3. Test Method.

2.3.1. General. Conduct the thermal efficiency test as prescribed in section C4.1 of Appendix C of ANSI/AHRI Standard 1500-2015.

2.3.1.1. Do not use section C4.1.1.1.2 of ANSI/AHRI Standard 1500-2015. Instead, adjust oil or non-atmospheric gas to produce the required firebox pressure and CO_2 or O_2 concentration in the flue gas, as described in section 5.3.1 of ANSI/AHRI Standard 1500-2015. Conduct steam tests with steam pressure at the pressure specified in the manufacturer literature shipped with the commercial packaged boiler or in the manufacturer's supplemental testing instructions pursuant to § 429.60(b)(4) of this chapter, but not exceeding 15 psig. If no pressure is specified in the manufacturer literature shipped with the commercial packaged boiler or in the manufacturer's supplemental testing instructions (pursuant to § 429.60(b)(4)) of this chapter, or if a range of operating pressures is specified, conduct testing at a steam pressure equal to atmospheric pressure. If necessary to maintain steam quality as required by section 5.3.7 of ANSI/AHRI Standard 1500-2015, increase steam pressure in 1 psig increments by throttling with a valve beyond the separator until the test is completed and the steam quality requirements have been satisfied, but do not increase the steam pressure to greater than 15 psig.

2.3.2. Steam Test Steady-State. Replace section C4.1.1.1.4 of ANSI/AHRI Standard 1500-2015 with the following: Ensure that a steady-state is reached by confirming that three consecutive readings have been recorded at 15-minute intervals that indicate that:

2.3.2.1. The measured fuel input rate does not vary by more than ± 2 percent between any two readings; and

2.3.2.2. The steam pressure varies by no more than ± 5 percent between any two readings.

2.3.3. Water Test Steady-State. Replace section C4.1.2.1.5 of ANSI/AHRI Standard 1500-2015 with the following: Ensure that a steady-state is reached by confirming that three consecutive readings have been recorded at 15-minute intervals that indicate that the measured fuel input rate does not vary by more than ± 2 percent between any two readings.

2.3.4. Condensate Collection for Condensing Commercial Packaged Boilers. Collect condensate in a covered vessel so as to prevent evaporation.

2.3.5. Total Fuel Input. In sections C4.1.1.2.3 and C4.1.2.2.3 of ANSI/AHRI Standard 1500-2015, do not use the last sentence which reads: "The total Heat Input measured during the Test Period shall be within ± 2% of the boiler Input Rating."

2.4. Calculations.

2.4.1. General. To determine the thermal efficiency of commercial packaged boilers, use the calculation procedure for the thermal efficiency test specified in section C7 of Appendix C of the ANSI/AHRI Standard 1500-2015. For water tests as described in section C4.1.2 of ANSI/AHRI Standard 1500-2015, if a recirculating loop is used, use the average

temperature during the "Test Period" measured at Point A for the inlet water temperature for all calculations.

2.4.2. Use of Steam Properties Table. If the average measured temperature of the steam is higher than the value in Table D in Appendix D1 of ANSI/AHRI Standard 1500-2015 that corresponds to the average measured steam pressure, then use Table 2.3 of this appendix to determine the latent heat of superheated steam in (Btu/lb). Use linear interpolation for determining the latent heat of steam in Btu/lb if the measured steam pressure is between two values listed in Table D in Appendix D1 of ANSI/AHRI Standard 1500-2015 or in Table 2.3.

Table 2.3. to Appendix A to Subpart E of Part 431—Latent Heat (Btu/lb) of Superheated Steam.

Average Measured Steam Pressure psi	Temperature °F							
	220	240	260	280	300	320	340	360
13	1155.1	1164.7	1174.3	1183.8	1193.2	1202.6	1212.0	1221.4
14	1154.6	1164.4	1174.0	1183.5	1193.0	1202.4	1211.8	1221.2
14.696	1154.4	1164.2	1173.8	1183.3	1192.8	1202.3	1211.7	1221.1
15	1154.3	1164.1	1173.7	1183.2	1192.8	1202.2	1211.7	1221.1
16	1153.8	1163.7	1173.4	1183.0	1192.5	1202.0	1211.5	1220.9
17	1153.4	1163.4	1173.1	1182.7	1192.3	1201.8	1211.3	1220.7
18		1163.0	1172.8	1182.5	1192.1	1201.6	1211.1	1220.6
19		1162.7	1172.5	1182.2	1191.9	1201.4	1210.9	1220.4
20		1162.3	1172.2	1182.0	1191.6	1201.2	1210.8	1220.3
21		1162.0	1171.9	1181.7	1191.4	1201.0	1210.6	1220.1
22		1161.6	1171.6	1181.4	1191.2	1200.8	1210.4	1219.9
23		1161.2	1171.3	1181.2	1190.9	1200.6	1210.2	1219.8
24		1160.9	1171.0	1180.9	1190.7	1200.4	1210.0	1219.6
25			1170.7	1180.6	1190.5	1200.2	1209.8	1219.4
26			1170.4	1180.4	1190.2	1200.0	1209.7	1219.3
27			1170.1	1180.1	1190.0	1199.8	1209.5	1219.1
28			1169.7	1179.8	1189.8	1199.6	1209.3	1218.9
29			1169.4	1179.6	1189.5	1199.3	1209.1	1218.8
30			1169.1	1179.3	1189.3	1199.1	1208.9	1218.6
31			1168.8	1179.0	1189.0	1198.9	1208.7	1218.4

Absolute Pressure psi	Temperature °F							
	380	400	420	440	460	480	500	600
13	1230.8	1240.2	1249.5	1258.9	1268.4	1277.8	1287.3	1334.9
14	1230.6	1240.0	1249.4	1258.8	1268.3	1277.7	1287.2	1334.8
14.696	1230.5	1239.9	1249.3	1258.8	1268.2	1277.6	1287.1	1334.8
15	1230.5	1239.9	1249.3	1258.7	1268.2	1277.6	1287.1	1334.8
16	1230.3	1239.8	1249.2	1258.6	1268.0	1277.5	1287.0	1334.7
17	1230.2	1239.6	1249.1	1258.5	1267.9	1277.4	1286.9	1334.6
18	1230.0	1239.5	1248.9	1258.4	1267.8	1277.3	1286.8	1334.6
19	1229.9	1239.4	1248.8	1258.3	1267.7	1277.2	1286.7	1334.5
20	1229.7	1239.2	1248.7	1258.2	1267.6	1277.1	1286.6	1334.4
21	1229.6	1239.1	1248.6	1258.1	1267.5	1277.0	1286.5	1334.4
22	1229.5	1239.0	1248.4	1257.9	1267.4	1276.9	1286.4	1334.3
23	1229.3	1238.8	1248.3	1257.8	1267.3	1276.8	1286.7	1334.2
24	1229.2	1238.7	1248.2	1257.7	1267.2	1276.7	1286.3	1334.2
25	1229.0	1238.5	1248.1	1257.6	1267.1	1276.6	1286.2	1334.1
26	1228.9	1238.4	1248.0	1257.5	1267.0	1276.5	1286.1	1334.0
27	1228.7	1238.3	1247.8	1257.4	1266.9	1276.4	1286.0	1334.0
28	1228.6	1238.1	1247.7	1257.2	1266.8	1276.3	1285.9	1333.9
29	1228.4	1238.0	1247.6	1257.1	1266.7	1276.2	1285.8	1333.9
30	1228.3	1237.9	1247.5	1257.0	1266.6	1276.2	1285.7	1333.8
31	1228.1	1237.7	1247.3	1256.9	1266.5	1276.1	1285.6	1333.7

Absolute Pressure psi	Temperature °F						
	700	800	900	1000	1200	1400	1600
13	1383.2	1432.4	1482.3	1533.2	1637.5	1745.5	1857.3
14	1383.2	1432.3	1482.3	1533.1	1637.5	1745.5	1857.3
14.696	1383.2	1432.3	1482.3	1533.1	1637.5	1745.5	1857.3
15	1383.1	1432.3	1482.3	1533.1	1637.5	1745.5	1857.3
16	1383.1	1432.3	1482.2	1533.1	1637.4	1745.5	1857.3
17	1383.0	1432.2	1482.2	1533.1	1637.4	1745.5	1857.3
18	1383.0	1432.2	1482.2	1533.0	1637.4	1745.5	1857.2
19	1382.9	1432.1	1482.1	1533.0	1637.4	1745.4	1857.2
20	1382.9	1432.1	1482.1	1533.0	1637.4	1745.4	1857.2
21	1382.8	1432.0	1482.1	1532.9	1637.3	1745.4	1857.2
22	1382.8	1432.0	1482.0	1532.9	1637.3	1745.4	1857.2
23	1382.7	1432.0	1482.0	1532.9	1637.3	1745.4	1857.2
24	1382.7	1431.9	1482.0	1532.9	1637.3	1745.4	1857.2
25	1382.6	1431.9	1481.9	1532.8	1637.3	1745.3	1857.2

26	1382.6	1431.8	1481.9	1532.8	1637.2	1745.3	1857.1
27	1382.5	1431.8	1481.9	1532.8	1637.2	1745.3	1857.1
28	1382.5	1431.8	1481.8	1532.8	1637.2	1745.3	1857.1
29	1382.4	1431.7	1481.8	1532.7	1637.2	1745.3	1857.1
30	1382.4	1431.7	1481.8	1532.7	1637.2	1745.3	1857.1
31	1382.3	1431.6	1481.7	1532.7	1637.1	1745.2	1857.1

2.4.3. Alternative Thermal Efficiency Calculation for Large Steam Commercial Packaged Boilers. To determine the thermal efficiency of commercial packaged boilers with a fuel input rate greater than 5,000,000 Btu/h according to the steam test (pursuant to section C4.1.1 of ANSI/AHRI Standard 1500-2015, either:

2.4.3.1. Calculate the thermal efficiency of commercial packaged boiler models in steam mode in accordance with the provisions of section 2.4.1. of this appendix; or

2.4.3.2. Measure and calculate combustion efficiency $\mathrm{Effy_{SS}}$ in steam mode according to section 3. Combustion Efficiency Test of this appendix and convert to thermal efficiency using the following equation:

$$\mathrm{Effy_T} = \mathrm{Effy_{SS}} - 2.0$$

where $\mathrm{Effy_T}$ is the thermal efficiency and $\mathrm{Effy_{SS}}$ is the combustion efficiency as defined in C6 of ANSI/AHRI Standard 1500-2015. The combustion efficiency $\mathrm{Effy_{SS}}$ is as calculated in section C7.2.14 of ANSI/AHRI Standard 1500-2015.

2.4.4. Rounding. Round the final thermal efficiency value to nearest one tenth of one percent. Round fuel input rate to nearest 1,000 Btu/h.

3. COMBUSTION EFFICIENCY TEST.

3.1. Test Setup.

3.1.1. Instrumentation. Use instrumentation meeting the minimum requirements found in Table C1 of ANSI/AHRI Standard 1500-2015 (incorporated by reference, see § 431.85).

3.1.2. Data collection and sampling. Unless otherwise specified, obtain all data digitally with the exception of measuring the weight of the combustion condensate and steam condensation, and conduct sampling at a rate not less than once per 30 seconds. Digital data representing a flow, rate, or flux must be integrated over 15-minute periods (pursuant to Table 3.1 of this appendix) with the resulting values recorded. All other digital data must be averaged over 15-minute periods with the resulting values recorded. Table 3.1. of this appendix specifies the data recording interval for all relevant measured quantities and replaces Table C4 of Appendix C in ANSI/AHRI Standard 1500-2015.

Table 3.1. to Appendix A to Subpart E of Part 431— Data to be Recorded Before and During Testing

Item Recorded	Before Test	Every 30 Seconds	Every 15 Minutes[1]
Date of Test	X		
Manufacturer	X		
Commercial Packaged Boiler Model Number	X		
Burner Model Number & Manufacturer	X		
Nozzle description and oil pressure	X		
Oil Analysis - H, C, API Gravity, lb/gal and Btu/lb	X		
Gas Manifold Pressure	Start and End only		
Gas line pressure at meter	X[2]		
Gas temperature	X[2]		
Barometric Pressure (Steam and Natural Gas Only)	X[2]		
Gas Heating Value, Btu/ft^3	Start and End only		

Item Recorded		Before Test	Every 30 Seconds	Every 15 Minutes[1]
Time, minutes/seconds			X	
Flue Gas Temperature, °F			X[3]	
Pressure in Firebox, in H_2O (if required per Section C3.4)				X[3]
Flue Gas Smoke Spot Reading (oil)				X[2]
Room Air Temperature			X	
Fuel Weight or volume, lb (oil) or ft^3 (gas)				X[4]
Inlet Water Temperature at Point A[4], °F			X	
Test Air Temperature, °F			X	
Draft in Vent, in H_2O (oil and non-atmospheric gas)				X[3]
Flue Gas CO_2 or O_2, %				X[2]
Flue Gas CO, ppm				Start and End only[2]
Relative Humidity, %			X	
Flue Condensate Weight, lb (Condensing Commercial Packaged Boilers only)			X[1,2, 4]	
STEAM	Separator water weight, lb			At a minimum at Start and End[2, 5]
	Steam Pressure, in Hg			X[3]
	Steam Temperature, °F (if used)		X[3]	
	Condensate collected, or water fed, lb		X[1, 2]	
WATER	Outlet Water Temperature, °F		X[3]	
	Water fed, lb		X[1, 2]	
	Inlet Water Temperature at Points A and B, °F		X[3]	

Notes:
1. If measured manually, this measurement may be taken once every 15 minutes.
2. Measurement may be made manually.
3. Record the average value of the data over the specified time period.
4. Report the integrated value of the data over the specified time period.

3.1.3. Instrument Calibration. Instruments must be calibrated at least once per year and a record must be kept as part of the data underlying each basic model certification, pursuant to §

429.71 of this chapter, containing, at least, the date of calibration and the method of calibration. Combustion measurement equipment (instruments listed in the "Gas Chemistry" row of Table C1 in ANSI/AHRI Standard 1500-2015) must be calibrated using standard gasses with purities of greater than 99.9995 percent for all constituents analyzed.

3.1.4. Test Setup and Apparatus. Set up the commercial packaged boiler for combustion efficiency testing according to the provisions of section C2 of Appendix C of ANSI/AHRI Standard 1500-2015.

3.1.4.1. For tests of oil-fired commercial packaged boilers, determine the weight of fuel consumed using one of the methods specified in paragraph 3.1.4.1.1. or 3.1.4.1.2. of this appendix:

3.1.4.1.1. If using a scale, determine the weight of fuel consumed as the difference between the weight of the oil vessel before and after each measurement period, as specified in paragraph 3.1.4.1.3.1. or 3.1.4.1.3.2. of this appendix, determined using a scale meeting the accuracy requirements of Table C1 of ANSI/AHRI Standard 1500-2015.

3.1.4.1.2. If using a flow meter, first determine the volume of fuel consumed as the total volume over the applicable measurement period, as specified in paragraphs3.1.4.1.3.1. or 3.1.4.1.3.2. of this appendix, and as measured by a flow meter meeting the accuracy requirements of Table C1 of ANSI/AHRI Standard 1500-2015 upstream of the oil inlet port of the commercial packaged boiler. Then determine the weight of fuel consumed by multiplying the total volume of fuel over the applicable measurement period by the density of oil, in pounds per gallon, as determined pursuant to section C3.2.1.1.3. of ANSI/AHRI Standard 1500-2015.

3.1.4.1.3. The applicable measurement period for the purposes of determining fuel input rate must be as specified in section 3.1.4.1.3.1. of this appendix for the "Warm-Up Period" or 3.1.4.1.3.2. of this appendix for the "Test Period."

3.1.4.1.3.1. For the purposes of confirming steady-state operation during the "Warm-Up Period," the measurement period must be 15 minutes and t_T in equation C2 in section C7.2.3.1 of ANSI/AHRI Standard 1500-2015 must be 0.25 hours to determine fuel input rate.

3.1.4.1.3.2. For the purposes of determining combustion efficiency during the "Test Period," the measurement period and t_T are 0.5 hours pursuant to section 3.3.1.1. of section 3. Combustion Efficiency of this appendix.

3.1.4.2 For tests of gas-fired commercial packaged boilers, install a volumetric gas meter meeting the accuracy requirements of Table C1 of ANSI/AHRI Standard 1500-2015 upstream of the gas inlet port of the commercial packaged boiler. Record the accumulated gas volume consumed for each applicable measurement period. Use equation C7.2.3.2. of ANSI/AHRI Standard 1500-2015 to calculate fuel input rate.

3.1.4.2.1. The applicable measurement period for the purposes of determining fuel input rate must be as specified in section 3.1.4.2.1.1. of this appendix for the "Warm-Up Period" and 3.1.4.2.1.2. of this appendix for the "Test Period."

3.1.4.2.1.1. For the purposes of confirming steady-state operation during the "Warm-Up Period," the measurement period must be 15 minutes and t_T in equation C2 in section C7.2.3.1 of ANSI/AHRI Standard 1500-2015 must be 0.25 hours to determine fuel input rate.

3.1.4.2.1.2. For the purposes of determining combustion efficiency during the "Test Period," the measurement period and t_T are 0.5 hours pursuant to section 3.3.1.1. of this appendix.

3.1.5. Additional Requirements for Outdoor Commercial Packaged Boilers. If the manufacturer provides more than one outdoor venting arrangement, the outdoor commercial

packaged boiler (as defined in section 3.2.6 of ANSI/AHRI Standard 1500-2015; must be tested with the shortest total venting arrangement as measured by adding the straight lengths of venting supplied with the equipment.

3.1.6. Additional Requirements for Field Tests.

3.1.6.1 Field tests are exempt from the requirements of section C2.2 of Appendix C of ANSI/AHRI Standard 1500-2015. Measure the flue gas temperature according to section C2.5.1 of Appendix C of ANSI/AHRI Standard 1500-2015 and the thermocouple grids identified in Figure C12 of ANSI/AHRI Standard 1500-2015, with the following modification: the thermocouple grid may be staggered vertically by up to 1.5 inches to allow the use of instrumented rods to be inserted through holes drilled in the venting.

3.1.6.3. Field tests are exempt from the requirements of section C2.6.3 of Appendix C of ANSI/AHRI Standard 1500-2015.

3.1.7. Additional Requirements for Water Tests. In addition to the provisions of section C2 of Appendix C of ANSI/AHRI Standard 1500-2015 (incorporated by reference, see § 431.85) and to the temperature measuring device at Point A in Figure C9 of ANSI/AHRI Standard 1500-2015, install a temperature measuring device at Point B of the same figure.

3.2. Test Conditions.

3.2.1. General. Use the test conditions from sections 5 and C3 of Appendix C of ANSI/AHRI Standard 1500-2015 for combustion efficiency testing but do not use section 5.1, 5.3.5, 5.3.7 (excluded for field tests only), 5.3.8, 5.3.9, or C3.1.3 of ANSI/AHRI Standard 1500-2015.

3.2.2. Burners for Oil-Fired Commercial Packaged Boilers. In addition to section C3.3 of Appendix C of ANSI/AHRI Standard 1500-2015, the following applies: for oil-

fired commercial packaged boilers, test the unit with the particular make and model of burner as certified by the manufacturer. If multiple burners are specified in the certification report for that basic model, then use any of the listed burners for testing.

3.2.3. Non-condensing Commercial Packaged Boiler Water Temperatures. For tests of non-condensing boilers (as defined in section 3.2.5 of ANSI/AHRI Standard 1500-2015; maintain the outlet temperature measured at Point C in Figure C9 to 180 °F ± 1 °F and maintain the inlet temperature measured at Point B at 140 °F ± 1 °F during the "Warm-up Period" and "Test Period" as verified by 30-second interval data pursuant to Table 3.1. of this appendix. If the commercial packaged boiler cannot be tested at the standard inlet water temperature of 140 °F ± 1 °F at Point B, as indicated in the manufacturer literature, test the equipment at the temperature closest to the standard 140 °F ± 1 °F that the equipment is capable of operating, as indicated in the manufacturer literature. Field tests are exempt from this requirement and instead must comply with the requirements of section 3.2.3.1 of this appendix.

3.2.3.1. For field tests, the inlet temperature measured at Point B in Figure C9 and the outlet temperature measured and Point C in Figure C9 of ANSI/AHRI Standard 1500-2015 must be recorded in the data underlying that model's certification pursuant to § 429.71 of this chapter, and the difference between the inlet (measured at Point B) and outlet temperature (measured at Point C) must not be less than 20 °F at any point during the "Warm-up Period" and "Test Period," after stabilization has been achieved, as indicated by 30-second interval data pursuant to Table 3.1. of this appendix.

3.2.4. Condensing Commercial Packaged Boiler Water Temperatures. For tests of condensing boilers (as defined in section 3.2.2 of ANSI/AHRI Standard 1500-2015; maintain the outlet temperature measured at Point C in Figure C9 to 120 °F ± 1 °F, and maintain the commercial packaged boiler inlet temperature to 80 °F ± 1 °F during the "Warm-up Period" and "Test Period" as verified by 30-second interval data pursuant to Table 3.1. of this appendix. If the commercial packaged boiler cannot be tested at the standard inlet water temperature of 80 °F ± 1 °F at Point B, as indicated in the manufacturer literature, test the equipment at the temperature closest to the standard 80 °F ± 1 °F that the equipment is capable of operating, as indicated in the manufacturer literature. Field tests are exempt from this requirement and instead must comply with the requirements of section 3.2.4.1 of this appendix.

3.2.4.1. For field tests, the inlet temperature measured at Point B in Figure C9 and the outlet temperature measured and Point C in Figure C9 of ANSI/AHRI Standard 1500-2015 must be recorded in the data underlying that model's certification pursuant to § 429.71 of this chapter, and the difference between the inlet (measured at Point B) and outlet temperature (measured at Point C) must not be less than 20 °F at any point during the "Warm-up Period" or "Test Period," after stabilization has been achieved, as verified by 30-second interval data pursuant to Table 3.1. of this appendix.

3.2.5. Air Temperature. Maintain ambient room temperature at 75 °F ± 5 °F at all times during the "Warm-up Period" and "Test Period" (as described in section C4 of Appendix C of ANSI/AHRI Standard 1500-2015; as indicated by 30-second interval data pursuant to Table 3.1. of this appendix. The ambient room temperature may not differ by more than ± 2 °F from the average ambient room temperature during the entire "Test Period" at any reading. Field tests are exempt from this requirement, but ambient room temperature must be recorded (using 30-second

interval data) as part of the test data underlying that model's certification pursuant to § 429.71 of this chapter.

3.2.6. Ambient Humidity. Maintain ambient room relative humidity at 60 percent ± 5 percent relative humidity at all times during both the "Warm-up Period" and "Test Period" (as described in section C4 of Appendix C of ANSI/AHRI Standard 1500-2015; as indicated by 30-second interval data pursuant to Table 3.1. of this appendix. Field tests are exempt from this requirement, but ambient room relative humidity must be recorded (using 30-second interval data) as part of the test data underlying that model's certification pursuant to § 429.71 of this chapter.

3.3. Test Method.

3.3.1. General. Conduct the combustion efficiency test using the test method prescribed in section C4.1 "Thermal Efficiency," of Appendix C of ANSI/AHRI Standard 1500-2015. Do not use section C4.2.1 of ANSI/AHRI Standard 1500-2015 and make the following exceptions:

3.3.1.1. The duration of the "Test Period" outlined in sections C4.1.1.2 of Appendix C of ANSI/AHRI Standard 1500-2015 (incorporated by reference, see §431.85) and C4.1.2.2 of Appendix C of ANSI/AHRI Standard 1500-2015 is 30 minutes.

3.3.1.2. In section C4.1.1.1.2 of Appendix C of ANSI/AHRI Standard 1500-2015, replace "Section 5.3.5" with "Section 5.3.6."

3.3.2. Steam Test Steady-State. Replace section C4.1.1.1.4 of ANSI/AHRI Standard 1500-2015 with the following: Ensure that a steady-state is reached by confirming that three consecutive readings have been recorded at 15-minute intervals that indicate that:

3.3.2.1. The measured fuel input rate does not vary by more than ± 2 percent between any two readings; and

3.3.2.2. The steam pressure varies by no more than ± 5 percent between any two readings.

3.3.3. Water Test Steady-State. Replace section C4.1.2.1.5 of ANSI/AHRI Standard 1500-2015 with the following: Ensure that a steady-state is reached by confirming that three consecutive readings have been recorded at 15-minute intervals that indicate that the measured fuel input rate does not vary by more than ± 2 percent between any two readings.

3.3.4. Procedure for the Measurement of Condensate for a Condensing Commercial Packaged Boiler. Collect flue condensate as specified in section C4.2.2 of Appendix C of ANSI/AHRI Standard 1500-2015 using a covered vessel so as to prevent evaporation. Measure the condensate from the flue gas during the "Test Period." Flue condensate mass must be measured within 5 minutes after the end of the "Test Period" (defined in C4.1.1.2 and C4.1.2.2 of ANSI/AHRI Standard 1500-2015; to prevent evaporation loss from the sample. Determine the mass of flue condensate for the "Test Period" by subtracting the tare container weight from the total weight of the container and flue condensate measured at the end of the "Warm-up Period."

3.3.5. Total Fuel Input. In sections C4.1.1.2.3 and C4.1.2.2.3 of ANSI/AHRI Standard 1500-2015, do not use the last sentence which reads: "The total Heat Input measured during the Test Period shall be within ± 2% of the boiler Input Rating."

3.4. Calculations.

3.4.1. General. Use the calculation procedure for the combustion efficiency test specified in section C7.3 of Appendix C (including the specified subsections of C7.2) of

ANSI/AHRI Standard 1500-2015. If a recirculating loop is used, use the temperature at Point A for the inlet water temperature for all calculations.

3.4.2. Adjustment to Steady-State Flue Temperature for Using Steam Mode Combustion Efficiency to Represent Hot Water Mode. For commercial packaged boilers with fuel input rate greater than 2,500,000 Btu/h and using combustion efficiency in steam mode to represent combustion efficiency in hot water mode pursuant to § 429.60(a)(5) through (6) of this chapter, adjust the steady-state stack temperature $T_{F,SS}$ (as defined in section C6 of ANSI/AHRI Standard 1500-2015; using the following equation before calculating combustion efficiency. Replace $T_{F,SS}$with $T_{F,SS,adjusted}$ as calculated below for all calculations in deriving combustion efficiency.

$$T_{F,SS,adjusted} = T_{F,SS} - T_{sat} + 180$$

Where:

$T_{F,SS,adjusted}$ is the adjusted steady-state flue temperature used for subsequent calculations of combustion efficiency,

$T_{F,SS}$ is the measured steady-state flue temperature during combustion efficiency testing in steam mode,

T_{sat} is the saturated steam temperature from Table D1 in Appendix D of ANSI/AHRI Standard 1500-2015 that corresponds to the measured steam pressure, and

180 is the required hot water outlet temperature pursuant to section 3.2.3.

3.4.3. Rounding. Round combustion efficiency to nearest one tenth of a percent. Round fuel input rate to nearest 1,000 Btu/h.

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